Report of the NRCB/CEAA Joint Review Panel
Application #9601 – Alberta Public Works, Supply and Services
May 1998

Little Bow Project/Highwood Diversion Plan
Application to Construct a Water Management Project to Convey and Store Water Diverted from the Highwood River

NRCB
Natural Resources Conservation Board

Alberta
GOVERNMENT OF ALBERTA

Canadian Environmental Assessment Agency
Agence canadienne d'évaluation

Canada

LITTLE BOW PROJECT/HIGHWOOD DIVERSION PLAN
APPLICATION TO CONSTRUCT A WATER MANAGEMENT PROJECT TO CONVEY AND STORE WATER DIVERTED FROM THE HIGHWOOD RIVER

NRCB Application #9601

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TABLE OF CONTENTS:

LIST OF MAPS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1. INTRODUCTION

This report incorporates the Panel's decisions and recommendations on matters that fall within the jurisdiction of both the Natural Resources Conservation Board (NRCB) and the federal *Canadian Environmental Assessment Act (CEAA)*.

1.1 Joint Review Panel

The *Natural Resources Conservation Board Act* (*NRCBA*) created a Board

> ...to provide for an impartial process to review projects that will or may affect the natural resources of Alberta in order to determine whether, in the Board's opinion, the projects are in the public interest, having regard to the social and economic effects of the projects and the effect of the projects on the environment.

The *NRCBA* defines which types of projects are subject to review. A reviewable project cannot be commenced unless the NRCB, has granted an approval for the project. The Regulations under the act require a review of water management projects that involve construction of a dam more than 15 m (49 feet [ft]) high or a canal or diversion capable of conveying more than 15 cubic metres (m) of water per second (cms) (530 cubic feet per second [cfs]). The proposed development is reviewable under the act, because the dam heights for the Little Bow River Reservoir and the expanded Squaw Coulee Reservoir each exceed 15m (49 ft).

The legal requirements for the federal *Canadian Environmental Assessment Act* (*CEAA*) apply to proposals:

- undertaken directly by the federal government;
- for which the federal government makes a financial commitment;
- are located on federally administered land; or,
- where the federal government has licencing, permitting or approving authority which enable the project to be carried out in whole or in part.

The *CEAA* is to be applied early in the planning process and before irrevocable decisions are taken. Where adverse environmental effects are potentially significant, or where public concern warrants, the decision-making department shall refer the proposal to the federal Minister of the Environment for public review by a panel.

Under the *CEAA*, Fisheries and Oceans Canada assumed the role of Responsible Authority. They also initiated a comprehensive study of the proposed project. While the comprehensive study was in progress, on January 10, 1997, the Minister of Fisheries and Oceans referred the proposal to the Federal Minister of the Environment for a public review by an environmental assessment panel pursuant to subsection 21(b) of the *CEAA*. When making this request for a panel review, the Minister of Fisheries and Oceans noted concerns about potential environmental effects and effects on lands and traditional values of First Nations.

The Minister of Fisheries and Oceans further requested that the Minister of the Environment enter into a joint public review of the project with the NRCB. On March 14, 1997 the Canadian Environmental Assessment Agency confirmed it would participate in a Joint Federal/Provincial Review.

In May 1997, the NRCB and the Canadian Environmental Assessment Agency (the Agency) entered into an agreement for the operation of a Joint Review Panel for the Little Bow Project/Highwood Diversion Plan Water

Management Project. The agreement covers the constitution of the Panel, cost-sharing arrangements and the conduct of the proceedings, as well as other administrative issues related to the operation of the Panel.

A Joint Review Panel consisting of Ken Smith (Chair), George Kupfer and Susan Nelson was established to review the Little Bow Project/Highwood Diversion Plan. The Panel will act as a division of the NRCB under the *NRCBA* and as a *CEAA* review panel as detailed in the Terms of Reference for the Panel (Appendix A) issued under the *CEAA*. Each member of the Panel has been appointed both to the division of the NRCB constituted to consider the application in accordance with the provisions of the *NRCBA*, and to the review panel established by the Minister of the Environment in accordance with the *Canadian Environmental Assessment Act*.

This report incorporates the Panel's deliberations on matters within the jurisdiction of both the *NRCBA* and the *CEAA*. On matters that fall within NRCB jurisdiction, an approval, subject to the authorization of the Lieutenant Governor in Council, is required if the proposed project is to proceed. Any conditions attached to an NRCB approval are binding. On matters that fall within federal jurisdiction, the Panel will submit any recommendations to the federal Minister of the Environment and to the responsible authority, Fisheries and Oceans Canada.

In its examination of the issues, the Panel will take into consideration all aspects of the two distinct areas of jurisdiction, federal and NRCB, and this will enable the process to be streamlined. For example, if the Panel concludes, on a preliminary basis, that a certain condition would be a necessary component of any approval issued in accordance with the *NRCBA*, the Panel could consider the effects from both an NRCB perspective and a *CEAA* perspective, as though the project were to incorporate such a condition. Having stated this, the Panel will not make continuous distinctions throughout this report between the powers and mandates of each jurisdiction. The Panel will make reference to its conclusions in a fashion that should be clear to all parties.

1.2 The Little Bow Project/Highwood Diversion Plan

Alberta Public Works, Supply and Services (APWSS or the Applicant) requests approval to construct a water management project (the Project) to convey and store water diverted from the Highwood River. The Project consists of four interrelated components, which are shown in Map 1-1.

1.2.1 Little Bow River Reservoir

The Little Bow River Dam and Reservoir would be constructed in the Municipal District of Willow Creek No. 26 and in the County of Vulcan No. 2, approximately 20 kilometres (km) (12 miles [mi]) west of Champion. The proposed $38.8 million dam would be 25 m (82 ft) high and create a reservoir that would hold 61,675 cubic decametres (dam^3) (50,000 acre feet [ac-ft]) of water. It would be filled from the natural runoff in the Little Bow River basin and water diverted from the Highwood River.

1.2.2 Highwood Diversion Works and Canal

A canal and diversion works would be created in the Town of High River and through the Municipal District of Foothills No. 31. This proposed $6.2 million component would triple the capacity of the existing canal

from 100 cfs to 300 cfs (2.83 cms to 8.50 cms) to allow more water to be diverted from the Highwood River to the Little Bow River during peak flows.

1.2.3 Clear Lake Diversion Works and Canal

The proposed $5.1 million Clear Lake diversion and canal would be constructed in the Municipal District of Willow Creek, about 15 km (9 mi) east of the Town of Stavely. The 10 km (6 mi) long canal would allow the lake and 12 wetlands along the route to be filled from natural spring runoff when flows in Mosquito Creek are high or from water diverted from the Highwood River during peak flows.

1.2.4 Expansion of Squaw Coulee Reservoir

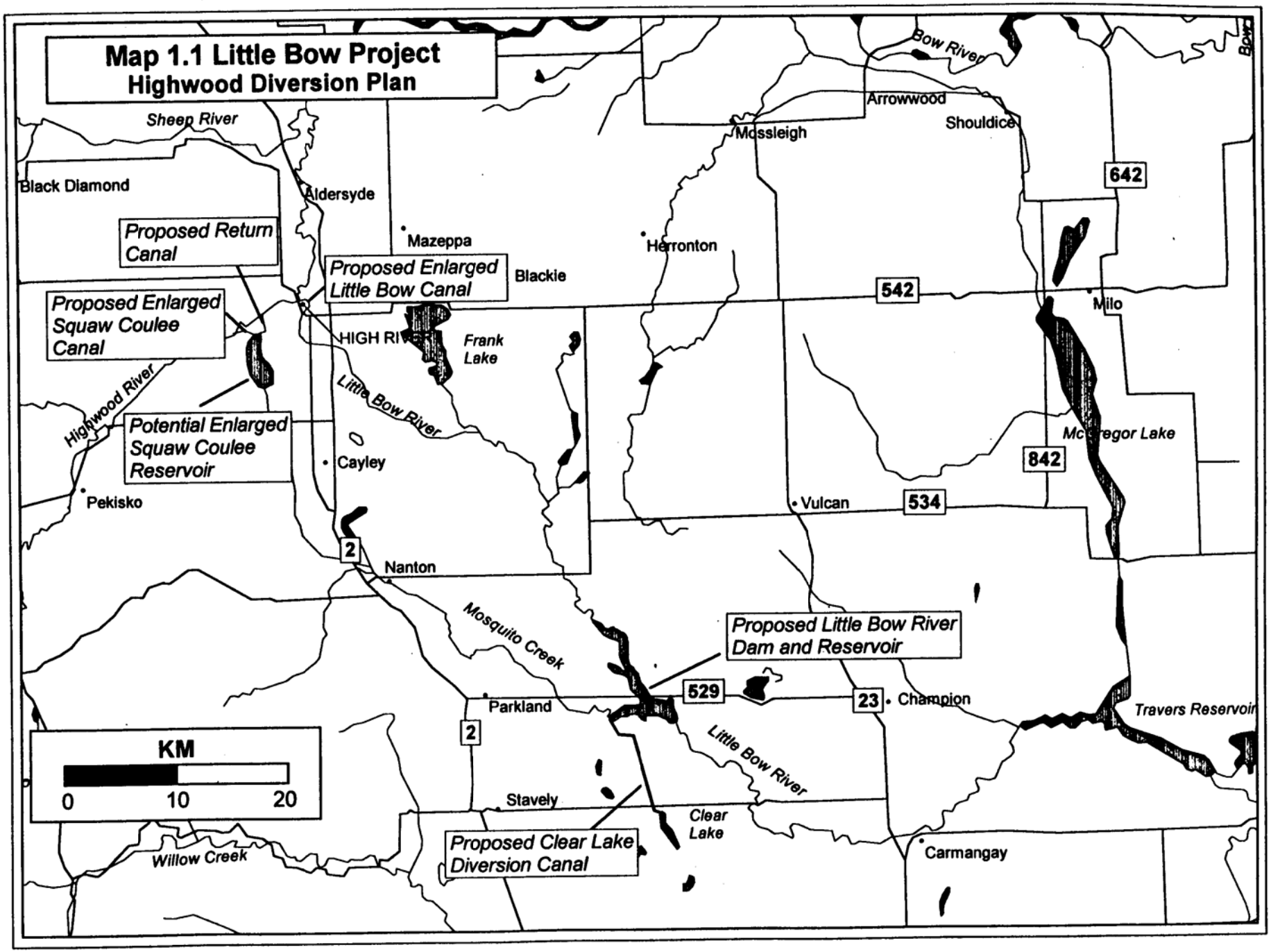
The existing Squaw Coulee Reservoir in the Municipal District of Foothills No. 31 would be enlarged from 361 dam^3 (293 ac-ft) to 6283 dam^3 (5,175 ac-ft) at a cost of $7.1 million by constructing upper and lower dams and a 0.65 cms (23 cfs) return canal to the Highwood River.

1.2.5 The Highwood Diversion Plan

The Highwood Diversion Plan is the proposed operating plan for the proposed water management structures described above, and for the existing Squaw Coulee Diversion. The plan is based on an assessment of the flows required to service the existing and projected licence demands and other consumptive demands in the Highwood and Little Bow river basins and to protect the aquatic resources of the Highwood River.

No change is proposed for the Highwood River diversion to the Little Bow Canal of 0.57 cms (20 cfs) for the winter months (October 15 to April 15). Throughout the rest of the year, the diversions vary from a minimum of 0.28 cms (10 cfs) to a maximum of 8.50 cms (300 cfs) subject to meeting the Highwood River Instream Flow Needs (IFN). Diversions greater than 0.28 cms (10 cfs) would commence with spring runoff on the Highwood River, normally in early May, and cease by late July.

There would be no diversion from the Highwood River through the Squaw Coulee Diversion from early October to the end of April. The minimum diversion would be 0.28 cms (10 cfs) throughout the summer. The maximum diversion would be 1.70 cms (60 cfs) and would be subject to meeting the Highwood IFN. The pattern of diversion would be similar to that of the Little Bow Canal. Diversion would start in May, and apart from maintenance of minimum diversions, would generally end in late July.


Map 1.1 Little Bow Project
Highwood Diversion Plan
Sheep River
Black Diamond
Aldersyde
Proposed Return Canal
Mazeppa
Herronton
Proposed Enlarged Little Bow Canal
Blackie
Proposed Enlarged Squaw Coulee Canal
HIGH RIVER
Frank Lake
Highwood River
Little Bow River
Potential Enlarged Squaw Coulee Reservoir
Cayley
Pekisko
Nanton
Mosquito Creek
Parkland
Stavely
Willow Creek
Proposed Clear Lake Diversion Canal
Clear Lake
Proposed Little Bow River Dam and Reservoir
Bow River
Arrowwood
Shouldice
Massleigh
642
542
Milo
Mcgregor Lake
842
Vulcan
534
529
23
Champion
Travers Reservoir
Carmangay
KM
0
10
20
2
2

Operations of the Little Bow River Reservoir would vary significantly from year to year in response to flow conditions and water demands. In most years the reservoir would fill by mid-May. The reservoir would remain full throughout June and levels would gradually start to drop until late September. A succession of dry years could result in drawdowns of as much as 13.9 m (45.5 ft) and there would be years when the reservoir would not completely fill.

The Clear Lake Diversion would be operated from mid-April to mid-September when water would be diverted to bring Clear Lake to its full supply level (FSL) and offset withdrawals and evaporation. Maximum diversions from Mosquito Creek would be 1.70 cms (60 cfs). Clear Lake would normally fill by late May and remain full through June and into July. Levels would then drop gradually until mid-September. In approximately 75 per cent of the years, the drawdown would be less than 1 m (3.3 ft), and would never exceed 2 m (6.6 ft).

The expansion of Squaw Coulee and the construction of a return canal to the Highwood River would provide the ability to release water back to the Highwood River. Reservoir operations would vary considerably from year to year depending on river flows and water demands. Normally, filling would start in mid-April with water being diverted from the Highwood River up to the maximum 1.70 cms (60 cfs), depending on the Highwood River IFN. The reservoir capacity would reach FSL by early June and would remain constant until late July or early August when releases would be required to meet licensed demands on Mosquito Creek or the IFN of the Highwood River. Reservoir levels would normally drop until late September or early October. Some refilling of the reservoir would often occur in the autumn when consumptive demand decreases. Reservoir levels would remain relatively constant throughout the winter. Average drawdown of reservoir levels over the summer would be less than 2 m (6.6 ft), but on occasion would exceed 10 metres (32.8 ft).

The operation of the proposed water management facilities are described in more detail In Appendix G.

1.3 Review Process

In December 1988, the Alberta Minister of the Environment announced that an environmental impact assessment (EIA) was required for the Little Bow Project/Highwood Diversion Plan. APWSS filed an application, which included the EIA, with the Natural Resources Conservation Board in May 1996, to obtain approval under section 5(1) of the *NRCBA*.

In addition to applying to the NRCB, APWSS applied to Fisheries and Oceans Canada on May 9, 1996 under section 5(1) of the *Navigable Waters Protection Act* for approval of three individual water management components of the Project comprising the proposed Little Bow Project/Highwood Diversion Plan, and the fourth involving the Squaw Coulee component. On August 19, 1996 the Applicant also applied to Fisheries and Oceans Canada under section 35(2) of the *Fisheries Act* for authorization to construct works affecting fish habitat associated with the Project.

A Pre-Hearing Conference dealing with procedural and preliminary matters was held on June 3 and 4, 1997, in High River, Alberta. On July 8, 1997 the Panel issued a Report of the Pre-Hearing Conference. Copies of this report are available from the NRCB's office.

A public hearing commenced on 12 November 1997 and concluded 9 January 1998 in the Town of Vulcan. During the 19 hearing days, including three sitting days in the Town of High River, the Panel heard the views of a number of participants and received a total of 378 exhibits.

Public consultation is a key element in the Joint Panel Review process. Public consultation allows the public to be informed at an early stage of the existence of the project. The Applicant established public advisory committees for the Little Bow Project and the Highwood Instream Flow Needs process (part of the Highwood Diversion Plan). In addition, the Applicant conducted public meetings, group meetings and open houses to discuss various aspects of the Project/Plan. Newsletters and media releases were also used by the Applicant to inform the public. With the exception of certain individuals affected by the Squaw Coulee component, the Panel is satisfied that potentially affected individuals, groups and communities were well informed and had the opportunity to become involved at the project design stage.

Prior to the Pre-Hearing Conference the Panel initiated an issue-focused approach to the review of this project. The Panel pursued early disclosure and sharing of information between participants so time spent at the hearing could focus on those issues that are critical to the Panel's mandate. In particular the Panel recognized a need to focus on project-related effects that are likely to be significant. Prior to the Pre-Hearing Conference the Panel directed the Panel Secretariat to conduct meetings with municipalities and the public to facilitate effective participation. The issue focused approach was incorporated in the Panel's report on the Pre-hearing Conference. One example of this may be found in the Panel taking notice of the Proponent's undertaking to ensure that those living in the vicinity of the Squaw Coulee component of the proposed project were informed about the nature of this project component.

1.4 Report Framework

In examining the Application, the Panel has had regard for the substantial amount of evidence tendered by the various participants. In identifying the effects of a complex project such as this, the Panel believes that it should properly assess a number of matters which relate to the context of the social, economic and environmental issues of the various project components. Participants in the hearing raised a number of matters related to public policy and jurisdiction, as well as other preliminary matters related to the adequacy of the evidence tendered during the hearing. The Panel is of the opinion that it should first consider:

- Policy framework
- Jurisdiction
- Sufficiency of information

The Panel believes that it must then consider, in some detail, the justification or need for the proposed project, including:

- The origins of the proposal
- The alternatives to and within the project
- The ability of the Applicant to implement the proposed project
- The economic viability of the proposed project

The Panel is aware of the need to consider cumulative effects, ecosystem integrity and sustainable development. This requires that instream flow needs and water management planning must be examined before proceeding to consider the effects of the project. The Panel will therefore consider:

- The background of water management in the Highwood and Little Bow basins
- The water management policies and diversion plans

- Baseline conditions at the time of the proposed project
- The Water Management Resources Model
- The proposed diversion plan

In stating its views, the Panel has adopted a sustainable development frame of reference and will focus on:

- The Project's effects in the context of sustainable development
- The need for water storage in the Highwood basin
- The ability of the operating plan to achieve the basic criteria of a sound water management project

Under the jurisdiction of both the *CEAA* and the *NRCBA*, the Panel intends to review all the relevant environmental effects of the project of interest to both Alberta and Canada. In assessing the social and economic effects of the project, the Panel will examine those effects primarily in relation to the Alberta public interest. Social and economic effects that arise from environmental effects of the proposed project will be examined to determine their relevance to both Alberta and Canada.

The Decision Report will specifically address the following:

Environmental effects including:
- Public concerns about water quality and sources of pollution
- Project effects on aquatic habitat and fish
- Prairie environments including vegetation and wildlife
- Impacts on soils and land capability

Social effects including:
- Effects on the Little Bow Hutterian Brethren
- Transportation
- Municipal, domestic and irrigation water users
- Recreational water use
- Municipal sewage and wastewater disposal
- Navigation
- Land use and planning
- Public safety issues
- Treaty 7 Aboriginal interests and concerns
- Public participation

Economic effects:
- Project construction and operating costs
- Irrigation benefits and costs
- Other benefits and costs
- Economic impact

The Applicant made the following specific request with respect to the Board's public interest determination:

"The proponent believes that the Little Bow Project is in the public interest and seeks an approval of the Board in relation to same. APWSS does not currently propose to build the enlarged Squaw Coulee component but believes that the Expanded Project which includes the Little Bow Project and the

Squaw Coulee component may be in the public interest. Consequently, APWSS seeks further Board approval for the Expanded Project. If the Board finds that the Little Bow Project and the Expanded Project are both in the public interest, the proponent seeks a Board recommendation as to which project is preferable with reasons."

TABLE 1.1 Key events in the review process for the Little Bow Project/Highwood Diversion Plan

DATE	EVENT
1996	
March 7	The NRCB sent the Applicant (APWSS) a response based on a review of the Environmental Impact Assessment the Applicant circulated for public comment.
May 7	The NRCB received Application #9601. *Preliminary Notice of Application* issued.
May 27	The NRCB conveyed a *Preliminary Request For Supplemental Information* to APWSS with respect to the Application.
July 26	Applicant's response to the *Preliminary Request For Supplemental Information*.
October 29	The NRCB conveyed the principal *Request for Supplemental Information* to APWSS. Questions were identified through the NRCB's internal review and the interdepartmental review of the EIA coordinated by Alberta Environmental Protection.
November 5	*Notice of Pre-Hearing Conference* issued. Parties were requested to register their interest in the Pre-Hearing Conference with the NRCB by December 6, 1996.
1997	
January 10	Minister of Fisheries and Oceans requests Minister of the Environment to establish a Joint Review Public Panel for the Little Bow Project/Highwood Diversion Plan.
January 29	Alberta Cabinet Order in Council provides approval for the NRCB to enter into a joint review with the Canadian Environmental Assessment Agency (CEAA).
March 14	CEAA announces it will participate in a joint federal-provincial review of the Application.
March 24	The draft Administrative Agreement for the Joint Review Panel, including proposed Terms of Reference and the *Federal Participant Funding Program* are advertised.
April 22	APWSS filed completed response to the October 29 *Request for Supplemental Information.*
April 25	Letter to Registered Participants announcing a Pre-Hearing Conference to be held on June 3 & 4, 1997.
May 12	Signing of Administrative Agreement for Joint Review Panel.
May 15	Press release regarding Appointment of Panel by Federal Minister of the Environment.
May 15	Pre-Hearing Information Session held, Highwood Memorial Centre, High River.
May 26	Deadline for Pre-Hearing Conference written submissions.
June 3 & 4	Pre-Hearing Conference held, Highwood Memorial Centre, High River, Alberta.
June 23	Alberta Environmental Protection confirms EIA sufficient to proceed to public review.
November 12	Public Hearing commences for NRCB/CEAA Joint Review
1998	
January 9	Public Hearing concludes in Vulcan, Alberta.

The Panel will make its decision as to whether the proposed project is in the public interest based on its conclusions respecting the various effects, including cumulative effects, that would result. As with any major project, some effects may be beneficial and some may be adverse to the public interest. The Panel will make any recommendations on the environmental effects of the proposed project on areas within federal jurisdiction. Should the Panel be prepared to approve the Application, it will also identify any conditions that it believes are required to ensure that the proposed project is in the Alberta public interest.

2. POLICY FRAMEWORK, JURISDICTION AND PRELIMINARY MATTERS

Diversions of water from the Highwood River to the Little Bow River can be traced back to an 1898 application submitted by the Government of the North-West Territories under the *North-West Irrigation Act*, to augment flows in the Little Bow River for both domestic and stockwatering purposes. The works for this diversion, which were capable of diverting 1.42 cms (50 cfs), were licensed in 1905. In 1922 the Little Bow Irrigation District (LBID) submitted an application and received a licence for a water diversion sufficient to irrigate 1335 hectares (ha) (3300 acres) through the construction of new works. The LBID entered into an agreement with Alberta in 1922 wherein the LBID's works would deliver the 1.42 cms (50 cfs) the Crown was entitled to under the 1905 licence in addition to the quantity the LBID required to satisfy its irrigation areas.

Following the construction of the works, the LBID experienced financial difficulties and was dissolved. A 1950 Order-in-Council dissolving the LBID transferred ownership and operation of the diversion works and specified that the authorizations pertaining to the LBID are transferred to the Crown. The Order-in-Council recognized the works served to provide water for domestic purposes in addition to water for irrigation needs. The Crown then assumed operation of the works and, subsequently, attended to necessary repairs and improvements. The Crown was not bound by the *Water Resources Act* until 1971.

The works that are currently in place serve the purposes set out in the applications for the 1905 and 1922 authorizations. That is, the Crown operates the current works, consisting of a headworks diversion structure and canal, to divert water from the Highwood River to augment the natural flows in the Little Bow River for domestic and irrigation purposes. The current Little Bow Diversion has a capacity of 2.83 cms (100 cfs) and, according to the Controller of Water Resources, a recognized priority dating back to 1921.

Construction of the existing diversion works from the Highwood River to Mosquito Creek was authorized in 1934 with an initial capacity of 0.71 cms (25 cfs). An application was filed in 1949 for the construction of a dam to establish the Squaw Coulee Reservoir. The dam was constructed in accordance with an interim licence issued in December, 1949. In 1977, the Department of Environment assumed the operation, maintenance and ownership of the diversion and dam. In 1979 the diversion was licenced to a total capacity of (1.70 cms) 60 cfs.

The Little Bow Water Users Association was formed in 1979 to promote increased and more secure water supplies for irrigated agriculture, industry and recreation in the Little Bow watershed. Presentations were made to the Ministers of Agriculture and Environment on water supply concerns and future water needs. Alberta Environment (AE, which in 1993 became Alberta Environmental Protection [AEP]) initiated a planning study in July, 1982 which was conducted in two phases. Phase I included an analysis of water supply, water demand and water quality, and identified problems and conflicts. Options for resolving problems and conflicts were identified and reviewed, culminating in the Phase I report (AE 1985). The Executive Summary of the Phase I report gave insight into future water management measures by stating that:

> "Ongoing investigations will be conducted in the short term to confirm the feasibility and cost of storage in the Little Bow basin to secure a reliable supply for existing needs and to provide for a modest level of irrigation expansion. The present moratorium on issuing of irrigation licenses will remain in effect until such time as measures may be taken to improve supply."

The Phase II study (AE 1986) investigated the feasibility of storage development at several locations in the Little Bow River basin. Engineering, economic, environmental and social factors were considered in this study. The Phase II report concluded that:

> "The study confirms that storage development would provide secure water supply to meet existing irrigation and municipal needs, allow considerable irrigation expansion, and at the same time, permit higher instream flows along the lower reaches of the Highwood River to improve fish habitat and water quality conditions over those of recent years.
>
> Site 7B1 on the Little Bow River downstream of the confluence with Mosquito Creek is the preferred location for storage development considering engineering, economic, social, and environmental factors. Three sizes of storage development at Site 7B1 were considered; 30,000 ac-ft, 50,000 ac-ft, and 70,000 ac-ft.
>
> Deliberations on the appropriate size of storage development should consider available funds, the level of irrigation expansion desired, the minimum flow requirement on the Highwood River, and the possibility of upsizing the Little Bow Diversion Canal at some future date."

On December 16, 1988 the Government of Alberta announced a decision to implement the Little Bow Project (AE 1988). The principal purpose of this project is to store spring run-off in the Highwood River and the Little Bow River systems for later use in the Little Bow River basin during low flow periods. This would provide an opportunity to improve water quality and fish habitat in the Highwood River by reducing diversions during low flow periods, while still providing a secure water supply for water users in the Little Bow River basin.

Although general operating concepts had been established at the time the project was announced, detailed plans for management of the waters in both basins still had to be formulated. Of particular concern was maintenance of the natural environment of the Highwood River. While planning studies to establish instream flow needs (IFN) for the Highwood River began in 1983, the comprehensive program needed to develop the proposed Diversion Plan began in 1989.

The Instream Flow Needs Task Force, an inter-departmental group charged with developing and implementing a process for determining IFN in the province, formed the Bow River Working Group (BRWG) to determine the IFN for the Highwood River. At this early stage of IFN development, the IFN technology and terminology were in an early developmental stage. The BRWG formed a Highwood River Public Advisory Committee (PAC) in 1990 to facilitate public input to the determination of IFN. The PAC in turn spawned a smaller group, the Technical Subcommittee (TSC) consisting of 10 stakeholders with an interest in IFN and an understanding of the IFN process. The formation of the TSC facilitated public input to the determination of the IFN. This process resulted in the establishment of an IFN for the Highwood River in 1991, and this formed the cornerstone of the Highwood River Diversion Plan completed in April 1993.

2.1 Management of Water Resources in Southern Alberta

In Alberta, a variety of provincial and federal legislation, regulations, policies and agreements govern water management. These have some bearing on the proposed project and are relevant to the Panel's review of the Application. These include the *Water Resources Act (WRA)* and new *Water Act*, the Prairie Provinces Water Board Apportionment Agreement, the South Saskatchewan River Basin Policy (SSRB Policy), the South Saskatchewan Basin Water Allocation Regulation (A.R. 307/91), the *Navigable Waters Protection Act* and the *Fisheries Act*. These are each described in the sections below.

Approvals of the proposed project are required from various regulatory authorities established under water management and related legislation. The Panel has sufficient understanding of the regulatory role of these authorities to reach a decision as to the public interest in the proposed project, while at the same time avoiding any unnecessary fettering of the discretion of those regulatory authorities. Under other statutes, such as the *Water Resources Act* or the *Fisheries Act*, approving authorities could have regard to the Panel's decisions and recommendations in making any decision to grant an approval. When they consider it appropriate to do so under the relevant statute, those authorities may also impose the same or similar conditions in their approvals as those included in an NRCB approval.

Should the proposed project proceed, the Applicant is obligated to meet the conditions imposed by all approving authorities. To the extent that the conditions and recommendations to be imposed by various authorities are based on the same information and have the same effect, the obligations of the Applicant will be clearly defined. The Panel will have regard for the jurisdiction of other regulatory authorities and will be mindful of the public interest in avoiding unnecessary duplication of regulatory conditions and avoiding, if possible, conditions and recommendations that could lead to conflict with other regulatory requirements.

The Panel also notes the nature of the consideration of the public interest, as required by its mandate, is to have regard for social, economic and environmental effects. Any conditions the Panel may impose would be those required to ensure the public interest, should the proposed Project proceed. The Panel acknowledges that it does not have the ongoing regulatory responsibilities of certain other authorities. However, the Panel believes that it has the jurisdiction and responsibility to impose any conditions that are necessary to the public interest. Conditions applied to project approvals may result in the practical effect of limiting the Applicant's submissions for approval to other responsible authorities.

2.1.1 Water Resources Act and Regulations and the Water Act

In Alberta, the *Water Resources Act* governs the management of water resources. Water diversion is prohibited unless authorized under the act. The *WRA* sets out the procedure to be followed in acquiring a right to divert and use water, the conditions under which works for the diversion and use of water may be constructed, and the responsibilities and rights of those authorized under the act to divert and use water. The *WRA* also defines the powers of the Minister charged with the administration of the act, including the construction of works. The establishment of agreements with other jurisdictions for the management of water is also provided for within the act.

The Controller of Water Resources (the Controller) is the regulator who grants the right to consume or use water for various purposes or to construct works within the beds, banks or shores of streams and lakes according to the procedures specified in the *WRA*. The act requires that applications submitted to the Controller must provide sufficient detail to permit evaluation of the effect of the proposed works on the source of supply, other water users in the vicinity, and other lands and works. After public notification and review of the application, the Controller may grant an interim licence authorizing the construction of the proposed works, with any changes and variations, and subject to any conditions the Controller considers necessary. After completion of the project, the Controller issues a permanent licence to the applicant for the diversion and use of the water, subject to any terms and conditions the Controller prescribes through licences or permits.

The Dam Safety Regulations under the *WRA* place certain responsibilities on the owner/operator of water diversion works to ensure public safety. The Controller is also required to examine an application to divert and use water to determine conformity with this regulation.

Administration of the WRA is shared between the Controller and the Water Administration Branch, with delegated authority. While applications for licences to divert or use water are generally made to the Office of the Controller of Water Resources, issues related to the administration of the water resource and water quality are within the purview of the Water Administration Branch. The Water Administration Branch is charged with operation of the diversion structures licenced to AEP. Employees of the Water Administration Branch monitor water quality and engage in water mastering efforts to facilitate efficient operations within the restrictions imposed by the licenced uses. There has also been some recent delegation of the authority to grant water licences to individuals within the Water Administration Branch; however, the Controller remains the licensing authority for all applications made by the Crown.

APWSS has applied for specific licences or permits for the proposed project to divert and use water, pursuant to the *WRA*. They submitted the application and supporting plans for licences for the Little Bow Project/Highwood Diversion Plan to the Controller on 2 September, 1997. The application includes information for both the diversion of water from the Highwood River, and the impoundment of water on the Little Bow River and at Clear Lake. The Controller's Office is processing the applications and is awaiting a review and final decision by this Joint Panel before making a final decision with respect to these licences. In making his decision, the Controller may also consider other provincial water management policies and regulations, instream flow requirements, and the impact the proposed project may have on other water users in the Highwood and Little Bow River basins and on other lands and works.

Under the *WRA*, no construction of works is allowed until the appropriate authorizations have been received. In addition, no person may commence a reviewable project unless an approval under the *NRCBA* has been granted. The Board may order that no licence may be issued under any other enactment to any person with respect to a reviewable project, until such time as an approval in respect of the project has been granted under the *NRCBA*. In the view of the Panel, the consideration of applications pursuant to the *WRA* for licences to divert and use water associated with the proposed Project may be appropriate following the review.

The Panel is aware that the Province has a new *Water Act*, which is awaiting proclamation. This new act is intended to replace the *WRA* and will provide flexibility in the allocation of water and provide for transfers and partial transfers of water licences. The Panel has familiarized itself with the provisions of the new legislation and believes it must have regard for the provisions in the *Water Act* even though it is not yet the law in Alberta.

There are a number of issues that arise in the transition from the existing *WRA* to the *Water Act*. One key issue relating to this project is the status of licence applications submitted prior to the proclamation of the new act. Section 171 of the new act deals with applications for permits, licences or other authorities made under the *WRA*. It specifies that if a complete application was made under the *WRA*, and no decision has been finalized prior to proclamation of the new *Water Act*, the application continues as an application under the *WRA* as if it were still in force. The Controller has deemed that the licence applications submitted by APWSS are complete, and therefore any licences to be issued would be processed under the provisions of the *WRA* and the rights granted would be continued under the *Water Act*.

The right to divert and use water pursuant to the *WRA*, although a very important component of the Project, is only one of many features of the project before the Panel. The Panel has no jurisdiction to make a decision regarding approval of a licence to divert and use water pursuant to the *WRA*. The licensing responsibilities of the Controller as they pertain to the proposed project are responsibilities the Panel should have regard for in determining whether the proposed project is in the public interest. During the hearing, the Panel was provided specific evidence concerning the Controller's decision-making responsibilities regarding this project.

The Panel believes that its jurisdiction is much broader than some other regulatory authorities. The Controller's current jurisdiction appears to be limited to matters pertaining to water quantity, which may not extend to examination of water quality or other environmental effects, and apparently does not extend to examining social and economic effects. The Panel will have regard for the jurisdiction of the Controller of Water Resources and other similar authorities. The Panel has the jurisdiction to review the construction of the works and the effects of the proposed Diversion Plan.

The Panel views the proposed Diversion Plan as also being an integral part of the Application for an approval to construct the works outlined in the Application. The Panel heard evidence regarding the merits of the proposed operation of the facilities. It believes that any consideration of the public interest in relation to this water management project necessarily includes consideration of the effects of the Diversion Plan. In the event of an approval, the Panel may recommend or impose conditions on the Diversion Plan.

At this time the Panel believes it important to make a finding on a matter that arose during the hearing. It was submitted by one of the participants that the provisions of the *Water Resources Act* do not permit the attachment of conditions that would protect instream flow needs on irrigation licences. APWSS and the Controller took exception with that interpretation. On this matter the Panel will proceed on the basis that the conditions protecting instream flow needs may be attached to a licence.

2.1.2 Prairie Provinces Water Board Apportionment Agreement

Water management in Alberta takes place in the context of the larger river basins that originate in or flow through the province. The Little Bow Project/Highwood Diversion Plan project is located within the broad drainage of the South Saskatchewan River basin. This basin is included within the interjurisdictional arrangement signed by the three Prairie Provinces and the federal government as set out in the Prairie Provinces Water Board Apportionment Agreement of 1969. This agreement defines the apportionment of the flows of rivers crossing provincial boundaries. It is administered by the Prairie Provinces Water Board, which has membership from each of the governments affected.

Under the terms of the agreement, Alberta is permitted to use or store one-half of the total annual natural flows of the rivers in Alberta that comprise the South Saskatchewan River basin. One condition of the agreement is that Alberta can keep, for its consumption, a minimum of 2,600,000 dam^3 (approximately 2,100,000 ac-ft) annually from the South Saskatchewan River basin. A second condition is that the instantaneous flow of the river at the border cannot drop below 42.5 cms (1,500 cfs). For apportionment purposes, the Government of Alberta considers the South Saskatchewan River as a single basin. On average, the total basin flow is made up as follows: 21 per cent from the Red Deer River, 43 per cent from the Bow River, and 36 per cent from the Oldman River.

2.1.3 South Saskatchewan River Basin Water Management Policy

This policy was approved in May of 1990. It establishes how the Red Deer, Bow, Oldman and South Saskatchewan rivers will be managed in concert to ensure that the province's commitments under the Prairie Provinces Water Board Apportionment Agreement are met, and to best serve the needs of all water users in the basin and each sub-basin. Water licences and their priorities, as established by the dates of application, are to be respected under the policy. The policy sets out the basis for allowing irrigation expansion in the Red Deer, Bow and Oldman basins, based on the water supplies available. It requires that consideration be given to individuals and communities that withdraw water for their use. The SSRB Policy also incorporates the principle of multiple use which reflects the Government of Alberta's objective of managing water resources to meet diverse needs including domestic, municipal, agricultural, industrial, fisheries, wildlife, recreation, and aesthetic requirements.

The SSRB Policy also recognizes the importance of retaining water in the river for instream needs, including recreation, fisheries, wildlife and the maintenance of adequate water quality to sustain the riverine ecosystem, and contemplates minimum and preferred instream flows. Minimum flows are to be established for individual reaches of rivers and are to be maintained to protect basic water quality and instream needs. Preferred instream flows are to be established for individual river reaches to protect instream needs. During low run-off periods, it is recognized that water shortages will occur and instream flows will occasionally drop below the preferred level. On regulated streams, projects are to be managed so that the instream flows drop to minimum levels only for short periods of time under drought conditions. Under the policy, the province of Alberta will reserve water when a predetermined level of allocation to licenced users and to instream flow requirements has been reached. A system of preferential use is to be used to determine further allocations of water.

The SSRB Policy requires that a maximum water allocation for irrigation purposes in the Red Deer, Bow and Oldman basins be established with consideration for the requirements of all other uses. Irrigation is the largest consumptive use of water in southern Alberta. The policy recognizes the need to establish guidelines to limit irrigation expansion in the South Saskatchewan River basin, based on the water supplies available. The policy provides for irrigation expansion to take place throughout the South Saskatchewan River basin, including areas served by irrigation districts.

The SSRB Policy also considered the need for additional water storage in the basin. During the extensive public consultations that preceded the adoption of the policy, the Alberta Water Resources Commission received submissions regarding the need for additional storage. As a result, the policy specifically recommended that storage and flow control options and priorities be developed and implemented for the upper tributaries reaches, including the Highwood and Little Bow sub-basins, the Willow Creek sub-basin, and other comparable areas. Such storage was required urgently to reduce current irrigation risks, improve municipal supplies or create opportunities to expand irrigation.

2.1.4 South Saskatchewan Basin Water Allocation Regulation (A.R. 307/91)

The Government of Alberta established the South Saskatchewan Basin Water Allocation Regulation (A.R. 307/91) to establish maximum water allocations for irrigation purposes. Pursuant to Section 12 of the *WRA*, this regulation reserves all water in the South Saskatchewan River basin that is not the subject of an existing licence or other authorization, and it sets out the basis under which it may be allocated. The regulation establishes a potential allocation for up to 38,445 ha (95,000 acres) of irrigation expansion in the Bow River basin, and specifically includes 8,090 ha (20,000 acres) for the Little Bow/Clear Lake project. In the regulation, the Little Bow/Clear Lake project is defined to mean diversions from all or any of the Little Bow River between the proposed Little Bow River Reservoir and Travers Reservoir, the proposed Little Bow River Reservoir, and Clear Lake.

The regulation also provides that any licence issued, in accordance with the regulation, may contain conditions limiting the amount of water that may be diverted and used when it is necessary to maintain minimum instream flows. Instream needs are the water quantities and quality needed to maintain aquatic and riparian ecosystems. Depending on circumstances, it may not be possible to fully satisfy the water requirements for instream needs and meet other current allocations, and it therefore becomes necessary to set an instream objective.

As part of the SSRB Policy, the Government of Alberta indicated that the irrigation guidelines described in the regulation will be reviewed in the year 2000. This policy review was referred to as the Year 2000 Review of Irrigation Expansion Guidelines. APWSS advised the Panel that any of its recommendations concerning the proposed project that are pertinent to the assessment of the ultimate limit of irrigation for the South Saskatchewan basin will be considered as part of the Year 2000 Review. The Year 2000 Review may not have implications for the project based on APWSS's assessment that the project would not have significant impacts outside the project area.

The Panel is cognisant of the authority of the Lieutenant Governor-in-Council, pursuant to Section 12 of the *WRA*, to reserve water within the Bow River basin and the Oldman River basin and thereafter to authorize the allocation of water. The Panel agrees with the Applicant and AEP that public policy in the reservation and allocation of water in the Bow and Oldman River basins has been expressed in the South Saskatchewan Basin Water Allocation Regulation. The Panel notes in particular the allocation of water sufficient for the irrigation of an additional 8,090 ha (20,000 acres) of land associated with Little Bow/Clear Lake project pursuant to Section 5(2) of the regulation.

The Panel adopts the view that the reservation and allocation of water for irrigation expansion for the Little Bow/Clear Lake components is relevant to the review of the effects of the proposed project. The Panel's review will have regard for the regulation as expressing public policy in the current reservation and allocation of water in the Little Bow basin, as a part of the context when considering the effects of the Applicant's project. The Panel notes that the regulation sets a limit on the amount of water that would be available within the Little Bow basin for irrigation purposes.

In reviewing the proposed Project, the Panel will examine the degree to which the proposed Highwood River IFN meets the broad policy criteria established for the South Saskatchewan River basin and the generally accepted scientific basis for IFN. The Panel heard evidence on this matter from a number of parties, including the Applicant, AEP, Fisheries and Oceans Canada, Environment Canada and various local interveners.

2.1.5 Navigable Waters Protection Act

The proposed project is subject to the *Navigable Waters Protection Act (NWPA)*, and must be approved by Coast Guard Canada before it could commence. Under the *NWPA*, the Coast Guard is responsible for protecting the public right of navigation. Part I of the act regulates the construction of works built or placed in, on, over, under, through or across navigable waterways. The Coast Guard determined that the Little Bow River and Mosquito Creek are navigable, and that sufficient information must be filed to enable a determination of the application under the act.

The Panel has no jurisdiction to decide on an approval pursuant to the *NWPA*. The Panel will have regard for those matters that are relevant to that jurisdiction and may provide recommendations for consideration by the federal Minister. The Panel believes that its report and recommendations regarding the proposed Project are to be completed prior to the issuance of any navigable waters approvals. The *NWPA* has served as a trigger for the federal process in this case. That process ensures that all appropriate environmental effects associated with various aspects of federal jurisdiction will be examined prior to any substantive federal regulatory decisions being made regarding the Project.

2.1.6 Fisheries Act

Under the *Fisheries Act*, the Department of Fisheries and Oceans (DFO) has a responsibility to prevent the harmful alteration, disruption or destruction of fish habitat and to prevent the deposit of deleterious substances. DFO relies on the advice provided by Environment Canada regarding issues pertaining to water quality. In addition, the federal government has made special arrangements by which the day-to day management of the inland fisheries of Alberta is administered by Alberta. However, the Minister of Fisheries and Oceans remains responsible to Parliament for all provisions of the *Fisheries Act*, including the conservation and protection of fish and fish habitat.

Of particular relevance to this project is Section 35(1) of the *Fisheries Act* which states "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat". Subsection 35(2) qualifies that prohibition by explaining that the federal Minister of Fisheries and Oceans may authorize harmful alteration, disruption or destruction of fish habitat under prescribed conditions. One important condition is that losses to the productive capacity of habitat caused by a project must be balanced by gains elsewhere. This requirement is derived from DFO's Policy for the Management of Fish Habitat.

In reviewing project proposals under the Habitat Policy, DFO applies the no net loss principle, according to which DFO will strive on a project-by-project basis to maintain the productive capacity of habitats supporting fisheries resources. The habitat policy also places emphasis on integrated resource planning, public involvement in the decision-making process and in review of project proposals on an ecosystem basis.

The Panel accepts that implementation of the Project may impact the fisheries resources in the Highwood and Little Bow basins. The Panel has no jurisdiction pursuant to the *Fisheries Act*. However, the Panel will have regard for those matters that are relevant to that jurisdiction and may provide recommendations for consideration by the federal Minister of Fisheries and Oceans. The Panel notes that APWSS has sought an approval for the Project pursuant to Section 35(2) of the *Fisheries Act*. DFO advised the Panel of its interest and potential regulatory role in establishing an appropriate IFN.

2.2 Other Relevant Legislative and Policies

A number of public policies not specifically related to water management in southern Alberta, both federal and provincial, were raised during the review of the Application. The following provides a brief summary of these other federal and provincial legislation and policies that are relevant to the Panel's review of this application.

2.2.1 Constitution Act, Indian Act and Treaty #7

The Panel has been directed by the federal Terms of Reference (Appendix A) to address issues falling within federal jurisdiction, including the impacts of the project relating to the concerns and interests of aboriginal people. The Panel is mindful of the fiduciary obligations of the Crown and, where specific evidence is provided that indicates that this reviewable project affects those obligations, the Panel will have due regard for those obligations. The Panel is an independent body required to function in a quasi-judicial manner. The Panel recognizes that there are constitutional and other legal constraints on its jurisdiction. The Panel believes that through the participation of the Blood Tribe and the Treaty 7 Coalition, represented by the Peigan First Nation, aboriginal interests and concerns were presented as they relate to the effects of the project and the Panel will have regard for those interests and concerns in fulfilling its responsibilities within its jurisdiction.

2.2.2 Historical Resources Act

The *Historical Resources Act* provides for the coordination of the orderly development, the preservation, the study and interpretation, and the promotion of appreciation of Alberta's historical resources. The Minister of Community Development may order any person proposing a development to conduct an Historical Resources Impact Assessment (HRIA), when the Minister is of the opinion that proposed activities will or are likely to result in the alteration, damage or destruction of historical resources. The rights to all archaeological and palaeontological resources in Alberta are vested in the Crown.

The Panel notes that the HRIA completed on all components of the project provided for a staged mitigation program for the Little Bow and Squaw Coulee reservoirs and that APWSS has agreed to this program. Alberta Community Development, in conjunction with APWSS, is willing to continue ongoing communications with any and all First Nations about cultural resources in the Project area.

2.2.3 Expropriation Act

The *Expropriation Act* provides for a two step process for an expropriation of an interest in land. The first step requires an assessment by an inquiry officer into whether the intended expropriation is fair, sound and reasonably necessary in the achievement of the objectives of the expropriating authority. Section 9 of the *Expropriation Act* provides "when, in the opinion of the approving authority, the owner has, pursuant to any other act, had substantially the same opportunity to object to the expropriation as he would have had on an inquiry under this act, the approving authority by

direction in writing may dispense with an inquiry." As a result of this provision, the Minister of Public Works, Supply and Services could dispense with an inquiry under the *Expropriation Act*.

The second step in the expropriation process is to determine the appropriate compensation for the expropriated interest in land. This process may include a review by the Land Compensation Board or the Court. The appropriate amount of compensation is based on a number of factors. These include the market value of the land, the damages attributable to disturbance, and the value to the owner of any element of special economic advantage arising out of, or incidental to, the occupation of the land to the extent that no other provision is made for its inclusion.

The Panel recognizes that a determination of whether the Project is in the public interest, as required by the *NRCB Act*, will necessarily involve an assessment of the social and economic effects associated with the acquisition, possibly by expropriation, of land required for the project. Assessment of the compensation payable for land expropriation is determined pursuant to the *Expropriation Act*.

The Panel accepts that the Applicant has notified all parties that could be subject to expropriation proceedings. The Panel heard detailed information from the Applicant and interveners concerning the steps APWSS has taken to advise each party so affected.

2.2.4 Municipal Government Act

The Panel notes the municipalities have jurisdiction over private lands while AEP has jurisdiction for Crown lands. The Panel believes that it should have regard for the potential effects of the project on land use in the project area. The *Municipal Government Act* (MGA) provides that NRCB approvals may affect any statutory land use authorizations that exist in a municipality. The Panel will consider effects on municipal land use as they relate to the proposed project.

2.2.5 Alberta Environmental Protection and Enhancement Act

The purpose of the *Alberta Environmental Protection and Enhancement Act (AEPEA)* is to support and promote the protection, enhancement and wise use of the environment while recognizing certain principles. Although the EIA report for this project was directed under the *Land Surface Conservation and Reclamation Act*, it is deemed to be an Environmental Impact Assessment Report under Section 48 of the *AEPEA*.

The Director of Environmental Assessment has advised the Panel by letter dated June 23, 1997 that, in his opinion, the Environmental Impact Assessment Report is complete pursuant to Section 51 of the *AEPEA*.

2.2.6 Migratory Birds Convention Act

The *Migratory Birds Convention Act*, administered by Environment Canada, provides for the protection of migratory birds and their habitat. The Panel received sufficient evidence from APWSS and Environment Canada on project effects on migratory birds.

2.2.7 Wildlife Act

The *Alberta Wildlife Act* provides for the day to day management of wildlife in Alberta, and AEP is responsible for their management within the Project area. The Panel received adequate evidence from APWSS, AEP and Environment Canada concerning project effects on wildlife resources.

2.3 Jurisdiction of the Joint Review Panel in Relation to Other Jurisdictions

As with most large projects reviewed by the NRCB or a Panel established under the *CEAA*, there are other municipal, provincial and federal authorities that have a jurisdictional mandate in relation to the project. Several of these authorities made submissions to the Panel at the hearing, describing their mandate and the considerations relevant to their processes.

The Panel directs its review to the environmental, social and economic effects that could be expected if the project were to proceed. After considering these effects, the Panel will conclude whether the project is in the public interest and will make recommendations to the federal government. In some instances, there is an overlap between the consideration of issues by the Panel and by another authority that will have or has exercised decision-making authority in respect to the project. The Panel acknowledges that the broad mandate given the Joint Review Panel may lead to the perception that there is duplication in the regulatory process. This perception is not supported on a closer review of the respective mandates of each decision-making authority.

The mandates of the various other regulatory authorities require that each of them assess certain aspects of the project and make decisions about those issues. None of these agencies is directed to apply as broad a test to their decision-making process as is the Panel. Therefore, it is reasonable to expect a detailed review of a narrower range of issues from these authorities rather than a broader consideration of a wide range of issues, as is conducted by the Panel.

In many cases, the role of these agencies is ongoing regulation rather than a one-time review. Therefore, the relationship between the Panel and these authorities may be complementary. The Panel appreciates the co-operation and information that it received from the municipal, provincial and federal agencies involved.

With an appropriate understanding of the mandate and process exercised by other regulatory authorities, the Panel has several options in fulfilling its mandate, depending on the nature of these other authorities. If another authority has already exercised, or partially exercised, its mandate with respect to the proposed project, the Panel is able to benefit from the greater certainty or definition that is attached to the project. On the other hand, if the other authority has not considered the project, it is helpful if the Panel has an understanding of the types of considerations that will be given to a project by the authority. By having regard to the mandate of the other jurisdictions, the Panel is better able to assess the range of effects that could be expected from a project and how the ongoing regulation of a proposed project would be managed. Understanding these processes assists the Panel to assess the public interest of a project and make recommendations. The Panel observes that, within the scope of these authorities, the public interest is very well protected by the "specialist" nature of these regulatory authorities.

Conversely, it is possible that the views of the Panel may assist these other authorities through the attachment of conditions or recommendations in this report or through observations made in the course of the review.

The Report of the Pre-Hearing Conference clearly indicated the Panel's intention to review the Diversion Plan as proposed by APWSS. The Panel views the proposed Diversion Plan as also being integral to the Application for an approval to construct the works outlined in the Application. Any consideration of the public interest in relation to this water management project necessarily includes consideration of the effects of the Diversion Plan. In the event of an approval, the Panel may recommend or impose conditions on the Diversion Plan.

While the Panel recognizes the ongoing jurisdiction of the Controller of Water Resources as the licencing authority for the works, the Panel is also aware of its responsibility to determine the effects that would result from the proposed operations. The Panel has provided more detail concerning the review of the Diversion Plan in Section 4 of this report.

2.4 Sufficiency of Information and Preliminary Matters

During the hearing, various participants argued that the Panel had inadequate information on which to base its decision and recommendations. These participants stated the Application, or certain aspects of the Application, was incomplete either because the Panel had inadequate information about the potential effects of the proposed project on the South Saskatchewan River basin as a whole, or alternatively, because information was lacking about specific areas.

Prior to the Pre-Hearing Conference, the Panel decided that an issue-focussed approach would provide a more effective review process. A number of interested parties identified project-related issues at the Pre-Hearing Conference and these issues were noted in the Report of the Pre-Hearing Conference, dated 8 July 1997. Examples of issues that were identified during this scoping exercise included:

- The need for and role of the proposed expansion and possible further expansion of the Squaw Coulee Reservoir.
- The policy framework for the management of water resources relevant to the project including IFN, existing water rights and water management planning.
- The relationship between the jurisdiction of the Joint Review Panel and other authorities that have a bearing on the construction and operation of the project.
- Effects on existing domestic and agricultural water users along the upper Little Bow River, lower Highwood River, and Mosquito Creek, including changes in water availability and water quality.
- The economic and social effects of displacing affected landowners, including any special effects on the Little Bow Hutterian Brethren Colony.
- The transportation effects related to road relocation, reservoir crossings and their impact on local communities.

- The relationship between the potential development of the Little Bow River and Squaw Coulee reservoirs and municipal planning activities.

- The effects of the proposed project on fish and fish habitat. The adequacy of instream flows in the Highwood and Little Bow rivers to provide habitat and environmental conditions to support fish and other aquatic life in these rivers and the lower Bow River. The need and efficacy of fish screening devices.

- The effects on historical and cultural resources in the region.

- The effects on existing rights, including water rights, property rights, Constitutional and Treaty rights.

The Panel believes that it is important to address projects in terms of the baseline ecosystem conditions found within the basins, as well as the additional impacts a project would have on existing conditions. This is necessary to understand the cumulative effects that could occur as a result of the project proceeding. Where scientific studies on various indicators of environmental impact are not available, the Panel undertakes a qualitative analysis.

The Panel believes that the sustainability of ecosystems is the proper frame of reference when assessing environmental impacts. Sustainable development is recognized as a purpose of the *AEPEA*. The Panel believes it appropriate to determine the public interest with the assistance of the framework of sustainable development. An ideal development would be one that brings long-term social and economic benefits and has a beneficial or neutral effect on the environment. Developments should be planned and operated to minimize adverse impacts on the environment. However, where adverse effects on the environment are likely, the Panel believes social or economic benefits should be weighed, balanced and evaluated in terms of the environmental effects and risks.

In the case of the project currently under review, the Panel has found it impossible to consider the overall public interest without considering the overall management of water in the basins, and in particular, the current state of the riverine environment. The Panel heard that the potential exists for both continuing economic benefits from the proposed project and long-term social benefits of stable rural and urban communities in particular, but that this potential would not be realized without effective management of the water resources in the basins.

The Panel must be satisfied that the basic characteristics of the proposed project meet key public interest tests that are detailed in other sections of this report. After the hearing process, and during the preparation of this report, the Panel had the opportunity to review all the information and believes that it has the information necessary to satisfy its responsibilities under both the *CEAA* and the *NRCBA*. As detailed in Section 4, the Panel is retaining jurisdiction over certain aspects of the project. The information expectations of the Panel with regard to those aspects have been set out in detail in Section 4.

3. PROJECT NEED AND JUSTIFICATION

The Panel has considered the purpose, need and justification for the proposed project as presented by APWSS, specifically the desire of residents of the Highwood River/Little Bow River region for a reliable supply of water for maintenance and development of agriculture, industry and communities. In doing so, the Panel will briefly review the history of inadequate water supply during hot and dry summer months in the Highwood River and Little Bow River basins. The Panel notes the desired rate of growth in consumption that has provided justification for the project, and describes how the project would supply more water for consumptive purposes. The Panel will also address the alternatives that the Applicant has identified with respect to certain components of the project. The Panel will briefly consider the ability of the Applicant to construct and operate the proposed facilities. The Panel also will briefly consider the economic viability of the proposed project. The assessment of economic impacts and benefit/cost considerations are dealt with in Section 7.

3.1 Domestic, Industrial and Agricultural Demands

The proposed project and Diversion Plan would affect both the Highwood and Little Bow River basins. The Highwood and Little Bow typify prairie rivers. They have large variations in both annual and seasonal flows. On average, 55 per cent of the annual natural flow of the Highwood River occurs during May and June.

The two river basins have been physically linked for almost a century by diversions from the Highwood River to the Little Bow River. These diversions are essential to domestic, municipal and agricultural water users in the Little Bow River basin. The diversions had little impact on the Highwood River until the 1970s. The introduction of mechanized irrigation equipment resulted in a sudden, large increase in irrigated farming in the more arid Little Bow River basin. This increase coincided with a period of low flows and drought. As demands for irrigation water grew, increased diversions from the Highwood River were accompanied by events such as incidences of fish kills in the lower Highwood River.

The problem according to APWSS, is not so much the quantity of water diverted, but the timing. Historically, diversions have averaged 5 per cent of mean annual flow of the Highwood at the point of diversion in the Town of High River and 3 per cent of the flow at the mouth where it joins the Bow River. In the last decade these have increased to 11 per cent and 6 per cent respectively. However, the irrigation demand period often coincides with the time when Highwood River flows are low and temperatures are high. Diversions during this period add significantly to the natural stresses on fish and other aquatic life.

Even with the diversions from the Highwood River, the Applicant believes that the water supply in the Little Bow River basin is not reliable. Diversions are frequently restricted during periods when water is most needed. This results in irrigation deficits, water quality problems for municipal and domestic water users, and stress on the aquatic ecosystem in the Little Bow River basin. Despite an abundance of irrigable land in the Little Bow River basin, there is a moratorium on further irrigation expansion, and much of the land that is irrigated produces below capacity due to restricted water supply. As well, protracted drought and other factors in the late 1970s and early 1980s caused Clear Lake to dry up, removing a valued recreation and wildlife resource from the region.

According to APWSS the proposed project and diversion plan addresses all these problems. In their view, it would:

- reduce diversions from the Highwood River during critical summer periods improving water quality and instream flows to benefit fish and recreation in the lower Highwood River;
- secure water supplies for Vulcan, Carmangay, Nanton, Cayley and three rural water co-operatives;
- give Champion an alternative or second water source which would provide a year round supply and lower pumping costs;
- reduce turbidity in the raw water supply for Vulcan, Carmangay and three water co-operatives and reduce water treatment costs;
- improve domestic and stock water supply for users along Mosquito Creek, the Little Bow River and around Clear Lake;
- secure water supplies for 4,660 ha (11,500 acres) of existing irrigated farming and for 8,090 ha (20,000 acres) of additional irrigation; and,
- restore and stabilize levels in Clear Lake and nearby wetlands for recreation, fish and wildlife habitat.

The proposed project and diversion plan, according to APWSS, reflects the principles established by the Alberta Water Resources Commission for water management in the South Saskatchewan River Basin in 1986. In particular APWSS believes it would:

- use water to stabilize and maximize agricultural economies while sustaining natural resources;
- support the multi-purpose use concept;
- secure domestic water supplies;
- enhance the use of water resources for fish and wildlife habitat and recreation needs;
- allow irrigation development which in turn would help stabilize the agricultural community and lead to improved economic and social well-being for residents of the region;
- use water storage and flow regulation to stabilize variable water supplies; and,
- sustain the integrity of the Highwood River ecosystem by improving instream flows during critical water supply periods.

The Panel will provide a detailed review of water use in the region in Section 4 of this report.

In the opinion of APWSS there are already serious problems of water shortages in the basin during low flow events. At these times the competing demands for the available water cannot be met fully and deficits occur with respect to certain water uses. Current water resource policies require that minimum flows be maintained for instream flow needs. The Highwood River provides the habitat necessary to support a world-class sport fishery in the Bow River. Protection of this habitat requires that instream flow needs be met during low flow periods. In the hot and dry summer months, maintaining minimum fishery habitat means that all of the available natural flow should be retained in the Highwood River. This is also the time when licensed water users require water. Water requirements for domestic and municipal consumption and irrigated agriculture are met from withdrawals and diversions from the Highwood River. This results in a conflict between consumptive uses and instream flow needs for fish and fish habitat for the limited water resources that are available during hot and dry periods. Current demands for water outstrip the available supply.

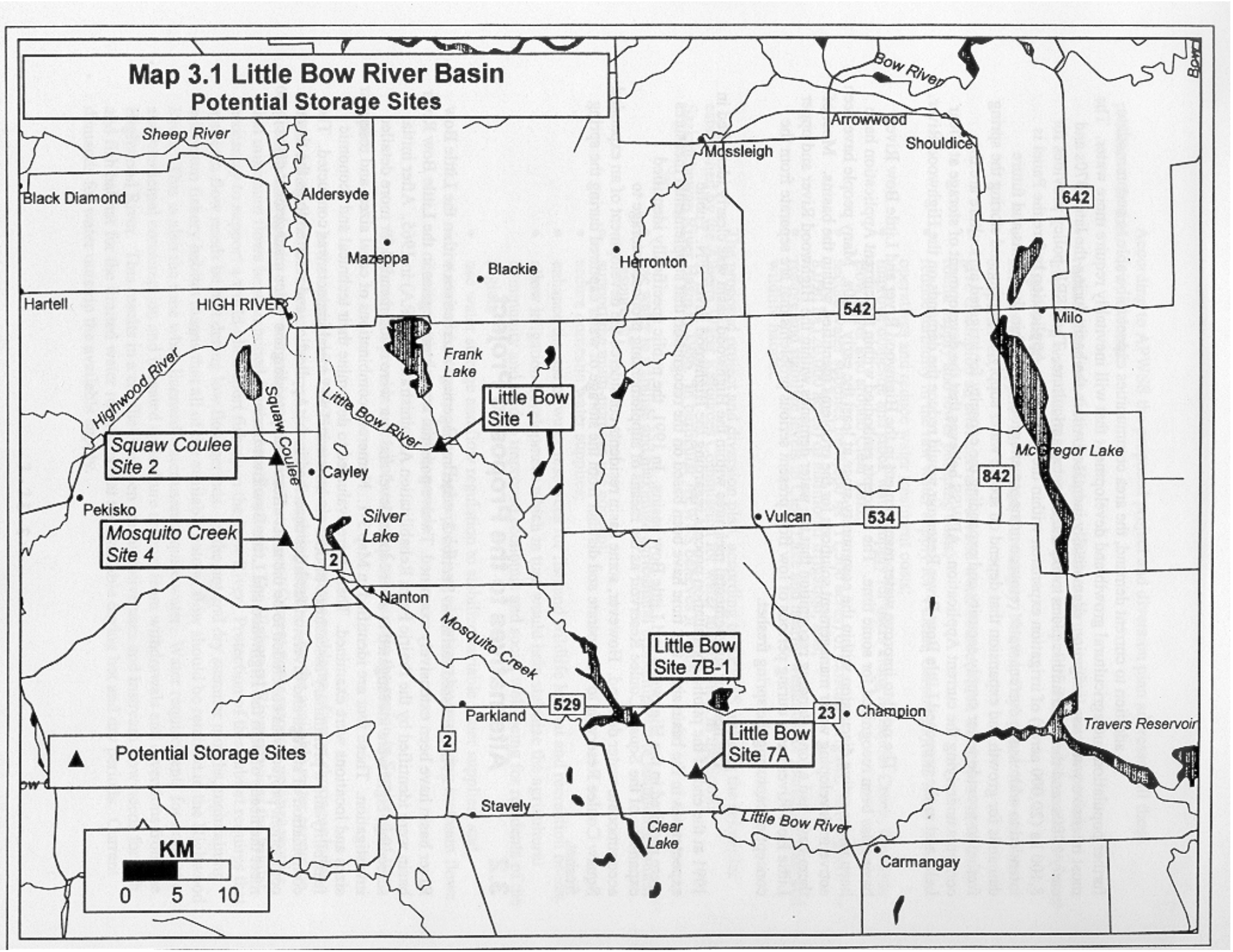
In addition to current demand, the area communities expect to be able to accommodate further population and agricultural growth and development that will inevitably require more water. The most intensive water use, irrigation, dramatically increased within the basin during the late 1970s and early 1980s, and there are further plans to expand irrigated agriculture. The SSRB policy provides for 8,100 ha (20,000 acres) of irrigation expansion within the basin. The Application before the Panel is intended to address the current water resource management problems within the basins and future demands for growth and expansion that depend on secure water supply. Capturing and storing the spring freshet to provide water supply security and expanding the capacity for irrigated agriculture are the concepts underlying the current Application. APWSS believes that the development of storage at Clear Lake and in the proposed Little Bow River Reservoir would reduce the demands on the Highwood River.

The need to improve water management in the Highwood River and Little Bow River basins has been recognized for some time. The concepts embodied within the current Application have been under active discussion within the community since at least the early 1980s. Many people have been active in developing water management solutions for the problems identified within the basins. Most of them have had a long-standing recognition that the water demands within the Highwood River and upper Little Bow River basin during periods of low flow present serious problems that are separate from the concept of capturing the spring freshet.

The need for supplemental measures within the Highwood basin was clearly identified in 1991 at the end of the public consultation process regarding the Highwood River IFN. Public expectations in the basin since that time have been based on the recognition that supplemental measures were required in the Highwood and Little Bow basins. In 1991, the public specifically identified expansion of the Squaw Coulee Reservoir as the means of supplementing proposed storage to accommodate water demand. However, some basin residents considered the development of an expanded Squaw Coulee Reservoir to be separate and distinct from the storage of water captured during the spring freshet.

3.2 Alternatives to the Proposed Project

As discussed earlier in Section 2, water management alternatives within the Little Bow River basin have been extensively examined. Twelve potential water storage sites in the Little Bow River basin were identified by the Prairie Farm Rehabilitation Administration (PFRA) in 1965. After initial screening, eight were investigated at a conceptual level and four were recommended for more detailed investigation. These four are identified in Map 3-1. Numerous combinations of canal sizes, and reservoir sizes and locations were examined. These were evaluated to determine their technical and economic feasibility and a preliminary assessment of their environmental and social impacts was conducted. The combination of storage and diversion facilities described in the Application and referred to as the three-component project was concluded to be the most effective in providing the water management capacity to meet the needs of both the Highwood and Little Bow river basins.


Map 3.1 Little Bow River Basin
Potential Storage Sites
Sheep River
Black Diamond
Aldersyde
Mazeppa
Blackie
Herronton
Bow River
Arrowwood
Mossleigh
Shouldice
642
Hartell
HIGH RIVER
542
Milo
Highwood River
Frank Lake
Little Bow Site 1
Little Bow River
Squaw Coulee
Squaw Coulee Site 2
Cayley
McGregor Lake
842
Pekisko
Silver Lake
Vulcan
534
Mosquito Creek Site 4
2
Nanton
Mosquito Creek
Little Bow Site 7B-1
529
Parkland
23
Champion
Travers Reservoir
Little Bow Site 7A
Potential Storage Sites
Stavely
Clear Lake
Little Bow River
Carmangay
KM
0 5 10

In the planning process conducted since 1980, numerous alternative solutions to the water supply and demand imbalances in the Little Bow and Highwood river basins were identified and evaluated. Options were examined from both a demand and supply management perspective.

Regarding demand management, the evidence indicates that the existing irrigation in the Little Bow River basin uses some of the most efficient water application technologies available. Water licences restrict the periods when irrigators may withdraw water, and water managers ensure diversions from the Highwood River are closely matched to irrigation demands. A moratorium on further irrigation expansion has been in effect since 1983. According to APWSS, little opportunity exists, for addressing the water management problems of the Highwood and Little Bow basins through further demand management. Currently irrigation practices in the basin are considered to be both modern and efficient. On a broader basis, the evidence received by the Panel did not indicate an interest in reducing current demands for water or limiting growth and expansion due to limited water supplies. On the contrary, the evidence clearly indicates a preference to maintain existing development and to accommodate future development through improved water management.

APWSS examined a number of alternatives to improve water management within the river basins. Their assessment of various ways to increase diversions from the Highwood River indicated that few benefits could be achieved without additional water storage in the Little Bow River basin. A proposal to supply irrigators in the Little Bow River basin with a water pipeline from Travers Reservoir was also examined by APWSS, but was rejected because of prohibitive costs.

The planning process used to consider the development of the Clear Lake component and Little Bow River Reservoir was lengthy and extensive. The public was thoroughly involved in considering the need for water management solutions, and a wide range of alternatives to meet identified needs was considered. Throughout the years a number of government officials have indicated support for these project components. The process used to consider the instream flow needs of the Highwood River was also extensive and thorough. When the Highwood River IFN Study was completed in 1991, it was clearly recognized that there was a need for supplemental water management in the Highwood River basin to meet various demands on the water available during low flow events. As noted earlier, the expansion of the existing Squaw Coulee Reservoir was identified as a potential solution to improve the water supply in the Highwood River. However, public examination of this alternative was much less thorough than the assessment of alternatives to Clear Lake and the Little Bow River Reservoir.

From the evidence before the Panel, the concept of expanding the existing Squaw Coulee Reservoir to meet water shortages in the Highwood basin was given only preliminary consideration in the public discussions that occurred in and after 1991. The diversion plans associated with the concept of expanding the existing Squaw Coulee Reservoir were not well defined or understood by the public. The evidence suggests that there was confusion about the role that would be played by the water stored in an expanded Squaw Coulee Reservoir. Some appeared to believe that the water available from storage in Squaw Coulee Reservoir would be used to meet existing water licenses in the lower Highwood River and along the upper Little Bow River. Others had the impression that any stored water would be used to restore and protect the habitat of fish in the Highwood River.

The Application presented by APWSS proposes using water from the Expanded Squaw Coulee Reservoir to protect fish habitat in the Highwood River. The Application indicates that, with the storage available through the expansion of the Squaw Coulee Reservoir, the Highwood River IFN would be met, but some licensed water users would experience deficits. The evidence available to the Panel indicates that the range of alternatives considered in addressing existing water shortages in the Highwood River basin was very narrowly conceived by APWSS. APWSS's approach assumed that it would be in the public interest to make trade-offs between meeting license commitments, conveyance flows, and IFN

since their proposed project could not completely satisfy all three demands. They assigned highest priority to meeting the IFN. Consequently the diversion plan associated with the Expanded Squaw Coulee project component failed to meet basic conveyance needs and licence commitments. This less comprehensive approach to identifying alternatives needed for storage for the Highwood River basin to meet the various demands for water during low flow events has serious implications. The Panel will discuss the implications of this approach in later sections of this report.

3.3 Ability of the Applicant to Implement the Proposed Project

The proposed project would be constructed by APWSS and would be operated by AEP. The Panel notes that APWSS is responsible for many projects in Alberta and was responsible for the design and construction of the Oldman Dam, a project costing much more than the project under discussion. The Panel also notes that AEP operates the Oldman Dam and many other major water management projects. APWSS is currently constructing the Pine Coulee Water Management Project. Given the experience of the two responsible departments, the Panel believes that the Applicant has the ability to design and construct the proposed project and that the proposed operator would also have the ability to carry out the operational aspects of the facilities.

The Panel notes as well that the two departments are involved in the design, construction and operation of the proposed project and act on behalf of Her Majesty the Queen in right of Alberta. For the Panel's purposes, it will adopt the view that the Government of Alberta will be the entity responsible for the design, construction and operation of the proposed project. Where convenient, the Panel will refer to the specific department involved in various phases of the project. Such references are not intended to imply that the obligations of the Government of Alberta for the Project are divisible nor does the Panel adopt the view that the commitments of APWSS are binding only on that specific agency. Rather, as indicated in the hearing, commitments made by APWSS or AEP were made on behalf of the Government of Alberta.

3.4 Economic Viability

The Panel considers the economic viability of the proposed project as one element in determining whether it is in the public interest. The Panel believes that its function in this regard is completely independent of the actual financing of an approved project. The Panel's duty is not to determine whether the Government of Alberta should invest public money in a project that receives approval. The Government of Alberta has the authority to make such a determination. If the Panel finds a project is in the public interest, it does not commit the Government of Alberta to invest public funds in the project. Nor does an approval of a Panel necessarily pre-empt any further decision by the Government of Alberta about a project, including decisions regarding its financing. The *NRCB Act* makes it clear that the NRCB approval is one of many approval processes.

If the NRCB does not approve a project, the question of the Government of Alberta financing all or part of that project will never arise. It is open to the NRCB to deny a project that is not in the public interest because of the adverse economic or other effects.

The Panel believes that in considering the potential economic effects of reviewable projects, it should also consider the return on public investment if the issue is relevant and if the proposed public investment is significant. The Panel notes that the issue of economic viability - the return on public money from particular projects, particularly in the context of infrastructure support - has been raised in previous NRCB hearings. The public is concerned about the use of public funds and public resources. The Panel believes it is appropriate that such concerns be heard and fully considered in its reviews of proposed projects.

In its previous decisions, the NRCB has considered the matter of the economic viability of a proposal. Although the current Application differs from private sector applications that would be financed from a purely private risk perspective, the Panel believes that it should consider the economic viability of a publicly funded project. During the hearing, the Panel heard that one criterion to be used in relation to a public investment was whether or not the benefit/cost ratio resulting from an economic analysis was greater than one; or alternatively, whether the internal rate of return on the investment of public funds fell between 4 and 10 per cent. There were no disagreements among participants as to the criteria to be applied to economic decisions associated with a publicly funded project. The Applicant's benefit/cost analysis yielded a benefit/cost ratio for the proposed project of approximately 0.92 using a mid-point discount rate. The internal rate of return on this investment is estimated to be 6.2 per cent, net of inflation.

According to the Applicant, a return of 4 to 10 per cent is generally considered acceptable for public investments. The Panel believes that there is sufficient evidence for it to consider the matter in more detail. The Panel recognizes that, regardless of its findings on the economic viability of a particular publicly funded project, a decision on whether to proceed with the financing of a specific proposal would have to be weighed by other decision-makers. Others would consider the relationship and priority of the particular project within broader public investment objectives. The Panel further recognizes that there are many non-quantifiable, qualitative and non-economic variables associated with determining whether an application is generally in the public interest. These other variables will be weighed in the Panel’s decision.

3.5 Panel Views on Project Need and Justification

The Panel has considered the Applicant's reasons for proposing this project as well as the views of the participants. The Panel accepts that some form of water management action is required for the Highwood and Little Bow River basins. There is a need to improve the potential for meeting instream flow needs in the Highwood River, particularly downstream of the proposed diversion works that lead to the upper Little Bow River, from the perspective of both water quantity and quality. The Panel also accepts that there is a need to provide increased security of supply for existing municipal, domestic, livestock and irrigation water users. The Panel also recognizes that the existing moratorium on new rights in the basin has curtailed irrigation expansion in the basin, and many potential irrigators in the basin have filed water rights applications.

The Panel has considered the reasonable alternatives to the proposed project. It is satisfied that the water management options within the Little Bow basin and at Clear Lake have been appropriately examined through a public planning process that included consideration of both structural and non-structural alternatives to meet the needs of basin residents. The Panel particularly notes, even though some basin residents would be adversely affected, that basin residents preferred the proposed three-component project over other water management options that have been considered. The Panel notes that alternative locations for the proposed three-component project and a variety of within-project

options have also been examined through a public process. The Panel is satisfied that the relevant options have been considered.

Alternatives to the development of the Squaw Coulee component of the project have been considered in a less thorough manner. The implications of this are discussed in detail in Section 4. The Panel is not satisfied that the Squaw Coulee component has received adequate attention by the Applicant. The Panel also has some serious reservations about the proposed operating plan for the Highwood Diversion Plan. The proposed plans, the alternatives to the plan and the process followed to develop the Highwood Diversion Plan are also discussed in more detail in the next section.

The Panel acknowledges that the matter of the economic viability of the proposed three-component project is not a major issue among participants. In fact, a number of interveners felt that the Applicant understated the economic impact of the proposed project. The Panel has noted that the economic viability of the proposed three-component project is one of a number of factors for which the Panel believes it should have regard. It also believes that quantifiable economic analysis must be considered along with non-quantifiable, qualitative and non-economic variables. The Panel has noted that the decision to proceed with the financing of a proposed project that might receive an approval from the NRCB, is a separate and independent decision that would be made by the Government of Alberta.

The Panel does not believe that the ability of the Government of Alberta to design, construct, and operate the proposed project is an issue for the participants. The Panel is satisfied that the Applicant has the ability to implement the project.

4. WATER MANAGEMENT IN THE HIGHWOOD AND LITTLE BOW BASINS

In considering water management the Panel believes that it must have regard for the entire Highwood and Little Bow basins and the sustainability of the water resources of those basins, taking into consideration existing and future use of those and related resources. The concept of sustainable development has been described as:

> "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development - Brundtland Commission, 1987); and
>
> "The principle of sustainable development, which ensures that the use of resources and the environment today does not impair prospects for their use by future generations" (AEPEA, s 2(a)).

In applying a sustainable development framework to the project, the Panel must determine whether a proposed project is in the public interest, having regard for the social, economic, and environmental effects. Ideally, in sustainable resource development projects, social, economic and environmental effects complement each other rather than conflict.

In considering the proposed project the Panel is adopting a sustainable development frame of reference that is based on a few basic principles strongly supported by the residents of the basins.

> First, water management projects must respect existing riparian rights and water licences, and should not result in the loss or injury to existing water rights;
>
> Second, water management projects must be able to meet basic environmental criteria to avoid significant adverse effects;
>
> Third, water management projects must be able to meet current and future needs for water for domestic, riparian, and municipal needs, and other consumptive uses.

These environmental, social, and economic considerations are basic to the determination of the public interest. A project must be able to meet these three criteria to be worthy of detailed consideration by the Panel with respect to project effects.

Communities in the basins place a very high priority on meeting current and future consumptive needs for water, with special priority on meeting the need for a reliable and high quality supply of potable drinking water. Similarly, basin residents place a very high priority on the social and economic importance of respecting and maintaining water rights. In using IFN as an environmental criterion, the Panel recognises that this is only one variable or indicator of riverine ecosystem integrity. Fish and people both require clean water, and water suitable for cold-water fish is also suitable as a source of water for domestic, municipal, and other uses. IFN is used as a key indicator because it assumes that other indicators of environmental quality are intrinsically met within the scope of meeting IFN, and because it reflects the value placed by basin residents and government policy on having a viable fish population.

This section of the report focuses on sustainable water management in the Highwood and Little Bow basins. The sustainability of the water resources of the basins is considered through a discussion of: (1) the concept of instream flow needs and its application to the riverine ecology of the Highwood basin, and (2) the planning and management of water resources for existing and future uses.

The sustainability of the riverine ecological resources of the Highwood basin has been expressed in the Application using the concept of instream flow needs for the Highwood River, which in turn are used as a key element in the proposed diversion plan. The Panel believes it would be helpful to consider both the basis for the proposed diversion plan, and the plan itself, before proceeding to examine the effects of the proposed project.

4.1 Water Use in the Highwood and Little Bow Basins

The Panel's assessment of water management in the basins begins by discussing the protection, diversion, allocation and consumption of water. The focus is primarily on the quantity and quality of water that may be allocated to consumptive demands, such as irrigation, and the match between supply and demand for both consumptive and environmental uses. The current water infrastructure and management practices in the Highwood and Little Bow basins reflect the history of human intervention in the watersheds, and the resulting over-allocation of water. The Panel will discuss current water use in the Highwood and Little Bow basins in terms of existing water licence commitments, infrastructure, conveyance flow needs, and operating guidelines. Existing water quality, quantity, and fisheries conditions in the Highwood and Little Bow rivers, and Mosquito Creek are also described.

4.1.1 Pre-development Hydrology of the Highwood and Little Bow Basins

The Highwood River originates in the eastern slopes of the Rocky Mountains and drains an area of about 4000 square kilometres (km2)(1544 square miles [mi2]) before emptying into the Bow River. Flows in the Highwood River are typical of east slope rivers and creeks with mountain headwaters. A large spring freshet caused by snowmelt in the headwater areas dominates the annual hydrograph. For the Highwood River, flows start to increase in early May (Week 18), peak in mid-June (Weeks 23 or 24), and then drop back to pre-freshet levels by mid August (Week 32). This flow pattern is evident in Figure 4.1 which shows estimated natural flows under average, wet and dry conditions.

The natural flow estimates suggest that average peak flows in the Highwood are on the order of 56.63 cms (2000 cfs) during the spring freshet. Natural flows then drop to less than 14.16 cms (500 cfs) in mid-August and less than 4.25 cms (150 cfs) by mid-September. The Highwood River basin discharges an average of about 619,000 dam3 (500,000 ac-ft) of water into the Bow River each year.

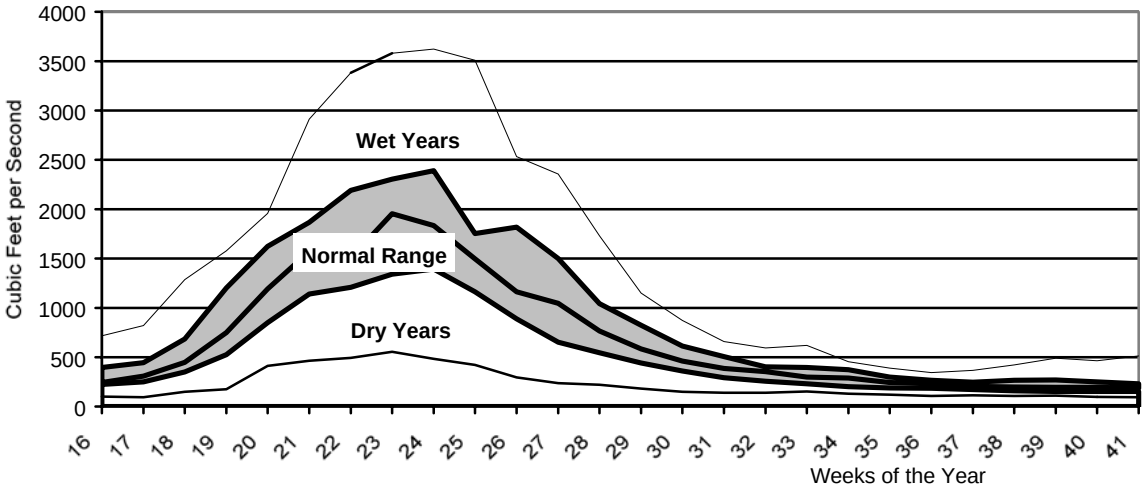


Figure 4.1: Natural Flows on the Highwood River (Reach 32)

The historical records show considerable variation in river flows from year to year, depending on the winter snow pack and precipitation. Figure 4.1 shows that natural peak flows would normally (4 out of 10 years) be in the range of 42.48 to 70.79 cms (1500 to 2500 cfs). For 3 of 10 years, peak flows could be above 70.79 cms (2500 cfs), and could even exceed 99.11 cms (3500 cfs). During dry years, peak flows of less than 42.48 cms (1500 cfs) could also occur (3 years of 10), and under extreme conditions peak flows could only reach 14.16 cms (500 cfs).

The Little Bow River drainage occupies 5930 km^2 (2290 mi^2), an area about 50 per cent larger than the Highwood River basin. Despite draining a larger area, the Little Bow River captures substantially less water than the Highwood. Only a small portion of the Little Bow River basin is located in the foothills. The balance is situated in the prairies and receives less annual precipitation. As a result, flows from the Little Bow River and its major tributary, Mosquito Creek, are equivalent to less than 10 per cent of the flow of the Highwood River. The Little Bow River basin discharges an average of only 39,900 dam^3 (32,350 ac-ft) of water into Travers Reservoir each year, and water from there eventually reaches the Oldman River.

The Little Bow and Highwood river drainage basins appear to overlap. The beginning of the Little Bow River is less than a kilometre from the Highwood River. During larger flood events on the Highwood River, some water spills over into the Little Bow basin in the vicinity of the Town of High River. Some of the evidence also suggests that flows between the two river basins may have occurred quite regularly prior to the period of record.

4.1.2 Development History

The Panel was made aware of the Aboriginal traditional use of the rivers and the valleys, including traditional names of the rivers and places. One translation of the aboriginal name for the Little Bow River by George Dawson, obtained from an elder in 1981, was Naked River. The junction of Mosquito Creek with the Little Bow River has been referred to as the Foul Water Creek, or the White Willow Place. Elders spoke of traditional uses in the region, with specific reference to the Squaw Coulee

and the Old Woman's Buffalo Jump[1], and the confluence of the Little Bow River and Mosquito Creek. Archaeological studies in the vicinity of the proposed project further confirmed traditional uses by aboriginal cultures over time.

European settlement of the Highwood and Little Bow river basins began in the 1880s. Attempts to manage water through human intervention have been a consistent theme since then, and continue to be a focal point of community action today. The current Application and the recent floods at High River in 1995 are examples of this ongoing focus of attention. The recurring themes of floods and droughts have been a constant reminder of the basic hydrological and climatic characteristics of the basins.

Flooding is a regular occurrence in the Highwood basin. Major floods occurred in 1894, 1899, 1902, 1908, 1912, 1923, 1929, 1932, 1942 and 1995. Early floods prompted the construction of several dikes. In 1908 the Lineham Spillway and Bypass was constructed to divert a portion of the flood flows from the main Highwood Channel around High River. The Hoeh dike was constructed in 1917 to prevent water from entering Baker Creek channel and flooding the town. Much of the dike was destroyed in the 1923 flood and rebuilt in 1924. Subsequent floods caused further damage to the Hoeh dike and to other dikes developed for flood control, necessitating further repairs and reconstruction. Historical records show continuous attempts to control flooding of the Highwood River since then. Other flood protection dikes have been built along the south side of the river in the town (1947) and along a portion of the Little Bow Canal to protect the north-east part of town (1977). Some new flood control structures are currently being planned.

Droughts have also been a common occurrence in the basins. The early 1890s were very dry and this prompted settlers to experiment with various forms of irrigation. Most of these attempts were small and fell into disrepair when the dry periods ended. However, a major initiative was undertaken in 1898 to develop a canal to divert water from the Highwood River to the Little Bow River for stock watering and domestic purposes. This project was initiated by the then Government of the North-West Territories and called for the construction of a canal with a 1.42 cms (50 cfs) capacity starting at a location near the Town of High River. Although eventually completed and licenced in 1905, flood damage to the diversion structure in 1908 and 1912 prevented diversions of water into the Little Bow. Repairs were short-lived due to further flood damage in 1916.

As previously indicated in Section 2, the Little Bow Irrigation District (LBID) applied for a licence to construct a separate structure on the Highwood River in 1922 to divert enough water for 1,335 ha (3,300 acres) of irrigation in the Little Bow River basin. This was deemed to be 1.42 cms (50 cfs). The licence was issued and the LBID agreed to divert an additional 1.42 cms (50 cfs) that the Crown was entitled to under its 1905 licence. When the LBID was later dissolved because of financial difficulties, the Crown took on the responsibility for operating the structure. The resulting diversions of water from the Highwood River provided a flow of up to 2.83 cms (100 cfs) of water into the Little Bow basin. This provided farmers and settlers in the region with a means to withstand the droughts that occurred in 1929, 1935 to 1937, 1959 to 1961, 1976 to 1977 and 1980 to 1988. In its original form, the Little Bow Canal was operated to divert about 9,990 dam^3 (8,100 ac-ft) of water from the Highwood River. With the expansion of the canal capacity and irrigation demand, these diversions increased to about 23,440 dam^3 (19,000 ac-ft) per year. At the present time about 37,000 to 43,170 dam^3 (30,000 to 35,000 ac-ft) of water are being diverted from the Highwood River into the Little Bow River basin.

1 The place names "Squaw Coulee" and "Old Woman" are offensive to aboriginal people but, because of their wide use in the Application and throughout the hearing, these place names have been used in the report. The Panel supports an application to rename these places.

The provincial government developed a second diversion project on the Highwood River in 1933. A canal with a capacity of 0.71 cms (25 cfs) was constructed at Squaw Coulee to provide water for domestic use in Nanton and the surrounding area. A small storage dam at Squaw Coulee was constructed by the Prairie Farm Rehabilitation Administration (PFRA) in 1949. These works were taken over by the provincial government in 1977. The capacity of the diversion works has since been upgraded to allow diversion of up to 1.7 cms (60 cfs).

The completion of the Little Bow and Squaw Coulee diversion works made it possible to divert up to 4.53 cms (160 cfs) of Highwood River water into the Little Bow River basin. The increased water availability gave farmers the opportunity to invest in irrigation equipment and reduce the risks associated with drought. Although the number of acres of irrigation in the Little Bow basin was small prior to the mid-1970s, dry conditions in 1976 and 1977 prompted many farmers to demand water for irrigation. Many new water licences were issued during this period. However, the provincial government imposed a moratorium on new irrigation licences in the fall of 1977 due to very low flows in the Highwood River. Some licences for other purposes, such as municipal and domestic use, continued to be issued.

The moratorium was lifted in the summer of 1981 after studies showed additional irrigation development could take place, if diversions were limited to the period from April 15 to July 21. Some licences were issued to farmers whose applications for water rights had been held in abeyance by the moratorium, while many other farmers also applied for water rights. The demand for irrigation in the Little Bow River basin rose rapidly particularly after another period of low water conditions in the Highwood River in the summer of 1983. The moratorium on irrigation water licences was reinstated in November of that year.

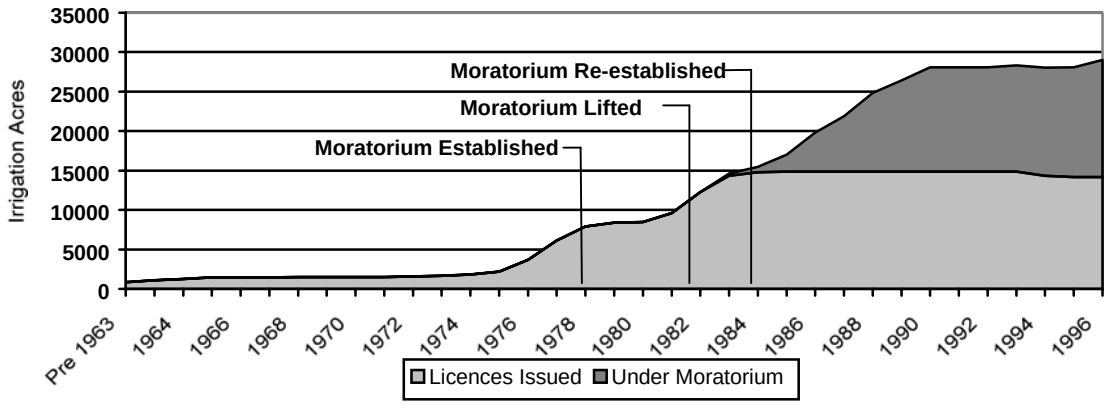


Figure 4.2 Historical Trends in Demand For Irrigation in the Little Bow River basin

The moratorium on irrigation licences in the Little Bow River basin remains in place today. However, many farmers have continued to submit applications for water rights. There are now 71 applications for irrigation water licences on about 6,010 ha (14,850 acres) in the Little Bow River basin above Travers Reservoir. This is roughly equal to the number of acres currently irrigated in the Little Bow River basin above Travers Reservoir (See Figure 4.2).

Water demands in the Highwood River basin have also increased steadily since the early 1970s. The total water demand in the Highwood basin is relatively small compared to the Little Bow. A substantial portion of the demand is for purposes other than irrigation. Two larger licences for industrial

water demand by the oil industry were issued in 1958 and 1974. Licences have also been issued for agricultural purposes (feedlots), municipal purposes (High River) and domestic uses. There was a considerable expansion of irrigation licences after the drought in 1977, much of it downstream of High River. A moratorium on irrigation expansion was imposed in 1985 due to low flows in the Highwood River during the mid-1980s. The moratorium did not apply to domestic, agricultural, municipal or "other" purposes and some such licences were issued, including one that allowed the diversion of up to 2,467 dam^3 (2,000 ac-ft) per year into Frank Lake. In 1990 the moratorium was also applied to "other" purposes and it remains in place today. As shown in Figure 4.3, there have been some applications for irrigation in the Highwood basin since the moratorium was imposed in 1985, but the water demands are still relatively small compared to other licence commitments.

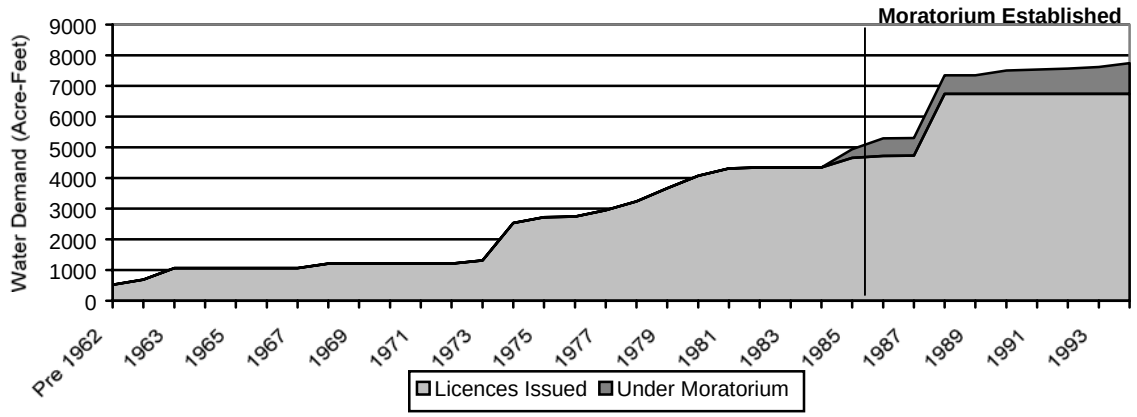


Figure 4.3 Historical Trends in Water Demand in the Highwood River basin

Since the early 1920s, Clear Lake has been considered as a potential storage site to support recreation, wildlife, and irrigated agriculture; it also had been identified as part of a potential drainage project. The majority of plans proposed for the lake involved the diversion of water from the Highwood River to Mosquito Creek to Clear Lake. In 1945 Ducks Unlimited proposed to construct a dam on Mosquito Creek to divert water to stabilize levels in Clear Lake. In 1956 the provincial Water Resources Branch investigated the potential for draining Clear Lake and surrounding low lands. In 1963 the Stavely Fish and Game Association urged the province to divert water to the lake to ensure sport fish populations would not be put at risk from dropping water levels. Clear Lake supported a popular northern pike/perch sport fishery as recently as the late 1970s. Fish kills were recorded in the winter of 1979-80 when the maximum depth had declined from 5 m to 3 m (16 ft to 10 ft). A summer kill occurred in 1981 when evaporation lowered the maximum depth to 2 m (7 ft). By the fall of 1985, the lake was dry and has basically remained so since then.

Low flows in the Highwood River during the late 1970s and the 1980s resulted in stresses on instream uses of the river, most notably fisheries, water quality, aesthetics and recreation. Similarly, municipal, domestic and irrigation users along the Little Bow River were placed at risk during this period due to limited water availability.

The Government of Alberta has played a central role in the development and management of the water resources in the two basins. Alberta Environmental Protection (AEP) is the government department responsible for licensing water diversions. AEP also holds the major water licences in the basin, and controls the diversions from the Highwood to the Little Bow through the diversion works into Squaw Coulee and at the Town of High River. Demand for water has increased

dramatically over the past two decades, primarily as a result of water licences being issued by AEP for the expansion of irrigation. Water availability during drought conditions has limited irrigation growth and placed a cap on development in the Little Bow basin. The Highwood and Little Bow basins are among the few basins in Alberta where a water licence moratorium has been in effect over a long period of time.

4.1.3 Consumptive Demands

A total of 183 licences for water use have been issued in the Highwood and Little Bow basins for domestic, municipal, agricultural, industrial, irrigation, and other purposes. The largest single licences authorize AEP to divert up to 4.53 cms (160 cfs) from the Highwood River into the Little Bow basin. Within the Highwood basin, licences authorizing withdrawals of up to 6.42 cms (226.68 cfs) have been issued, including the 4.53 cms (160 cfs) licensed to AEP. Within the Little Bow River licenced authorizations total 6.43 cms (227.24 cfs), of which 6.12 cms (216.09 cfs) are for irrigation purposes.

4.1.3.1 Highwood River Basin

The EIA indicated that 62 surface water licences have been issued in the Highwood River basin. However, 22 of these licences are for water use in the Sheep River sub-basin, and these would not be affected by the proposed project and diversion plan. As shown in Table 4.1, the remaining 40 licences allow diversion of water from the mainstem of the Highwood River and have been issued for a variety of purposes.

Water use by the Town of High River is not included in this summary. The Town has a licence for an annual withdrawal of up to 2,220 dam^3 (1,800 ac-ft) of water from wells, with a maximum diversion rate of 0.18 cms (6.39 cfs). Although this licence has been issued for groundwater, the wells are located adjacent to the Highwood River and the resulting water withdrawals have been considered as surface water within the water balance modelling conducted for the EIA.

TABLE 4.1
HIGHWOOD RIVER BASIN
SUMMARY OF SURFACE WATER RIGHTS

Purpose	Number	Annual Allocation (ac. ft.)	Irrigable Acres	Maximum Diversion Rate (cfs)
AEP Diversions	3	-	-	160.00
Irrigation	29	2,906	3,373	55.17
Other – Ducks Unlimited	1	2,000	-	7.00*
Industrial	2	1,340	-	4.20
Agricultural	2	434	-	0.08
Municipal	1	61	-	0.21
Domestic	2	2	-	0.02
TOTAL	40	6,743	3,373	226.68

* This is the maximum rate allowed in the licence for weeks 23 to 26.

The three licences held by AEP for diversion into the Little Bow River basin represent the most significant water use within the Highwood basin. As noted earlier, these licences authorize withdrawals of up to 2.83 cms (100 cfs) into the Little Bow Canal and up to 1.70 cms (60 cfs) into Squaw Coulee.

Irrigation is the second largest licensed water use in the Highwood basin. Licence information shows that about 40 per cent of irrigation occurs upstream from the Little Bow diversion canal. On average, irrigation licences in the Highwood basin were issued for about 267 millimetres (mm) (10.5 in) of water per acre. This is considerably less than for irrigation licences in the Little Bow basin because of greater natural precipitation in the Highwood basin.

The third largest licensed water use in the Highwood basin is for "other purposes". This licence has a priority date of 1988 and was issued to Ducks Unlimited to divert up to 2,467 dam^3 (2,000 ac-ft) to stabilize water levels in Frank Lake for wildlife propagation. The Town of High River and the nearby Cargill Ltd. beef processing plant project are now discharging treated municipal and industrial effluent into Frank Lake. Between 1991 to 1993, Highwood River water constituted 35 to 40 per cent of the diversions to Frank Lake; annual quantities diverted ranged between 1,000 and 1,075 (810 and 873 ac-ft). Diversions of Highwood water into Frank Lake ceased in mid 1993.

Within the Highwood basin there has been a substantial allocation of water for industrial purposes. The two industrial licences have priority dates of 1958 and 1974. The amounts of surface water allocated to other purposes like agricultural, municipal and stock watering were for relatively small amounts of water (7 per cent of the total). If the water requirements of High River are included, municipal water use in the basin becomes much more significant, with a total allocation of more than 2,220 dam^3 (1,800 ac-ft). Based on recent trends in population growth for the region, water consumption by the Town of High River is expected to increase in the near future. A population projection adopted in the EIA suggests that by the year 2011, the population of High River will have nearly doubled over 1990 levels. Municipal water demands have been assumed to increase by 91 per cent to accommodate this growth.

Future water demands for other uses are difficult to determine. Water use forecasts for the Highwood basin include some small increases in industrial and agricultural demand. As noted previously, there is considerable demand for additional irrigation in the basin, but there is currently a moratorium on issuing new licences for irrigation and “other” purposes. These future demands can only be supplied if additional water can be diverted from the Highwood River.

4.1.3.2 Little Bow River Basin

Irrigation is clearly the most significant type of water use within the Little Bow River basin. The EIA shows that water licences have been issued for 146 projects in the Little Bow River basin with a total allocation of 26,056 dam^3 (21,124 ac-ft) of water. This includes 127 irrigation licences for 24,020 dam^3 (19,475 ac-ft) of water on 6,194 ha (15,305 acres) of land. Most of the other licences are for municipal purposes, although a few licences have been issued for agricultural, domestic and industrial purposes. Some of these licences are for diversion works downstream of Travers Reservoir so not all of the 146 licences would be affected by the proposed project or operating plan. (See Table 4.2). A review of more recent water licence information suggests that 143 water licences are for diversion points upstream from Travers Reservoir.

TABLE 4.2
LITTLE BOW RIVER BASIN
TOTAL OF MAINSTEM DIVERSIONS UPSTREAM FROM TRAVERS RESERVOIR

Purpose	Number	Annual Allocation (ac. ft.)	Irrigable Acres	Maximum Diversion Rate (cfs)
Irrigation	133	18,406	14,395	216.09
- Mosquito Creek	30	2,299	2,055	35.76
- Little Bow	103	16,107	12,340	180.33
Municipal	9	1,103	-	8.48
Industrial	1	140	-	4.20
TOTAL	143	19,649	14,395	227.24

The licence data shows that the vast majority of water use in the Little Bow River basin upstream from Travers Reservoir is for irrigation purposes. Farmers in this area use sprinkler irrigation, either centre pivot or wheel move, and are licensed to apply a maximum of about 389 mm (15.3 in) per acre. As noted earlier, irrigation expansion was allowed in the late 1970s and early 1980s subject to the seasonal availability of water. As a result, 44 licences for irrigation on 2,601 ha (6,427 acres) of land have a cut-off date of July 31st and another 13 licences for irrigation on 377 ha (1,673 acres) have a cut-off date of July 25th. In the last decade, irrigators were cut off in July or early August in 1984, 1985, 1988, 1989, and 1994. In 1990 water was unavailable for fall irrigation. However, extensions have been granted to licensees with July cut-off dates when sufficient water was available from the Highwood River.

Irrigation water use in the Little Bow basin is currently constrained by the imposition of a moratorium on irrigation licences in 1983. Although people continue to apply for irrigation licences, these applications are being held in abeyance pending the decision of whether proposed storage on the Little Bow River will be developed.

Municipal water licences have been issued to a variety of large and small communities in the basin. These range from the towns of Nanton and Vulcan to small water co-operatives and Hutterite Colonies. Existing licences are predicted to be adequate to accommodate expected growth in each of these communities for the near future. However, the Town of Vulcan has submitted an application for another 259 dam^3 (210 ac-ft) of water.

Another water demand in the Little Bow River basin is termed “conveyance flow”. Technically this is defined as the amount of water that must be diverted from the Highwood River to maintain the capacity to withdraw water from the Little Bow River and Mosquito Creek during water-short periods. Conveyance flow is required to ensure that consumptive users can physically withdraw water (i.e. pump intakes are covered) and to provide for contingencies (i.e. emergencies, unauthorized withdrawals, miscommunication in the timing of supply and demand). Estimates of conveyance flow requirements during the spring, summer and fall ranged from 0.14 to 0.43 cms (5 to 15 cfs) for both the Little Bow River and Mosquito Creek. Conveyance flows are not licensed demands but are provided through the Crown’s licences to divert water from the Highwood River. During the hearings several interveners referred to flows in the upper Little Bow River and in Mosquito Creek at rates between 1.13 and 0.85 cms (40 and 30 cfs) respectively as being conveyance flows. Such flows are not really conveyance flows in the technical sense of the term and the Panel believes they were reflective of the desired instream flows sought by various water users during low flow events. Stream flow rates between 1.13 and 0.85 cms (40 and 30 cfs) reflect what the Panel would call an instream flow objective or IFO for

the upper Little Bow River and Mosquito Creek during low flow events. These flows would protect the riverine ecology and provide conveyance flows.

4.1.4 Diversion Operating Guidelines

Water is vital to the communities within the basins. During low flow events, the stability of water supply becomes a critical issue to all the individuals and families that depend on the Little Bow River for their drinking water. Diversions from the Highwood River play a key role in the supply of water to the Little Bow basin, and have a major influence on the condition of the Highwood River since diversion during periods of low flows can constitute a major fraction of the available supply.

The policies governing the operation of the diversion works controlled by AEP have been a focal point for communities that depend upon the water in or from the Highwood River. New information has emerged about the environmental requirements of the Highwood River, and public attitudes about sustainable resource management have been changing. At the same time there has been increasing pressure to accommodate expansion of irrigated agriculture. The following discussion outlines the development and evolution of the policies governing the operation of the diversion works.

The diversion works from the Highwood River are some of the most intensively managed diversion facilities in Alberta. The operating guidelines for the diversions have evolved and changed over the years as circumstances and knowledge changed. However, one compelling fact remains regardless of the changes that have occurred in the guidelines. Water is in short supply during hot and dry summer months in some years, and the demands on available supply outstrip the water that is available. Attempts to manage the scarce resource among competing demands have not and cannot meet all demands. At times there just is not enough water.

It is important to keep in mind that the licences governing the diversion of water from the Highwood River to the Little Bow basin place an upper limit on the amount of water that can be diverted from the Highwood River. AEP, as the operator of the diversion works, has adopted policies to restrict diversion to amounts less than those legally authorized to protect the Highwood River during low flows, or to ensure a minimum diversion for consumptive purposes in the Little Bow basin. These policies are called the Diversion Operating Guidelines.

The Development and Operations Division of AEP operates the Little Bow and Squaw Coulee diversions. Operational procedures have evolved over a long period of time. From 1974 to 1978, the Little Bow Canal was generally operated to carry 0.57 to 0.85 cms (20 to 30 cfs) between May and September. Over the winter (October through April), a flow of 0.28 cms (10 cfs) was maintained. Prior to 1978 the Squaw Coulee Canal was operated at a maximum rate of 0.57 cms (20 cfs) between May and September and was closed in winter.

In 1979, the rate of diversion to the Little Bow Canal was increased to a maximum of 2.83 cms (100 cfs) or 10 per cent of the Highwood flow, whichever was less. The diversions were increased to meet expanded irrigation requirements. Winter operation remained at 0.28 cms (10 cfs). The Squaw Coulee diversion guideline was also increased in 1979 to a maximum of 1.7 cms (60 cfs) or 10 per cent of the river flow, whichever was less. No diversions down Squaw Coulee were to occur when the Highwood River flow was below 2.83 cms (100 cfs).

In 1982, the operating guideline for the Little Bow Canal was modified to include a provision for allowing diversion of 2.83 cms (100 cfs), or 30 per cent of the recorded Highwood River flow at the diversion works, whichever was less, between May and September. Winter diversions remained at 0.28cms (10 cfs).

In July, 1984, low flows in the Highwood made it physically impossible to divert 2.83 cms (100 cfs) or 30 per cent of the flow down the Little Bow Canal, so a temporary gravel groyne was constructed in the river to raise the water level at the diversion intake. Similar groynes had been constructed in 1964, 1965, 1966 and 1977. In fall of 1984, the winter diversion was changed from 0.28 cms (10 cfs) to 0.57 cms (20 cfs) to ensure the Little Bow River would continue to flow year round (i.e. would not freeze up). The winter guideline has remained at 0.57 cms (20 cfs) since then. The Squaw Coulee Canal remains in operation only between May and October.

In May, 1985 a new guideline was approved by Alberta Environment. It stated:

> "In general, the Squaw Coulee diversion and the Little Bow Canal diversions will be operated at full capacity during the irrigation season with the following restrictions:
>
> 1. The flow in the Highwood River below the Little Bow Canal diversion shall not be allowed to become less than 70 cfs (1.98 m^3/s) as a result of diversions from the river.
>
> 2. The maximum combined rate of diversion through the Squaw Coulee and Little Bow diversions shall not exceed sixty (60) percent of the natural flow in the Highwood River at High River."

In June of 1986 the 1985 guideline was modified for the period from July 1 to August 10 period to reduce the risk of fish kills in the Highwood River during the hottest part of the summer. The 1986 guideline is described in Table 4.3 and states:

> "Operation of the Squaw Coulee and the Little Bow Canal diversion can proceed as in 1985 with the following exception:
>
> If the flow in the Highwood River at High River falls below 360 cfs (10.19 m^3/s) during the period July 1 to August 10, diverted flow will be reduced when either or both of the following conditions apply:
>
> a) air temperature reaches 30°C
> b) water temperature downstream of High River reaches 22.5°C"

Under these conditions the guidelines allowed diversions of 4.53 cms (160 cfs) when natural flows in the Highwood were 10.19 cms (360 cfs) or greater. The amount of water being diverted would proportionately decrease to 1.98 cms (70 cfs) when Highwood River flows reached 3.96 cms (140 cfs).

TABLE 4.3
DIVERSION SCHEDULE FOR 1986 GUIDELINES WHEN TEMPERATURE CRITERIA ARE REACHED*

Natural Flow Range		Minimum Instream		Maximum Diversion	
cms	**cfs**	**cms**	**cfs**	**cms**	**cfs**
10.19	360	Natural minus 4.53	Natural minus 160	4.53	160
7.93 to 10.19	280 to 360	5.66	200	Natural minus 5.66	Natural minus 200
4.53 to 7.93	160 to 280	Natural minus 2.26	Natural minus 80	2.26	80
3.96 to 4.53	140 to 160	50% of Natural	50% of Natural	50% of Natural	50% of Natural
1.98 to 3.96	70 to 140	1.98	70	Natural minus 1.98	Natural minus 70
1.98	70	Natural	Natural	0	0

* At High River, air temperature of 30ºC or Highwood River water temperature of 22.5ºC
Source: AEP 1993. Highwood River Diversion Plan

TABLE 4.4
STANDARD OPERATING PROCEDURES FOR LITTLE BOW AND SQUAW COULEE DIVERSIONS UNDER 1989 OPERATING GUIDELINES (Irrigation Season)

Natural Flow at High River		Upper Limit Diverted Flow		Minimum Flow Below High River	
cms	**cfs**	**cms**	**cfs**	**cms**	**cfs**
7.64	270	4.53	160	3.11	110
7.36	260	4.39	155	2.97	105
7.08	250	4.25	150	2.83	100
6.79	240	3.96	140	2.83	100
6.51	230	3.82	135	2.69	95
6.23	220	3.68	130	2.55	90
5.95	210	3.54	125	2.41	85
5.66	200	3.40	120	2.26	80
5.38	190	3.11	110	2.26	80
5.10	180	2.97	105	2.12	75
4.81	170	2.83	100	1.98	70
4.53	160	2.55	90	1.98	70
4.25	150	2.26	80	1.98	70
3.96	140	1.98	70	1.98	70
3.68	130	1.70	60	1.98	70
3.40	120	1.42	50	1.98	70
3.11	110	1.13	40	1.98	70
2.83	100	0.85	30	1.98	70
2.55	90	0.57	20	1.98	70

When natural flow is greater than 7.64 cms (270 cfs), the upper limit for diverted flow is the total canal capacity of 4.53 cms (160 cfs). When natural flow is between 1.13 and 2.66 cms (40 and 90 cfs), the diverted flow will remain at 0.57 cms (20 cfs). When natural flow is less than 1.13 cms (40 cfs), the diverted flow will be limited to 50 per cent of the natural flow. This table shows the upper limit of diverted flow. The actual diverted flow may be less depending on demand for water in the Little Bow basin.
Source APWSS EIA

Current operations reflect the 1989 operating guidelines which are shown in Table 4.4. The specific procedures for dealing with extreme low flows are now as follows:

> "When low flow conditions exist in the Highwood River (i.e. the flow remaining in the Highwood River, downstream of the Little Bow Canal, is 150 cfs (2.26 m^3/s) or less) every attempt will be made to keep the flow in the Highwood River, downstream from the Little Bow Canal diversion, from falling below 150 cfs (2.26 m^3/s) by ensuring that no more water than is absolutely necessary to meet domestic and licensed municipal, irrigation and industrial uses is diverted from the Highwood River. In order to assist in achieving this objective, the following will be undertaken:
>
> 1. Irrigation licence extensions will be suspended.
>
> 2. User demands, and water quality and flows at Carmangay, will be closely monitored with the aim of targeting flows into Travers Reservoir at 20 cfs (0.57 m^3/s).
>
> 3. To achieve objective #2, diversions at Squaw Coulee and Little Bow diversions will be reduced.
>
> When the Highwood River is approaching stress (i.e. water temperature is between 22.5°C and 24°C or dissolved oxygen is between 5 mg/L and 5.5 mg/L), real time monitoring and flow regulation will be implemented to prevent oxygen or temperature stress to the fish population in the Highwood River as a result of diversions. Irrigation diversions are temporarily suspended when water temperature reaches 24°C."

AEP stated during the hearing that they have changed this procedure, relying instead on computer model predictions of afternoon temperatures.

Flow conditions in 1994 exemplify the difficulties in managing water in the Highwood and Little Bow basins and the impacts of low flows on instream needs and water users. Low flows and high air temperatures resulted in Highwood water temperatures exceeding 24°C for 16 days in the July 20 to August 14 period; flows ranged between 5.66 and 8.50 cms (200 and 300 cfs). Although the dissolved oxygen concentration did not drop below 6 mg/L, small numbers of dead mountain whitefish were observed. Irrigation diversions from the Little Bow canal ceased on July 21, affecting 59 irrigation projects during the hottest time of the year, and flows in the Little Bow Canal were limited to 0.57cms (20 cfs). No water was diverted from the Highwood River into Squaw Coulee Reservoir although 0.71 cms (25 cfs) was released from the reservoir into Squaw Coulee and Mosquito Creek. Reservoir storage was depleted by the end of July. Little Bow irrigators were very concerned because their livelihoods were directly affected. Available water was distributed among irrigators according to licence priorities, although some general voluntary sharing of water occurred as a result of water mastering. The Village of Carmangay expressed concerns with the reduced diversion. High temperatures and low flows resulted in significant algae growth in the Little Bow River. By late August complaints were received from Little Bow domestic water users regarding the quality of water, and Carmangay officials stated the quality was so bad the water could not be adequately treated. There were attempts to flush the river at the end of

August by increasing flows to 1.98 cms (70 cfs) through the Little Bow Canal, followed by two days of higher releases through Squaw Coulee into Mosquito Creek.

During this period of high temperatures and low flows, an aerial survey of the Little Bow basin was conducted to identify active irrigators. Irrigators were all notified of the need to reduce diversion to protect Highwood River instream flow needs. Licensees co-operated, reducing irrigation demands from 1.56 cms (55 cfs) to between 0.08 and 0.28 cms (3 and 10 cfs).

4.1.5 Baseline Conditions

The Panel heard considerable evidence concerning the many aspects of existing water quality, quantity, and fisheries conditions in the Highwood and Little Bow Rivers, and Mosquito Creek. The following discussion provides a summary of the current state of the water resources in the basin, and the effects that current resource management practices have had on the social, economic, and environmental characteristics that are present in the basins. Understanding the current status of the water resource will provide the basis for the subsequent discussion of the complex problems faced in managing water resources in the face of competing demands.

The Highwood River supports one of the best fisheries in the province of Alberta. The upper Highwood and Sheep river systems provide an estimated 90 per cent of the available spawning and rearing areas for Bow River rainbow trout. The presence at the hearing of the Fisheries Coalition, a group of angling outfitters and non-profit associations with environmental interests, attests to the importance of the fish resources of the Highwood River. The world-class Bow River trout fishery depends on maintaining a suitable habitat in these river systems. The Highwood River also supports a healthy resident population of mountain whitefish, which is a favourite species for local anglers. Further sport species include bull trout, cutthroat trout, and brook trout, which are known to inhabit primarily the upper reaches of these rivers.

During the summer months, heavy irrigation demands often deplete the flow in the river to the point where fish habitat conditions below the town of High River deteriorate to an unacceptable level. The removal of water from a river to the point that habitat is severely reduced constitutes the destruction of fish habitat.

The following discussion examines in more detail the evidence before the Panel regarding the current status of water quality and fisheries in the Highwood River, and the implications of the current practices of water diversions.

4.1.5.1 Highwood River Water Quality

The Highwood River is a valuable resource, with excellent water quality attributed to its mountain headwater origins. Such waters originate primarily from snowmelt and precipitation and thus undergo a natural distillation/condensation process. Although there is no absolute definition of water quality because each use has unique constraints, Highwood River water is generally suitable for all consumptive purposes. For human drinking consumption, Highwood River water requires minimal treatment beyond disinfection and clarification to remove suspended sediments.

These baseline conditions for the EIA were initially evaluated in 1990 and 1991 and further updated during the hearings. The Applicant and general public expressed their views at the hearings that Highwood River water is considered excellent and that the fish populations of the Highwood River are valued resources. Water analysis confirmed the historically low levels of nutrients such as ammonia, nitrates, phosphates; low levels of metals; low levels of algae; and low levels of both natural and manmade organic compounds that would give rise to objectionable colour, taste, and odour. Turbidity associated with suspended silt and river sediments varies seasonally, peaking during the annual spring freshet and to a lesser degree during seasonal rainstorm events.

Water quality problems in the late 1980's attributed to the Town of High River sewage effluent were eliminated after 1989 when they commenced discharging their partially treated municipal waste into Frank Lake wetlands for natural attenuation. This meant that wastes with a high biological oxygen demand and high nutrient loads were no longer being discharged into the Highwood River for dilution and assimilation. Hearing evidence confirmed EIA observations that fish kills caused by depleted oxygen levels and/or elevated ammonia levels have not re-occurred in the Highwood River since municipal wastes were discharged into Frank Lake. Highwood River water currently being diverted into Squaw Coulee or into the Little Bow River is classified as oligotrophic, meaning it contains low populations of aquatic organisms and low levels of organic matter due to the low levels of nutrients. While the use of Frank Lake to treat sewage has improved water quality conditions in the Highwood, recent overflows from Frank Lake have caused water quality problems in the Little Bow basin. At the hearing increased drinking water treatment costs for the Town of Vulcan were attributed to these water quality problems.

The biological productivity of the Highwood River is also determined by dissolved oxygen levels in the water and this is partly determined by water temperature since temperature governs oxygen solubility in water. Water temperature determines dissolved oxygen concentrations only if the waters are free of other oxygen-consuming wastes or organisms, which is presently true for the Highwood River. The maximum equilibrium amounts of dissolved oxygen in fresh water over the range of ambient temperatures and atmospheric pressures are naturally small at about 8 to 10 parts per million (ppm). This range is sufficient to sustain aquatic life, primarily fish and the plants and organisms on which they feed. Dissolved oxygen levels do not affect the suitability of water for consumptive uses such as drinking water or irrigation.

There is an inverse freshwater-solubility relationship between temperature and dissolved oxygen. Maximum concentrations of dissolved oxygen (about 10 ppm) in freshwater occur at 15 ^{o} C and normal atmospheric pressure, but this decreases to about 7.5 ppm as water temperatures reach 30^{o}C. However dissolved oxygen levels can drop below 5 to 6 ppm (levels that stress coldwater fish) if oxygen-consuming biodegradable compounds (i.e. municipal sewage, industrial effluent, agricultural runoff, naturally decaying vegetation) or living organisms (aquatic plants, algae) are present. The latter are stimulated by the presence of sunlight and dissolved nutrients, worsening oxygen depletion during rapid summertime growth.

Water quality in the Highwood River can be affected by water diversions from the river. This is because water quality parameters relevant to sustaining aquatic life also include *physical* variables in addition to chemical conditions. These physical variables include:

- Sufficient volume and spatial distribution of calm/turbulent regions to meet diverse physical habitat needs for various species and life-stages.
- A temperature range within upper and lower limits permitting sufficient biochemical reaction rates for organisms to feed, grow, reproduce, and overwinter.
- Sufficient dissolved oxygen to support respiration by aerobic organisms such as fish.

Changing water quantities and flow rates does not intrinsically alter the chemical composition of dissolved constituents in river water but may cause changes in these physical parameters with subsequent implications for biological activity and aquatic habitat. For example, if diverting water out of the Highwood River causes the volume of water overlying aquatic plants to decrease, then oxygen released via daytime photosynthesis will dissolve in a smaller volume of water. This effectively leads to an increase in dissolved oxygen concentrations, which could be beneficial for fish. Increased oxygen due to daytime photosynthesis could be offset by a nightly sag in dissolved oxygen when the same plants consume oxygen. The effects of daytime photosynthesis may also be offset by a simultaneous decrease in oxygen solubility due to warmer water temperatures that may occur during summer hot spells. The Panel observes from hearing evidence that attempts to accurately predict the water quality effect of "fine-tuning" small changes in the volume of diversions were fraught with difficulties, reflecting the complex interactions between water quantity, quality, and aquatic habitat.

4.1.5.2 Highwood River Diversions and Water Quality

Currently, water is diverted from the Highwood River into the Little Bow Canal throughout the year, but the amounts are greatest during the irrigation season, May through September. This includes the July-August period when water is most needed in the Highwood River to maintain physical habitat, temperature and dissolved oxygen levels for fish. Outside of July and August elevated temperatures are not a concern and dissolved oxygen levels are higher due to seasonally cooler water temperatures and less prolific plant growth. In spring, temperature and dissolved oxygen are least likely to be affected by reductions in river flows because of substantially higher freshet volumes.

River water temperature depends on many uncontrollable physical influences. These include ambient air temperatures, exposure (vs. cloud shading) to direct sunlight, water depth, inflow of cooler groundwater, inflow of warmer or cooler precipitation, degree of wind or flow mixing, duration of exposure to the heating or cooling sources, rate of heat transfer, and extent and rate of evaporative cooling. Because of these many variables, attempts to mathematically correlate historic data of daily maximum water temperature with only one or two variables such as flow rate and/or river depth showed great scatter in the plotted data. For flow rates below about 11.33 cms (400 cfs), recorded daily maximum water temperatures ranged up to $+4^{o}C$ above and $-4^{o}C$ below an average daily maximum temperature. Thus, it is impossible to accurately estimate a daily maximum water temperature, or to confidently predict the extent to which water temperatures can be cooled by reducing diversions out of the Highwood River. Too many other factors are involved. However, in terms of water quality, two general conclusions can be deduced from the evidence (note: aquatic habitat concerns are different). First, water diversions out of the Highwood River will definitely not benefit the Highwood River. Second, the probability of harmful temperature effects increases as river flows decrease especially during very hot days.

Evidence received at the hearings showed the possible effects of incremental changes in diversion flows on maximum daily water temperatures in the Highwood River. Based on incremental increases in flows of 1.0 cms (35.3 cfs), changes in water temperature were found to be small, variable, and within the range of operating error. The models indicated that, at flows of 0.99 to 1.98 cms (35 to 70 cfs), an additional 1.0 cms (35.3 cfs) would decrease temperatures by a maximum of $1.0^{o}C$. At slightly higher flows (1.98 to 2.83 cms or 70 to 100 cfs) an increase of 1.0 cms (35.3 cfs) would decrease river temperatures to a lesser extent (a maximum of 0.7^{o} C). And, at even greater flows (3.96 to 4.96 cms or 140 to 175 cfs), an additional 1.0 cms (35.3 cfs) would cause a minor impact reduction in temperatures (a maximum of $0.4^{o}C$). Although these results from data regression and mathematical derivatives were submitted as exhibits in support of the current operating guidelines, evidence assessing the statistical significance of the relationship between flow and temperature was deficient.

During the hearing interveners challenged the fundamental validity of the derived correlation between temperature and flow rate and its application. There was consensus among intervener consultants and government experts that more field measurements are required, especially during low flow events where possible effects are most likely to occur, and that these measurements be statistically significant and scientifically valid.

The Panel recognizes that AEP diversion operators may have situational experience that was not reflected in the submissions before the Panel, and that a cautionary policy of restricting flow diversions is intended to provide some measure of protective risk-management in the Highwood River. In the Panel's view this has been a necessary compromise because the widespread social, economic, and environmental consequences of losing or damaging the Highwood River ecosystem are unacceptable. Therefore, the Panel observes that the uncertainties in operating diversion flows to manage water temperatures in the Highwood River are part of the baseline conditions.

Historically, acute high water temperatures (above 24^{o}C) and resulting acute low dissolved oxygen levels (below 5.0 ppm) have been experienced naturally in the Highwood River. These conditions occur during July and August when low river discharge coincides with very hot summer air temperatures (26-30^{o} C and above) and prolific aquatic plant growth. The rapid development of such physical water quality conditions is detrimental to and, in extreme conditions, may be fatal to fish that cannot escape to more favourable habitat. The Panel's assessment of the baseline condition is that this state is a periodic natural summer occurrence, intensified in drought years, that is further intensified by human withdrawals for consumptive use.

The Panel believes that sustainable development that preserves Highwood River water quality is possible by implementing IFN protection. Other protective measures include proactively managing regional growth and land management practices so that new contaminants do not enter the Highwood River. The cumulative effects of unabated agricultural, municipal and industrial contamination of the Highwood River would eventually consume dissolved oxygen below acute levels even at historically "safe" temperatures, negating the environmental benefits of water management in the Highwood and Little Bow basins. This is of concern given the magnitude of public investment being made in this project, and the scope of public interests and resources affected by it.

4.1.5.3 Highwood River Diversions and Fish and Fish Habitat

Fish in the Highwood River are exposed to a high degree of water quality-based stress, even under natural flow conditions. Fisheries management objectives should, therefore, ensure that criteria are not exceeded more frequently than under natural flow conditions.

To establish the frequency with which temperature and dissolved oxygen criteria may be violated without causing irreparable harm to fish populations, consideration must be given to the natural frequency and severity of such events. Events of limited magnitude and duration are not necessarily fatal and, if they fall within the frequency and severity to which the species is adapted, there may only be an additional stress to the population. The population may tolerate even occasional severe disturbances, if these events are rare enough to allow complete recovery of the population in the interim. Therefore a management objective for the Highwood River could be to ensure that the frequency of exceedence for both the acute and chronic criteria for temperature and dissolved oxygen must be equal to, or less than, the frequency of natural occurrences. This would provide adequate protection for the fishery.

Fish kills in the Highwood River were reported in 1977, 1979, 1983, 1984, 1985 and 1988. Dates of fish kills in 1977 were not recorded; there were reports of minor kills in late July and greater kills in early August. The kills were attributed to elevated water temperatures and loss of physical habitat. Flow in 1977 was the second lowest in 70 years. Low flows and high air temperatures have been associated with most fish kills. Oxygen concentrations of less than 5 mg/L were measured on numerous occasions in late July and early August of 1984 and 1985 and in late July of 1988. A combination of low, early morning oxygen levels and elevated afternoon temperatures, in turn related to reduced flows and over-abundant plant growth in sections of the river, seem to have been the main causes of fish mortality. A malfunction of the High River Sewage Treatment Plant caused the release of partially-treated sewage, resulting in low dissolved oxygen levels and fish kills during the period July 27 to August 9, 1984. Since July 1989 the treated sewage effluent from High River has been pumped to Frank Lake, significantly reducing the probability of low oxygen levels in the lower Highwood River.

Fish and Wildlife Division conducted a scientific assessment of the 1984 fish kill. It did not find substantial mortality upstream of High River, or substantial rainbow trout mortality. Mountain whitefish adult mortality was estimated at 1840, with juvenile mortality estimated to be equal to or greater than the adult kill. Sixty dead fish were counted in 1988, including suckers, 28 mountain whitefish and 2 rainbow trout. The extent of fish kills in other years is unknown, though none appear to have been as large as those observed in 1984.

The Applicant predicted the number of days in July-August for each year that water temperature and dissolved oxygen would have exceeded acute and chronic criteria. From 1950 to 1987 there was an apparent cyclical trend in the number of days that the chronic temperature and oxygen criteria for juvenile/adult rainbow trout were exceeded. Both criteria were also exceeded relatively frequently from 1981 to 1988. High frequencies of exceedences occurred recently in the years that major fish kills also were reported; these years were 1979, 1983, 1984 and 1985. The other year, 1977, when a significant fish kill was reported, had an extremely low July-August discharge. It was evident from this analysis that there have been periods of poor habitat quality for rainbow trout and mountain whitefish between 1950 and 1988.

The Applicant quantified the effects of historic water management activities on microhabitat availability in the Highwood River by making comparisons with estimated habitat availability under natural flow conditions. These effects were estimated using the Physical Habitat Simulation System group of models in the instream flow incremental methodology (IFIM), i.e. the scientific IFN. Changes in habitat in range of the 5 to 9.9 per cent were categorized as *minor*, those between 10 and 19.9 per cent were considered moderate, while habitat changes in excess of 20.0 per cent were categorized as *major*. Habitat changes were either positive (i.e., increases in habitat) or negative (i.e., reduction in habitat). Habitat changes of less than 5 per cent were considered to be within the confidence limits of the computer modelling approach, and thus considered very minor or insignificant. The analysis of habitat used recorded hydrograph data, which were then compared to the estimated natural flows, for various reaches of the Highwood River and for various fish species and life stages. The results are shown in Table 4.5. The effects of the historic water management activities during the open-water season on the Highwood River were estimated by the Applicant to be minor reductions for rainbow trout in Reaches 2 and 4 and major reductions in Reach 5. For mountain whitefish, habitat reductions were concluded to be minor to major in Reach 2 and major in Reaches 4 and 5.

TABLE 4.5
EFFECTS OF HISTORICAL WATER MANAGEMENT ON RAINBOW TROUT AND MOUNTAIN WHITEFISH HABITAT IN THE HIGHWOOD RIVER: COMPARISON OF HISTORICAL AND NATURAL FLOWS

Species	Life Stage	Reach		
		2	4	5
Rainbow Trout	Fry			
	Juvenile			
	Cold Water Juvenile			
	Adult			
	Spawning			
	Overall			
Mountain Whitefish	Fry			
	Juvenile			
	Adult			
	Spawning			
	Overall			

Adapted from Exhibit 58: Technical Fisheries Evaluation of the Highwood River Diversion Plans, Golder Associates Ltd., 1994.

Shaded areas indicate a decline in habitat.

	5-9.9% minor
	10-19.9% moderate
	> 20% major

Reach 2 Squaw Coulee Diversion to the Little Bow Diversion Canal
Reach 4 Downstream from Highway 2 to Sheep River confluence
Reach 5 Sheep River confluence to Bow River

The removal of water from a river to the point that habitat is severely reduced constitutes the destruction of fish habitat. The Government of Canada has responsibility for the protection of fish habitat and has established policies in this regard referred to as the Policy for the Management of Fish Habitat. Legislative authority for this policy is found in the *Fisheries Act (Canada)*. Specifically, Section 35.(1) states the following: "No person shall carry on any work or undertaking that results in the harmful alteration, disruption, or destruction of fish habitat."

The Applicant has acknowledged that the historic water management activities during the open-water season on the Highwood River sometimes have had the effect of causing major habitat changes in excess of 20 per cent. In the opinion of the Panel, water management practices that lead to such significant adverse environmental effects are inconsistent with the policy intent of the federal Policy for the Management of Fish Habitat and the principle of sustainable development. Current water management practices that enable water withdrawals and diversions under low flow circumstances can not be considered to be sustainable if they result in major habitat changes that constitute the harmful alteration, disruption, or destruction of fish habitat. The Panel has serious concerns about the existing situation regarding the management of fish habitat in the Highwood River, and does not believe it should be considered acceptable to allow the current practices to be carried forward into the future. In short,

current water management practices in the Highwood River at times appear to be inconsistent with the *Federal Fisheries Act* and the Policy for the Management of Fish Habitat.

4.2 Determination of Environmental Requirements for Water

In 1990, the Government of Alberta announced the "South Saskatchewan River Basin Management Policy" in which there is a two-level system for instream flow requirements. *Preferred* flows are those required to protect desirable instream uses, and *minimum* flows are those required to protect basic water quality. Under this policy, *preferred* flows are to be met most of the time. Flows can drop below the *preferred* and, in times of drought, may drop to *minimum* levels for short periods. The Panel notes that, in the context of the Highwood River, *minimum* instream flow requirements may not be achieved during low flow events. The policy does not contemplate instream flows dropping below *minimum* instream requirements and it provides no guidance in this regard.

Minimum and preferred IFN were developed for the Highwood River in response to this government policy. The following discussion attempts to outline the development of the criteria for the protection of the aquatic environment of the Highwood River. The process used to develop the criteria was called the Highwood IFN Study.

4.2.1 Highwood IFN Study

The Highwood IFN Study was carried out under the auspices of the Highwood River Public Advisory Committee (HRPAC). At the suggestion of the MLA for Highwood, a smaller Technical Sub-Committee (TSC) was formed for the purpose of providing advice in the set-up and testing of IFN scenarios. The TSC consisted of representatives from Trout Unlimited, the Little Bow Water Users Association, the Lower Highwood Residents' Association, and the Highwood Irrigators.

The TSC was assigned three tasks:

- Establish an IFN for the lower Highwood
- Define "excess" Highwood flows
- Develop an operational plan for diversion of water from the Highwood River to the Little Bow basin.

The TSC identified and evaluated a number of operations scenarios, and eventually identified one scenario that might satisfy the interests of all parties. A comprehensive analysis of this scenario determined that it supported the Little Bow Project and seldom violated the IFN. This scenario was considered satisfactory by fisheries interests because it was acceptable to the then Alberta Department of Forestry, Lands and Wildlife.

The major drawback to this scenario was that diversions would be cut off during low flow periods to protect the Highwood fishery. To resolve this issue, the TSC reviewed several possibilities, including dugouts and small-scale storage on the upper Little Bow. In the end, the TSC proposed that measures be taken to reduce water supply deficits to existing licensed users along Mosquito Creek and the upper Little Bow. These measures included increasing the amount of storage at Squaw Coulee Reservoir and the development of a Highwood Basin Water Management Plan.

4.2.2 The Progress Report of 1991

In May, after the IFN Study was completed, the Director of Planning for Alberta Environment (Bruce MacLock) sent a five-page progress report on the IFN, Diversion Plan and EIA to all people who had attended previous meetings or expressed an interest in the study. In the opinion of the Panel, the progress report is central to the understanding of the background leading to the current Application before the Panel and many of the issues raised during the Hearing. The 1991 MacLock letter from AEP is reproduced in Figure 4.4 for convenience.

The Panel makes the following observations regarding the MacLock letter and related discussions during the hearings:

1. The objectives clearly indicate that meeting the IFN and the needs of existing licensed water uses were considered requirements of acceptance.

2. It was recognised that, without storage within the Highwood River basin, it would not be possible to simultaneously meet the IFN in the lower Highwood and the licensed demands for consumptive uses in the lower Highwood River and the upper Little Bow River.

3. One possible solution suggested by the TSC involved development of additional storage at the existing Squaw Coulee Reservoir. While additional storage was seen by the various parties as being promising, the small amount of storage being considered at that time had the capacity to meet only identified IFN requirements but would be unable to meet existing licensed uses.

4. A small expansion of the Squaw Coulee Reservoir was not acceptable to all those involved, since it would not have the capacity to also meet existing licensed uses in addition to IFN. A larger expansion of this reservoir could have met both IFN and licenced demands.

5. Expansion of the Squaw Coulee Reservoir would require supplemental measures to improve flow and quality conditions in the lower Highwood and reduce the water supply deficits of existing licensed irrigation uses.

6. The development and completion of a Highwood water management plan was seen by many as part of the agreement.

7. Perhaps most importantly, the precise nature of the supplemental measures required to make the diversion plan viable were not identified at that time, and were not brought forward by APWSS in the current Application.

The Panel will return to this last significant observation later in this report.

Figure 4.4

TEXT RETYPED FROM R. Bruce MacLock letter dated May 2, 1991.
Alberta Environment Planning Division

"May 2, 1991

Dear Participant:

Re: Highwood River Instream Flow Needs (IFN) and Diversion Plan

The purpose of this letter is to bring you up to date on what has been accomplished to date and review the next stage of this work.

Since May 1989, a number of government agencies under the leadership of Alberta Environment, have been working with people interested in water management in the Highwood and Little Bow River Basins to:

1. *establish Instream Flow Needs (IFN) for the lower Highwood River, and,*
2. *develop a plan for the diversion of excess Highwood River flows to the Little Bow Project.*

There has been extensive public involvement in this process as follows:

1. *six public meetings were held in High River;*
2. *government agencies have met on nine occasions with a volunteer Public Advisory Committee (PAC) and on eleven occasions with a Technical Subcommittee (TSC) of the PAC;*
3. *MLA's and government staff have attended various informal meetings with individuals and interest groups.*

Instream Flow Needs (IFN)

An IFN for the lower Highwood River (from the Little Bow Diversion Works at High River to the mouth of the Bow River) was recommended by the Bow Basin Working Group (BWG) to the interdepartmental IFN Task Force and was approved by the Task Force on April 16, 1991. This recommended IFN will be forwarded to the Alberta Water Resources Commission.

This IFN, which incorporates the habitat requirements for Rainbow Trout and Mountain Whitefish and an annual flushing flow to maintain the general health of the river, has been recommended for application during the period from April 15 to October 15 each year. This is the period during which information on fish habitat requirements is available; it is also the period during which water will be diverted from the Highwood to the Little Bow Project.

In developing the recommended IFN, the BWG considered the water quantity and quality requirements for five identified purposes which are: fish habitat, recreation, streambank vegetation maintenance, aesthetics and flushing. We were advised by Alberta Recreation and Parks that the IFN for fish would, in their view, be adequate for recreational use. Data required to establish a relationship between Highwood River flows and streambank vegetation is not yet available. A streambank vegetation research and data gathering program is now underway, however results will not be available for a few years. Planning Division has a survey underway that is expected to yield some information on public opinion regarding different rates of flow from an aesthetic point of view. This information was not available to contribute to the development of the IFN but will be available for use in the EIA.

The flushing flow requirement is based on the results of a review and application of a number of methodologies for determining flushing flow requirements undertaken by Planning Division.

The fish habitat flow requirements are those recommended by the Fish and Wildlife Division. These are based on analysis undertaken by the Division as reported in Allan G.H. Locke, Instream Flow Requirements for Fish in the Highwood River, Alberta Forestry Lands and Wildlife, Fish and Wildlife Division, 1989 and their review of scientific literature on water quality criteria for fish species native to the Bow-Highwood system.

The BWG was unable to recommend an IFN for the period October 15 to April 15 as reliable data and research was unavailable. It was recommended that Alberta Forestry, Lands and Wildlife, Alberta Environment and other agencies undertake work leading to recommendations on the flow required to prevent the lower Highwood from freezing to the bottom and to provide habitat for fish and wildlife during the period October 15 to April 15.

The recommended IFN and a discussion of its development are included as Attachment No. 1 to this letter.

Highwood Diversion Plan

Since September 1990, a Technical Subcommittee (TSC) of the Highwood IFN Public Advisory Committee (PAC) has been involved with staff from Alberta Environment, Alberta Agriculture and Alberta Forestry, Lands and Wildlife in the development and analysis of water use and management scenarios. The purpose of this scenario analysis was to provide a basis for development of a Diversion Plan that would satisfy the following objectives:

1. *maintenance of sufficient flow in the Highwood River to satisfy the IFN for the Highwood River;*
2. *diversion of sufficient water from the Highwood River to the Little Bow Basin to support the Little Bow Project;*
3. *provision of sufficient water to meet the needs of existing licensed water uses in the Highwood and Little Bow Basins.*

The analysis undertaken by the TSC and government staff indicated that because of the great variability of Highwood river flows over the course of a year and from one year to another, it is not possible, with existing management capability, to simultaneously meet the IFN in the lower Highwood and the demands of consumptive uses licensed to withdraw water from the river. Further analysis, led to the development of a scenario that would meet both the recommended Highwood IFN and the needs of irrigators in the Little Bow Basin located below the proposed Little Bow River Reservoir. This combination would also support the development of the additional 20,000 acres of irrigation allocated to the Little Bow/Clear Lake area by the government's Irrigation Expansion Guidelines. It would also provide for recreational use and increased wildlife habitat at Clear Lake. Management to meet the IFN would result in higher flows, improved water quality conditions and better fish habitat in the lower Highwood River.

Management in accordance with this scenario would, however, increase the water supply deficits to the licensed municipal, domestic and irrigation uses in the Little Bow Basin located above the proposed Little Bow River Reservoir and to licensed irrigation uses on the Highwood River. These water supply deficits would occur in low flow years mainly during the months of July and August. To alleviate these problems the TSC recommended the following supplemental measures:

1. *the implementation of measures to reduce the water supply deficits of existing uses reliant on the Little Bow River or Mosquito Creek that are located above and thus not supplied from the proposed Little Bow Reservoir, and,*

2. *the development of a plan for water management in the Highwood Basin that would seek means to improve flow and quality conditions in the lower Highwood and reduce the water supply deficits of existing licensed irrigation uses.*

On January 23, 1991 the Minister of Environment, the Hon. Ralph Klein, the Minister of Municipal Affairs, the Hon. Raymond Speaker and Mr. Don Tannas, the MLA for Highwood, were briefed on progress toward the finalization of a Highwood River Diversion Plan. The Minister of Environment agreed to support the inclusion of these supplemental measures noted above in the interests of maintaining the sustainable development aspects of the Little Bow Water Management Project.

The following members of the TSC indicated their support for a Diversion Plan based on this scenario and upon ministerial commitment to the supplementary measures:

Will Bilozir	*Lower Highwood Residents Association*
Bob Elliott	*Highwood River Resident Association*
Gary Flitton	*Little Bow Water Users*
Gerry Porter	*Highwood River Resident Association*
Glen Roemmelle	*Chairman, Public Advisory Committee, Little Bow Basin*
David Soltess	*Trout Unlimited Canada*

The recommended Diversion Plan is consistent with the Water Management Policy for the South Saskatchewan River Basin as it:

1. *meets the recommended IFN for the Highwood River to the satisfaction of the criteria set by Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division, and,*

2. *supplies sufficient water to the Little Bow Project to support the development of 20,000 new acres or irrigation in the Little Bow Basin (15,000 below the proposed Little Bow Reservoir; 5,000 at Clear Lake) to the satisfaction of irrigation performance criteria set by Alberta Agriculture.*

Excerpts from the government's May 1990 Water Management Policy for the South Saskatchewan River Basin pertinent to the Diversion Plan are included as Attachment No. 2 to this letter.

The Diversion Plan, including the agreed upon supplementary measures, was presented to the Highwood Public Advisory Committee at an Open House in High River on February 7, 1991. The response to the plan from the PAC members and others who attended the Open House was favourable. One group of interests representing some residents along the lower Highwood and the Alberta Fish and Game Association remains strongly opposed to the Diversion Plan and the Little Bow Project.

A Calgary consulting firm, W-E-R Engineering Ltd., has put forward a conceptual plan for the enlargement of Squaw Coulee Reservoir and the construction of conveyance works. This is a promising measure with excellent potential for reducing the water supply deficits of existing licencees on the Little Bow River and Mosquito Creek upstream from the proposed Little Bow Reservoir. W-E-R Engineering Ltd. is currently undertaking a more detailed feasibility study of this concept which will be completed by May 1, 1991. The results of this study will be reviewed with landowners in the area and at an open house.

Alberta Environment is preparing terms of reference for the development of a water management plan for the Highwood River Basin. Staff will be consulting with water users and other interested groups and individuals to identify issues that will be addressed in the development of the plan.

Submission of the recommended Highwood Diversion Plan for examination in an Environmental Impact Assessment (EIA) concludes the work in which Alberta Environment and the PAC have been jointly involved in over the past two years. The IFN and the Highwood Diversion Plan represent conditions that will be realized in future years when the Little Bow Project has been implemented. In the meantime we will continue to consult on the management of the Highwood River keeping in mind all of the interests that must be accommodated. In this context, the guidelines for operation of the Highwood River will be reviewed on an annual basis.

Environmental Impact Assessment (EIA)

The Little Bow Project and Highwood River Management, including the Highwood Diversion Plan are being subjected to EIA's. The two EIA's will be blended under the joint direction of Alberta Environment and Alberta Public Works, Supply and Services, into one EIA for submission to the Natural Resources Conservation Board (NRCB). The blended EIA will be ready for the EIA review process on October 1, 1991.

The NRCB hearings will provide a further opportunity for public comment on the IFN and the Highwood Diversion Plan. I encourage you to participate in the EIA process, both during the preparation stage and after its submission to the NRCB.

An Open House is scheduled for May 16, 1991, 6 p.m. to 9 p.m. at the Highwood Memorial Centre. The Open House will focus on a review of the Highwood environmental component of the EIA and will also provide an opportunity to review the proposed Squaw Coulee enlargement concept. Additional Open Houses for other aspects of the EIA will be scheduled for later this year. I hope you will be able to attend.

Thank you for your patience and dedicated interest in the process that led to the recommendation of the Highwood IFN and Diversion Plan. We look forward to your continued involvement in the EIA process. I look forward to seeing you at the upcoming Open House.

Signed by R. Bruce MacLock
Director"

4.2.3 Highwood River Preliminary IFN

The Highwood River Preliminary IFN is summarized in Table 4.6. The Preliminary IFN for the Highwood River was calculated for each week from April 15 to October 15 using 39 years of flow data. The Preliminary IFN is governed by physical fish habitat and water quality. The preferred flow is that which produces the maximum physical fish habitat. The minimum is based on flows required to maintain adequate habitat to preserve the fishery over the long term and to protect against severe water quality deterioration that can lead to fish kills. The minimum is based on natural flow patterns and varies from week to week and year to year. It provides more habitat when ample water is available and protects against severe stress to the fish population at low flows. The preferred and minimum instream flows of the Preliminary IFN form an upper and lower envelope around the scientific IFN. The preferred flows defined in the Preliminary IFN are essentially impossible to obtain in the Highwood River. The

Preliminary IFN also calls for an annual flushing flow, a brief period of high flow in the spring that is required to clean accumulated sediments out of the river.

TABLE 4.6
HIGHWOOD RIVER PRELIMINARY INSTREAM FLOW NEEDS (INTERIM): APRIL 15 TO OCTOBER 15

Preferred	Throughout the period	14.2 cms (500 cfs) or the natural flow, whichever is less
Minimum	High flow periods (natural flows in 20% or less exceedence range for that week)	14.2 cms (500 cfs) or the natural flow, whichever is less
	Moderate flow periods (natural flows in 20% to 70% exceedence range for that week)	70% exceedence fish habitat flow value or flow required to maintain water quality* (whichever is greater)
	Low flow periods (natural flows in 70% to 100% exceedence range for that week)	Fish habitat flow value or flow required to protect water quality (whichever is greater)
Flushing Flow	Three consecutive days each year	The lesser of 28.3 cms (1000 cfs) or the maximum natural flow

*See Appendix F for a discussion of fish habitat flow values (Fish Rule Curves) and water quality flow requirements.

A flow of 14.2 cms (500 cfs) provides maximum fish habitat and is the preferred flow at all times. Whenever the natural flows are less than this, the preferred flow is the natural flow of the river. Since late summer and fall flows rarely exceed 14.2 cms (500 cfs), any withdrawals during this period result in a failure to attain preferred flows.

When the natural Highwood River flows are in the highest 20 per cent of the range for a given week, the minimum and the preferred flow both call for the entire natural flow of the river whenever flows go below 14.2 cms (500 cfs). Consequently, during some high flow periods, any withdrawal often results in a failure to attain either minimum or preferred flows.

When natural flows are in the lowest 30 per cent of the range, the minimum flow is defined as "fish habitat flow or flow to protect water quality (whichever is greater)." Much of the time, these criteria call for the entire natural flow. Consequently, in this flow range as well, any withdrawal often results in a failure to meet either the minimum or preferred flows.

During moderate natural flow periods any withdrawal results in a failure to attain *preferred* flows, but some water can be withdrawn without violating the *minimum* flow criteria. During very low flows, however, water withdrawals can result in not meeting the *minimum* flow criteria.

The Panel also notes that the Applicant provided no IFN for either of the upper Little Bow River or Mosquito Creek, although some preliminary work was done in this regard during the EIA. The residents along both the upper Little Bow River and Mosquito Creek felt that instream needs for environmental protection were important considerations that had not received appropriate attention. The failure to provide IFN for these two streams led directly to the confusion observed during the hearing regarding conveyance flows and the desired instream objectives for the upper Little Bow River and Mosquito Creek. Based on the evidence produced during the hearing the Panel believes that flow rates of 1.13 and 0.85 cms (40 and 30 cfs) respectively reflect the minimum instream objective desired by

adjacent landowners during summer months at times when low flow events occur. The 0.28 cms (10 cfs) conveyance flows specified in the Application by APWSS are far too low to be considered acceptable for IFN purposes.

During the Hearing, the Panel heard that the description of minimum flows in the EIA contained an error. The minimum flows for moderate flow periods should have been "flows that would result in 80 per cent of the fish habitat as defined by the 'scientific' IFN." (This is described in Appendix F). APWSS stated that the absence of an established IFN for the winter period was not a limitation in developing the Highwood Diversion Plan or conducting the EIA because they were not proposing to change current operations outside the April 15 to October 15 period. Other participants in the hearing said that there would be little value in conserving fish habitat in summer if current and future winter water withdrawals limit fish populations in the Highwood River.

4.2.4 Instream Flow Needs and Instream Flow Objectives in the Highwood River

With respect to the development of the Highwood River IFN, the Panel believes that it should comment in more detail regarding the concepts of Instream Flow Needs and Instream Flow Objectives. It is necessary to provide the distinction between these two concepts to more fully understand the process used to develop the Highwood IFN. In the Panel's view it is important to be able to put into perspective the true nature of the IFN used in the Application.

The ultimate purpose of undertaking an instream flow analysis is to answer a practical question: "What flows must be maintained to achieve a socially and environmentally acceptable level of protection for instream values?" The answer to this question has scientific, legal and policy aspects, which are best understood as distinct parts of the overall problem. Each aspect demands a different approach. The scientific task is to determine how fish populations and other instream values respond to changes in flow and water quality. The problem, stated in this form, is devoid of value judgement. Normally, the scientific assessment is undertaken by an agency whose job is to address the legally mandated protection of instream resources or to comply with regulatory guidelines. The scientific management problem becomes one of determining what instream flows are needed to meet a management objective prescribed by a law or regulation that expresses a societal value judgement that instream values are worthy of protection. The policy problem is to decide whether the protection of instream values should be compromised to achieve other social values and goals, particularly those tied to consumptive demands, when there is not enough water to meet both instream and consumptive demands.

In a previous application to the NRCB, APWSS maintained a distinction between the scientific question of determining instream flows needs and the policy matter of making trade-offs between instream needs and consumptive uses. The Province adopted this distinction when AEP first implemented instream flow assessments. The IFN Task Force recommended that the scientific assessment of instream flow needs be conducted separately from the water management planning process. Scientific IFN analyses would provide credible and defensible estimates of the flows and water quality conditions required for protecting instream uses. Allocation decisions and existing or proposed resource developments should not fetter the scientific determination of IFN. An IFN would serve as a benchmark against which a proposed water management plan would be measured. If, during the development and assessment of alternative water management plans, a trade-off between consumptive and instream uses was adopted, the water management plan might specify an Instream Flow Objective (IFO) lower than the IFN.

In this decision report, the Panel will use the words Instream Flow Needs (IFN) to refer to the scientific assessment of instream flow needs and Instream Flow Objectives (IFO) to refer to flow targets adopted as a compromise between consumptive demands and instream needs. The phrase Instream Flow Allocation (IFA) is sometimes used synonymously with Instream Flow Objectives. The Panel will employ the term Instream Flow Allocation to mean flows licensed for instream use.

The assessment of IFN in the Highwood River began with a scientific assessment of the conditions needed for full protection of the fishery. Soon afterwards, members of HRPAC and the TSC began to explore potential diversion plans. The TSC soon discovered that consumptive demands could not be met if the IFN were fully protected. They approached the government with a request to lower the standard of protection. What ensued was not a science-based re-examination of the IFN. It was an attempt to work out a compromise among conflicting requirements for the use of scarce water resources among the various stakeholders. They had different vested interests and understanding of the significance of the information before them. The result, dubbed the 'Preliminary IFN', is not an IFN by our definition. The result is, in the Panel's opinion, more appropriately referred to as an Instream Flow Objective or IFO.

The public process adopted by the TSC and HRPAC to develop the IFN attempted to simultaneously merge the scientific assessment of instream flow needs with the policy oriented water management planning process, contrary to the recommendations of the IFN Task Force. The result, in the Panel's view, lends support to the IFN Task Force's recommendation against this practice. The failure to maintain a distinction between scientific and policy aspects of the problem misled participants about the appropriate objective of the dialogue between members of the public and government technical staff. In the Panel's view, the appropriate role for government experts was to help public participants understand the implications of any trade-offs or compromises in instream objectives or IFO's they were prepared to contemplate. Government technical staff would be able to assist in this matter to the extent that the scientific assessment of instream flow needs illustrated the relationship between flows and instream values. Instead of attempting to redefine the IFN, an explicit focus could have been placed on identifying an acceptable IFO. There was no scientific justification for altering the IFN.

The Panel notes that the stakeholders' impetus to trade off instream values during the public consultation process was an inevitable consequence of the way the water allocation problem was framed for the TSC. Highwood instream flow needs and consumptive demands could not be met within the constraints imposed by the natural flow of the Highwood River. Trade-offs between instream flow needs and consumptive uses became the focal point of the public consultation process. The Panel believes that identifying water allocation problems in the context of basin-wide planning, including an assessment of potential storage, would not have forced the consideration of a trade-off between fundamental values associated with instream needs and consumptive uses. The Panel's views on this topic are outlined in Section 4.4.

The Applicant chose to demonstrate the environmental acceptability of its proposed diversion plans by modelling their compliance with the instream objective (IFO), instead of the science based IFN. This approach produced less compelling evidence in support of the Applicant's claim of environmental acceptability, since this IFO itself is a compromise and any failure to meet this objective is twice removed from the IFN. In the view of the Panel it is important to be able to put into perspective the true nature of the 'Preliminary IFN' used in the Application. Some caution should be used when considering the technical analysis provided by the Applicant that relies upon the IFN as described in the Application. The Panel also notes that the Applicant could have provided a quantitative assessment of habitat loss for any proposed operating plan because the scientific IFN describes the relationship between flows and fish habitat. APWSS did provide a qualitative analysis.

4.3 The Proposed Diversion Plans

It is clear now, and it has been recognised for some time, that the present licensed use of water in the Highwood basin is inconsistent with sound resource management practices and is not protective of fish habitat in a stream that is essential to support a world class sport fishery. The proposed project and diversion plan have been proposed by APWSS as means of resolving current problems while allowing additional diversions from the Highwood River to support irrigation expansion in the Little Bow River basin.

As discussed in Section 3, the Little Bow River Project/Highwood Diversion Plan was developed to achieve multiple objectives. APWSS also stated that the project reflects the principles established by the Alberta Water Resources Commission for water management in the South Saskatchewan River basin in 1986. To accomplish these objectives, specific diversion plans were prepared for the project, using the Water Resources Management Model (WRMM) and data from the historical water records. Thirty-nine years of flow data were used in the modelling. An explanation of WRMM and the assumptions and procedures used to evaluate the diversion plan is provided in Appendix F.

Natural and Base Case conditions were calculated for comparison. The Natural condition was a calculation of the flow conditions that would have existed over the period of record if no water had been diverted or withdrawn for any purpose. The 1986 Base Case was calculated using existing levels of irrigation development and licensed levels of municipal and industrial water demands. It represents conditions similar to those that occurred in the 1980s and provides an approximation of conditions that may be expected to continue if the Project/Plan is not implemented and no other significant water management initiatives are undertaken. The Base Case is the standard against which comparisons are made in the impact assessment.

Various rules for the operation of the existing and proposed water management structures in the study area were tested with the computer model. The rules that were used in the final diversion plan scenario would form the basis of the operating plans that AEP would employ when operating the diversion structures if the proposed project is implemented. The general operation of these structures is described in Appendix G.

4.3.1 The Highwood Diversion Plan/Expanded Diversion Plan

The Highwood Diversion Plan is the operating plan for the proposed three-component project (which consists of the Highwood diversion works and canal, the Little Bow River Reservoir and the Clear Lake diversion works and canal), and for the existing Squaw Coulee Diversion. The plan is based on an assessment of the flows required to protect the aquatic resources of the Highwood River. As discussed earlier, the Preliminary IFN was determined through an intensive process of scientific analysis and public consultation and is summarized in Table 4.6.

The Diversion Plan is based on the Preliminary IFN. According to APWSS, the Highwood Diversion Plan would shift diversions from the late July and August low flow periods to the high runoff periods of May and early June. Based on the period of analysis, the proposed Project/Plan would increase average annual diversions from 9.7 per cent of flow under current conditions (the Base Case – 36,390 dam^3 or 29,500 ac-ft) to 14.9 per cent (59,210 dam^3 or 48,000 ac-ft). The flow changes for August and low flow years are more indicative of the rationale for Project/Plan implementation. Average

diversions in August would decrease from 16.5 per cent in the Base Case (4,180 dam^3 or 3,390 ac-ft) to 7.6 per cent under the Diversion Plan (2,420 dam^3 or 1,960 ac-ft).

The Expanded Diversion plan was developed as a means of using increased storage in Squaw Coulee to alleviate the predicted IFN deficits in the lower Highwood River that would occur were the three-component project and Highwood Diversion Plan to be implemented. The Expanded Diversion Plan would marginally increase average annual diversions from the Highwood River by 0.1 per cent to 15.0 per cent (60,195 dam^3 or 48,800 ac-ft annually). This occurs because of higher diversions during high flow years and lower diversions during low flow years. The Expanded Diversion Plan would further decrease August diversions to only 3.3 per cent of Highwood flows (1,480 dam^3 or 1,200 ac-ft).

A further analysis of the effects of implementing the Diversion Plan and Expanded Diversion Plan was undertaken using 1984 as an example. For the period of record, 1984 represents an extremely low flow year in the Highwood River. Implementation of either of the proposed diversion plans would allow slightly more of the annual Highwood flows to be diverted into the Little Bow basin. Annual diversions would increase from 19.0 per cent under current conditions to 21.8 per cent under the Diversion Plan and 19.2 per cent with the Expanded Diversion Plan. However, during critical low flow periods in August, substantially less water would be withdrawn from the Highwood under either plan. Currently, about 34.2 percent of August flows would be diverted into the Little Bow but this would decline to only 11.0 per cent under the Diversion Plan and would cease altogether under the Expanded Diversion Plan. Thus, the diversion plans were developed to shift diversions from the low flow summer months to the high run-off periods.

In its 1986 report on water management in the South Saskatchewan River basin, the Alberta Water Resources Commission recommended that "where withdrawals are taken from relatively uncontrolled streams during the low flow summer periods, licensing could be limited to as low as 25-30 per cent of the mean annual flow" (pg. 97). Both the proposed Diversion Plan and Expanded Diversion Plan would be consistent with this recommendation, as would current operations.

In the EIA, APWSS used two general criteria to evaluate the effectiveness of proposed diversion plans in meeting water demands in the two river basins. One criterion was the size of deficits to irrigation demands. The second was the ability of the diversion plan to meet instream flow objectives. A third criterion, namely, deficits for municipal, industrial and agricultural demands, could have been used but such deficits seldom occurred because of the priority assigned to these demands and their relatively small size. The ability of the system to provide conveyance flows could also have been used as an evaluation criterion. However based on the 0.28 cms (10 cfs) conveyance flows assumed in the model and the high priority assigned to this use, these demands were always met under both the Diversion Plan and the Expanded Diversion Plan.

4.3.1.1 Irrigation Deficits

Using the results of the WRMM model, average annual irrigation deficits were calculated for a base case and the two diversion plans. Comparisons of changes in these average deficits were used to gauge the impacts of the diversion plans. The EIA employed the 1986 Operating Guidelines as the Base Case and showed the changes in irrigation deficits for the Diversion Plan and Expanded Diversion Plan. The analysis presented in Table 4.7 shows a substantial increase in average deficits for existing irrigators who would not benefit from water storage in the Little Bow River Reservoir, Clear Lake or Squaw Coulee, in the case of the Expanded Diversion Plan.

TABLE 4.7
IRRIGATION DEFICITS PREDICTED IN THE EIA

Irrigation Block	Base Case (1986 Guidelines)	Diversion Plan	Expanded Diversion Plan
Highwood River Basin			
1. Upstream of the Little Bow Diversion	0.0%	24.5%	22.1%
2. Little Bow Diversion to Aldersyde	0.0%	22.9%	21.1%
3. Aldersyde to Sheep River	0.0%	22.3%	20.0%
4. Downstream from Sheep River	0.0%	0.0%	0.0%
Little Bow River Basin			
5. Upstream of Little Bow River Reservoir	1.3%	12.3%	5.7%
6. Downstream of Little Bow River Reservoir	0.7%	2.9%	3.0%
7. Mosquito Creek	0.5%	8.9%	8.6%
8. Clear Lake		2.1%	7.0%

During the hearings a revised assessment of average irrigation deficits was provided by APWSS. These revisions were based on a number of factors. First, the 1986 Operating Guidelines are no longer being used and the Base Case was better described in terms of the 1994 Operating Guidelines. Second, the analysis presented in the EIA included substantial water requirements to meet the dissolved oxygen and water temperature objectives for the Highwood River. At the hearing, APWSS noted that dissolved oxygen levels in the river have not been a limiting factor since the Town of High River no longer discharges treated sewage into the Highwood River so that this water demand can be removed from the analysis. Irrigation deficits were then recalculated using these different assumptions about the Base Case and dissolved oxygen requirements. The revised deficits are summarized below in Table 4.8:

TABLE 4.8
REVISED IRRIGATION DEFICITS

Irrigation Block	Base Case (1994 Guidelines)	Diversion Plan	Expanded Diversion Plan
Highwood River Basin			
1. Upstream of the Little Bow Diversion	0.2%	21.7%	20.7%
2. Little Bow Diversion to Aldersyde	0.2%	21.4%	20.0%
3. Aldersyde to Sheep River	0.2%	20.6%	19.3%
4. Downstream from Sheep River	0.0%	0.0%	0.0%
Little Bow River Basin			
5. Upstream of Little Bow River Reservoir	1.7%	8.5%	4.2%
6. Downstream of Little Bow River Reservoir	1.8%	2.4%	2.7%
7. Mosquito Creek	1.7%	5.4%	7.5%
8. Clear Lake		2.0%	6.5%

The revised estimates show very little difference in terms of irrigation deficits under Base Case conditions. Although average deficits are shown to be slightly higher under the 1994 Guidelines, these differences are considered insignificant given that model results are considered to be accurate to within ± 2 per cent. The revised analysis also confirms that implementation of either of the proposed diversion plan would still cause a substantial increase in deficits for irrigators along the Highwood River.

Irrigators along the upper Little Bow River and Mosquito Creek would still experience minor increases in average deficits.

In interpreting these estimates of irrigation deficits, a number of important observations were made in the EIA and during the hearing. First, APWSS noted that deficits are calculated in terms of the total amount of water specified in irrigation licences but that this full amount is not required in many years to achieve target crop yields. Consequently, they conclude that the estimates of average deficits based on licensed amounts actually overstate the actual deficits that would occur. Second, APWSS concluded that, under the Diversion Plan, the increases in deficits indicated for irrigators along the Highwood River and Upper Little Bow River would only have minimal impacts on crop yields. These impacts would be minor because either the deficits would be small or they would occur in the late July/August period when water shortages would have a minor impact on crop yields (these are discussed in more detail in Section 7). Third, AEP indicated that they would initially operate the project in accordance with the water licence priorities established under the *Water Resources Act*. Thus, senior licencees along the Highwood River could continue to divert water as they had prior to implementation of the project. The deficits predicted by WRMM would then be experienced by other uses, either junior licencees or the Preliminary IFN. Fourth, APWSS indicated that, based on continuation of AEP's current water mastering practices, the predicted deficits would be shared equally among all irrigators in each block on a voluntary basis, thus reducing impacts on individual irrigators.

In response to questions about how to interpret the assessment of irrigation deficits, APWSS indicated that deficits would be most critical during dry periods. They suggested that the significance of these deficits could be determined by examining the model results when Highwood River flows are at the 90 per cent exceedence level; this is equivalent to the one in 10 year drought. Evidence presented to the Panel suggests that these conditions have occurred twice during the 39-year simulation period (1950 to 1988). During the drought of 1977 flows in the Highwood River dropped to the 97.5 per cent exceedence level (i.e. the one in forty year drought) for an eight week period during peak irrigation season (Weeks 22 through 29). The second major drought event occurred in 1985. Highwood River flows were at the 90 per cent exceedence level or worse for seven of nine weeks also during the peak period for irrigation (Weeks 24 through 32). The resulting irrigation deficits calculated by WRMM for these years is provided in Table 4.9, along with a description of the frequency with which deficits would occur were water being diverted from the Highwood River in accordance with the Diversion Plan or Expanded Diversion Plan:

TABLE 4.9
FREQUENCY OF IRRIGATION DEFICITS

Irrigation Block	1977 Deficit	1985 Deficit	Number of Occurrences		
			Base Case	Diversion Plan	Expanded Diversion Plan
Highwood River Basin					
1. Upstream of the Little Bow Diversion	0.0%	8.9%	1/39	38/39	38/39
2. Little Bow Diversion to Aldersyde	0.0%	8.9%	1/39	38/39	38/39
3. Aldersyde to Sheep River	0.0%	6.5%	1/39	38/39	38/39
4. Downstream from Sheep River	0.0%	0.0%	-	-	-
Little Bow River Basin					
5. Upstream of Little Bow River Reservoir	15.7%	22.5%	2/39	6/39	2/39
6. Downstream of Little Bow River Reservoir	8.9%	22.7%	2/39	4/39	4/39
7. Mosquito Creek	12.1%	18.8%	2/39	5/29	6/29

This analysis shows that the frequency of major deficit events would increase substantially if the Diversion Plan was implemented. Such deficits would be almost the norm in the Highwood basin because shortages as severe as those in 1977 and 1985 would be expected to occur in 38 of 39 years. Along the upper Little Bow River, irrigators would experience a three-fold increase in major drought events if the Diversion Plan were implemented. The incidence of deficits similar to those of 1977 or 1985 would at least double for irrigators in the lower Little Bow and along Mosquito Creek.

4.3.1.2 Environmental Requirements

The Diversion Plan proposed by the Applicant does not meet the Preliminary IFN used in the evaluation. As shown in Table 4.10, the percentage of time when the minimum IFN is met would increase as a result of implementing the Diversion Plan. However, the minimum IFN would not be met 100 percent of the time and would be met less than 50 per cent of the time in August through October. If the evaluation had been based on the scientific IFN criteria alone, instead of the Preliminary IFN, the results would have been worse. As noted earlier, the Expanded Squaw Coulee was proposed to overcome these shortfalls in meeting the basic criteria of the minimum Preliminary IFN. The analysis of the Expanded Diversion Plan indicates that it would be able to meet the minimum IFN criteria successfully, but it does not meet the preferred criteria nor would it meet the requirements of a science-based IFN.

TABLE 4.10
PERCENT OF TIME WHEN HIGHWOOD RIVER PRELIMINARY IFN IS MET UNDER BASE CASE, DIVERSION PLAN AND EXPANDED DIVERSION PLAN

Month	April[1]	May	June	July	August	Sept.	Oct.[2]	Total
Minimum								
Base Case	62%	96%	96%	67%	17%	37%	37%	60%
Diversion Plan	62%	97%	99%	84%	30%	42%	38%	67%
Expanded Plan	100%	100%	100%	100%	100%	100%	100%	100%
Preferred								
Base Case	22%	76%	91%	47%	8%	4%	4%	40%
Diversion Plan	22%	75%	94%	56%	10%	4%	4%	42%
Expanded Plan	49%	75%	94%	63%	65%	48%	53%	66%

[1]April 15 to April 30 only.
[2]October 1 to October 15 only.

4.3.1.3 Discussion

Most interveners supported the concept of diverting Highwood River flows during high flow events for storage and subsequent use during periods of low flow. During high flow events, the Highwood Diversion Plan meets both consumptive demands and instream flow needs. However, during low flow events, the proposed Highwood diversion plans do not work. Consequently, none of the interveners were prepared to provide unconditional support for the proposed Diversion Plan or the proposed Expanded Diversion Plan, because neither plan would provide all benefits that were sought by the various interveners and were agreed to in 1991.

From the interveners' evidence, the proposed Diversion Plan does not meet the basic project objectives during low flow events, because license commitments are not met, conveyance flows are inadequate, and the Preliminary IFN is not met. The proposed Diversion Plan does not respect existing licence commitments, and if those commitments were fully exercised, most of the water available during low flow events would be stripped from the Highwood and Little Bow rivers to meet consumptive uses. Both diversion plans represent an improvement of instream conditions from the currently unacceptable situation, but the Diversion Plan would fail to meet even the minimum Preliminary IFN fairly frequently. Irrigation deficits projected under the proposed diversion plans are totally unacceptable to those affected. The Expanded Diversion Plan with increased storage at Squaw Coulee is an improvement over the basic project since it meets the minimum Preliminary IFN, but licence commitments would still not be met and conveyance flows would be inadequate. There is simply no public support for a diversion plan that makes existing water users worse off. All interveners rejected any diversion plans that would ignore existing water rights priorities.

Interveners also questioned APWSS's conclusions that the irrigation deficits predicted were not serious because deficits were calculated in terms of licenced diversion rates rather than actual use under water mastering conditions. APWSS also concluded that the irrigation deficits for irrigators on the upper Little Bow River and the Lower Highwood River were too small to quantify. They also argued that, with water mastering, shortages would be shared. Evidence from Upper Little Bow irrigators suggests otherwise. The more senior irrigators indicated that they were not adversely affected by shortages such as occurred in 1985. However, more junior licensees indicated that, despite having adapted their operations to reflect seasonal irrigation cut-offs, they are the first to be asked to cease operations during dry periods and, in dry years like 1985, this had major effects on their agricultural operations. Any increase in the frequency of large deficits would have very significant impacts for junior licensees. It appears to the Panel that APWSS's assessment of irrigation risk was incorrect.

Similar observations were made during questioning of the lower Highwood residents, but they are less concerned because they generally have senior licences and have been told that this will save them from deficits. However, the model predicts that deficits for this group would increase under either diversion plan. The question becomes would the anticipated deficits likely occur to irrigators or to the Preliminary IFN? Because irrigators have licence seniority, the model may be overstating the probability that the Preliminary IFN would be achieved.

For non-irrigation consumptive demands, the model predicts no deficits. However, this may be due to priorities used in modelling, not licence priorities. Testimony from Upper Little Bow and Little Bow water users associations regarding appropriate levels of conveyance flows indicates that conveyance flows of 0.28 cms (10 cfs) are inadequate to provide good quality water for consumption and river ecosystem needs in the Little Bow River and Mosquito Creek.

During the hearing, the Panel heard that it was possible to expand irrigation around Clear Lake and around and downstream from the Little Bow River Reservoir using stored water diverted out of the Highwood River during high flow events. Some interveners felt that the Diversion Plan with the three-component project would meet the project objectives during high flow events, and this was confirmed by evidence from APWSS and AEP. Specifically, the Preliminary IFN would be met, the irrigators and other licensed water users would be able to withdraw water to the extent authorized by licence, and there would not be a concern regarding conveyance flows. During high flows, the Expanded Project is not needed to support the expansion of irrigation or to increase the security of water supplies. During low flow events, the Diversion Plan would not affect the storage-based expansion of irrigation at and below the Little Bow River Reservoir. Regardless of whether or not the Little Bow River Reservoir and the Clear Lake projects are developed, some interveners pointed out that there would remain a shortage of water in the lower Highwood River and upper Little Bow River.

Most interveners expressed serious reservations about the proposed interim operating plan suggested by AEP and adopted by APWSS as a means of moving to the Diversion Plan over time. Most doubted this plan could actually work because of the difficulties in trying to respect existing water rights and accommodate new demands at the same time. Most felt that the interim operating plan implied a recognition that the Diversion Plan, as proposed, could not succeed.

In short, interveners indicated their opinion that the diversion plans do not work and also do not appear to satisfy the objectives stated by the Applicant.

4.3.2 A Super Expanded Squaw Coulee Reservoir

Due to the inherent limitations associated with the diversion plans proposed by the Applicant, the Panel was interested in alternative diversion plans predicated on the development of additional storage for the Highwood basin at the site of the existing Squaw Coulee Reservoir. APWSS produced model runs that showed that a Super Expanded Squaw Coulee Reservoir with a storage capacity of 16,235 dam3 (13,140 ac- ft) could be developed and would:

- Eliminate all deficits to current and future irrigation.
- Meet the 100% Fish Rule Curve values at all times.
- Provide a 0.28 cm (10 cfs) conveyance flow down the Little Bow River and Mosquito Creek at all times.
- Significantly augment flows in the Little Bow River and Mosquito Creek much of the time, but not to reliably supply 0.85 cms (30 cfs) to these streams.

A further model run, based on an IFN that includes the 80% Fish Rule Curve plus flow reservations for temperature and for flushing, showed that the Super Expanded Squaw Coulee Reservoir would:

- Eliminate all deficits for municipal, industrial and domestic demands.
- Meet all existing water licences.
- Meet the 80% Fish Rule Curve.
- Achieve improved conveyance flows. The model predicts an average shortfall of 0.15 cms (5.2 cfs) to the target flow of 0.85 cms (30 cfs) for the Little Bow River and an average shortfall of 0.07 cms (2.4 cfs) for the desired conveyance flow of 0.57 cms (20 cfs) in Mosquito Creek.
- Show small deficits in irrigation expansion downstream of the Little Bow River Reservoir (0.46 per cent) and Clear Lake (2.85 per cent), and not support Highwood irrigation expansion since deficits would be on average 48.6 per cent.

The Panel's views on these very important model predictions are provided in Section 4.4.3.

While most interveners were uncomfortable with the process used to involve the public in the development and evaluation of the Super Expanded Squaw Coulee Reservoir, there was a general concensus at the end of the hearing that additional storage for the Highwood basin was needed. There was also recognition that the Super Expanded Squaw Coulee Reservoir seemed to have the capacity to fulfil the basic project objectives that the public had identified in 1991. Interveners acknowledged sympathy for Baker Creek residents' concerns regarding the location of the return canal. During the hearing, APWSS presented alternative return canal routes that would mitigate potential impacts in the

Baker Creek area, including the option of avoiding the disturbance associated with a surface canal by replacing it with a buried pipeline. There was an additional concern about the quality of water that would be returned to the Highwood River after having been stored in the Squaw Coulee Reservoir for some time. Other concerns about project effects related to the possible loss of archaeological sites and vistas, loss of native grasslands, disruption to farming operations, transportation disruptions, and environmental effects in the Baker Creek area. There were also concerns about the lack of appropriate public consultation and clarity of information regarding the proposed expansion of the Squaw Coulee reservoir, the time allowed for public review of information, and evaluation of alternatives to storage. The major drawbacks of the Super Expanded Squaw Coulee Reservoir, as identified by the various interveners, were that its social and environmental impacts had been inadequately documented, that alternative storage sites had not been adequately assessed, and that the public consultation process was weak.

All these matters are reviewed in more detail in Section 4.4. where consideration is given to the matter of additional storage and a revised operating plan.

4.4 Panel Views on Water Management

The role of the Panel is to determine whether the proposal is in the public interest. Thus far, we have reviewed the proposal in relation to the proponent's objectives. The Panel believes that any project it approves should be an example of sustainable development.

4.4.1 Development of the Little Bow River Reservoir and the Clear Lake Project

The Panel makes an important distinction between two basic issues presented during the hearing:

meeting the expansion plans for irrigation, in the lower Little Bow River basin and around Clear Lake, through the diversion of water during the spring freshet and times of high flow, and storage of this water;

the resolution of the critical water needs during low flow events in the upper Little Bow River basin, in the lower Highwood River basin, and in the lower Mosquito Creek basin.

The need for storage for the Highwood basin is independent of the consideration of the expansion of irrigation at and below the Little Bow River Reservoir and around Clear Lake, as these rely on water diverted and stored during high flow events In this context, the development of the Highwood diversion works and canal, the Little Bow River Reservoir and the Clear Lake diversion works and canal are not completely relevant to the problems of low flows in the lower Highwood River. Regardless of whether development of the Reservoir and Clear Lake components proceeds, the current situation during low flows in the lower Highwood, upper Little Bow, and lower Mosquito Creek would still need to be addressed. This has been recognised since at least 1991.

With respect to the Highwood diversion works and canal, the Little Bow River Reservoir and the Clear Lake diversion works and canal, the Panel believes that the location and size of the proposed works have been determined using criteria relevant to their operation during high flow events. Regardless of the operating plan required to guide diversions during low flows, the same size and type of works would be required to capture the spring freshet flows.

The Panel has carefully examined the relationship between the operation of the diversion works on the Highwood River and the expansion of irrigation near Clear Lake and the proposed Little Bow River Reservoir. The Panel concludes that consideration can be given to the construction of the proposed Highwood Diversion works and canal and their operation on the basis that the expanded capacity of these diversion works will be used to divert and store the spring freshet. At low flows, the water required for irrigation expansion would be available from storage in the Little Bow River Reservoir. The Panel notes that the additional diversion capacity required to convey the spring freshet to support expanded irrigation is not used during low flows. Therefore, the expanded capacity of the diversion works and canal is not relevant to the capacity and operating guidelines required during periods of low flow.

The Panel adopts a sustainable development frame of reference for the consideration of the proposed project. This frame of reference is based on basic principles that are strongly supported by almost all of the residents of the basins. The Panel takes the view that, on a preliminary basis, the proposed Highwood diversion works and canal, Little Bow River Reservoir, and Clear Lake diversion works and canal must meet the three previously stated criteria:

First, water management projects must respect existing riparian rights and water licences, and should not result in the loss or injury to existing water rights;

Second, water management projects must be able to meet basic environmental criteria to avoid significant adverse effects;

Third, water management projects must be able to meet current and future needs for water for domestic, riparian, and municipal needs, and other consumptive uses.

These considerations are basic to the determination of the public interest, and a project must be able to meet these criteria to be worthy of further consideration by the Panel with respect to the more detailed consideration of associated environmental, social, and economic effects.

The Highwood diversion works and canal, Little Bow River Reservoir and Clear Lake diversion works and canal appear to respect riparian rights and water licences, to meet basic environmental criteria, and to meet current and future demands for water. Diverting freshet flows from the Highwood River and Mosquito Creek does not infringe upon existing water rights and licences since there is enough water to meet all license requirements. At the time of the freshet, environmental concerns are minimal, and the diversion of a fraction of the freshet flow is not expected to have significant adverse environmental effects on the Highwood River. The evidence before the Panel indicates that the diversion works, canals, and reservoir are based on meeting existing and future needs that are known at this time, and there is no evidence to suggest that they are not capable of meeting the purposes for which they are proposed.

The Panel believes it should consider the Highwood diversion works and canal, Little Bow River Reservoir and Clear Lake diversion works and canal in terms of the multi-purpose objectives of the Application. The proposed three-component project satisfactorily meets the criteria of increased security of supply at and below the Little Bow River Reservoir and at Clear Lake for existing and future irrigation, and for municipal and domestic use, including livestock. The reservoir could improve the potential for meeting downstream water demands from the perspective of both water quality and quantity, and it could also provide additional water-based recreational opportunities. The proposed Highwood diversion works and canal, Little Bow River Reservoir and Clear Lake diversion works and canal also provide for the expansion of irrigation in the basin. As proposed, the three-component project would also be consistent with the South Saskatchewan Basin Water Allocation Regulation, which specifies 8,090 ha

(20,000) acres of irrigation expansion for the Little Bow/Clear Lake project. However, the creation of storage at Little Bow River Reservoir and Clear Lake would not completely remove the risk of water shortages during drought conditions.

The Panel believes the Highwood diversion works and canal, Little Bow River Reservoir and Clear Lake diversion works and canal could serve to advance overall sustainable development and management of water in the basin. This is based in part on the conclusion that implementation of these three water management structures could reduce some of the existing irrigation and municipal demands on the Highwood River during the low flow periods. The Panel finds that the proposed three-component project in the Little Bow basin and at Clear Lake is consistent the multiple water use principles of the Government of Alberta.

On a preliminary basis, setting aside the matter of a diversion plan during periods of low flow, the Panel believes that the Highwood diversion works and canal, Little Bow River Reservoir and Clear Lake diversion works and canal do meet the three basic sustainability criteria. Therefore, in the opinion of the Panel, these three components warrant a detailed assessment of their social, economic, and environmental effects. This assessment is provided in later sections of this report.

The Panel is cognisant of the fact that enlargement of the Highwood diversion works and canal, and construction of the Little Bow River Reservoir and Clear Lake diversion works and canal will take some time to complete. Depending on when construction commences, the availability of funds and other factors, such as weather, project construction may take two or three years to complete, at which time an operations plan would be required to commission and start operating the works. The Panel believes that there is sufficient time available to deal with some of the important operational issues previously identified.

4.4.2 Water Management in the Highwood Basin

In the discussion that follows, the Panel will consider whether the proponent's objectives and the proposed diversion plans are compatible with sustainable development. The Panel notes that the management of the water resources in the Highwood and Little Bow basins has proceeded without benefit of the overall water management plan that was promised in 1991. The Panel also observes that, under drought conditions, the water resources in the basins are over-allocated to consumptive uses and the need to remedy this situation has been recognised in the basins for some time. In some cases, the seriousness of the situation is not understood.

The Panel will examine whether the Applicant’s proposed diversion plans are sustainable and are capable of remedying the problems that already exist. In the context of sustainable development, the Panel will comment on the need for storage for the Highwood basin, the options available for storage in the basin, and the need for a sustainable plan to guide diversions during low flows in the Highwood River. The Panel will identify the criteria that might be used to decide the merits of any proposed solution to the current problems and the communities’ desire for further development. The Panel will comment on the need for and the suitability of the Super Expanded Squaw Coulee Reservoir. Finally, the Panel will comment on the development of a Highwood River Management Plan.

4.4.2.1 The Unsustainable Management of Water Resources in Droughts

The Panel notes that the Highwood River has been the subject of public concern regarding water allocation and management since at least the early 1980s. Water quality concerns associated with the Town of High River treated sewage discharge, fish kills, and demands for irrigation have been central issues. Recently, outflows from Frank Lake into the Little Bow basin have been of concern to the people living along the upper Little Bow River. The Highwood River has been the subject of intensive examination and study during much of the past two decades. Unfortunately, these activities have proceeded without the benefit of an overall management plan, an approved set of management objectives, or a clear understanding of how current and future demands will be managed. The Panel believes that the circumstances found within the basins require that a comprehensive and integrative planning perspective be adopted to achieve sustainable development.

Fortunately, most of the time in the Highwood basin there is an adequate supply of water and no special water management interventions are required. During most years, and during most times within a given year, there are sufficient flows to meet consumptive demands and environmental requirements, and any disruptions are not too great. The Panel believes that it is important to be mindful of this current key aspect of the basin hydrology when considering sustainable development of the water resources in the basin.

The Panel also believes it is important to focus upon the circumstances when more extreme events occur. The Panel is aware that flooding does occur in the basin and it heard evidence regarding the recent flood on the Highwood River in 1995. In the context of the application before the Panel, the events that are of particular interest are the low flow events associated with droughts, when water is in short supply and demands are accentuated for consumptive and environment requirements. Droughts also have water quality implications that affect domestic and municipal water use.

From an environmental perspective, the Panel is concerned with low flows because it is under such conditions that certain valued aquatic species, particularly game fish, are placed under stress. Summer low flows result in lower oxygenation of the water and reduced habitat for fish. When low flows coincide with high ambient temperatures, water temperatures can also approach or exceed physiological tolerances. In extreme events, fish and other aquatic life may fail to reproduce or may die. The impacts of episodes of low dissolved oxygen and high temperature depend on the frequency and duration of poor water quality conditions. Winter low flows also create water quality difficulties for aquatic life by reducing the amount of habitat, preventing the movement between pools and freezing wintering eggs in the gravel.

Since the Highwood River has experienced periods of low flows in both summer and winter under natural conditions, some have argued the aquatic and riparian biological communities are adapted to cope with these extremes. The Panel recognises that the natural discharges of the Highwood River provided less than ideal habitat and water quality for aquatic life at certain times and has adversely affected domestic use. It is also true that withdrawals and diversions of water for consumptive uses can only increase the frequency and duration of lower instream flows. The Panel believes it would be unwise to assume that, just because the aquatic species of the Highwood River are adapted to a certain level of natural and man-made or human disturbance, they can cope with more in the future.

The Panel has examined the evidence regarding low flow events. Droughts have occurred in the recent past, with 1977, 1984 and 1986 being noted as dry years. It is not possible to predict when dry years such as these will reoccur but, statistically, such events can be expected once in 20 to 40 years. The Panel adopts the view that examining conditions during dry events is critical to assessing

the sustainability of the water management practices in the basins. It is especially serious when dry periods occur close together. This has occurred in the past and may occur again at any time in the future.

Natural flows in the Highwood River decline more or less steadily after the spring freshet. Based on the 30-year period of record used by the Applicant, weekly average flows in dry years decline to about 3.96 cms (140 cfs) by mid August and decline again to about 3.11 cms (110 cfs) by mid September. This trend is shown in Table 4.11. More extreme lower flows may well have occurred during the full historical record of recorded flows or in the more distant past. Some daily flows would also be less than these weekly averages. The Panel believes that flows below 2.83 cms (100 cfs) are possible during extreme events but, for its purposes, believes that 3.96 cms (140 cfs) represents a typical flow during August in a very dry year.

TABLE 4.11
LOWEST WEEKLY AVERAGE LATE SUMMER NATURAL FLOWS IN RECENT DRY YEARS

Julian Week	Calendar Week Ending	Year	Natural Flow (cms)	Natural Flow (cfs)
31	August 5	1985	3.99	141
32	August 12	1985	3.99	141
33	August 19	1984	4.28	151
34	August 26	1984	3.68	130
35	September 2	1984	3.40	120
36	September 9	1984	3.06	108
37	September 16	1984	3.26	115
38	September 23	1984	3.03	107
39	September 30	1960	3.17	112

The Panel understands and appreciates that, during low flow events, licence holders have co-operated with AEP by sharing the available water. However, for the purposes of examining sustainability in the management of the resource, the Panel does not believe it is reasonable to assume that such co-operation will always occur, or should be relied upon. The Panel adopts the view that existing water licences, which are protected in law, will likely be exercised fully during periods of drought to achieve the purposes for which they were issued.

On the Highwood River, there are licences for the diversion of about 6.43 cms (227 cfs). The priorities of these licences are determined by their dates of application under the Water Resources Act. The highest priority within the Highwood basin rests with a private 1893 irrigation licence for diversion at a maximum rate of 0.50 cms (17.67 cfs) from a location upstream of the Squaw Coulee diversion works. As reported earlier, AEP holds a 1921 licence divert 2.83 cms (100 cfs) into the Little Bow River. AEP also holds a 1933 licence to divert 0.71 cms (25 cfs) into Squaw Coulee and a 1979 licence to divert an additional 0.99 cms (35 cfs). The rest of the licensed diversions from the Highwood River have been issued for a variety of purposes and are held by various parties. The Town of High River holds a ground water licence that may rely upon the Highwood River for about 0.17 cms (6 cfs). However, this is not included in the 6.43 cms (227 cfs) of authorised surface water withdrawals from the Highwood River. Unauthorised but legal riparian uses are also not included in this 6.43 cms (227 cfs). Clearly, if all these licenses and withdrawals were fully exercised simultaneously when natural flows in the Highwood River were as low as 3.96 cms (140 cfs), all the water would be withdrawn from the Highwood and it would be dry.

As a licence holder, AEP exercises its rights according to policies adopted by the Minister. The current AEP policy is described as the 1994 Operating Guidelines. These guidelines limit diversions by AEP to amounts that are below those legally authorised to ensure some flow remains in the Highwood River. The 1994 Guidelines specify that, at flows of 3.96 cms (140 cfs), 1.98 cms (70 cfs) would be diverted to the Little Bow and Squaw Coulee, leaving 1.98 cms (70 cfs) in the Highwood River below High River. Licences authorising diversions below High River and upstream of the confluence of the Sheep River allow total withdrawals of about 0.60 cms (21.3 cfs). If these rights to the 0.60 cms (21.3 cfs) were to exercised simultaneously, there would only be about 1.39 cms (49 cfs) left in the Highwood River upstream of the confluence with the Sheep River. Flows from the Sheep River, which contains treated sewage from Okotoks, would supplement flows in the Lower Highwood. However, the combined flow at the confluence with the Bow River would only be in the order of 1.84 to 1.98 cms (65 to 70 cfs).

The 1.98 cms (70 cfs) being diverted into the Little Bow basin would also be insufficient to meet consumptive demands and conveyance flows in that basin. Existing licences authorize maximum total diversions of 0.70 cms (24.63 cfs) from the upper Little Bow River and 1.19 cms (41.93 cfs) from Mosquito Creek. This represents a combined demand of 1.89 cms (66.57 cfs). However, current practice is to leave 0.28 cms (10 cfs) for conveyance flows in each of the Little Bow River and Mosquito Creek, so that total diversion of 1.98 cms (70 cfs) would only leave about 1.70 cms (50 cfs) available to meet consumptive demands. Clearly, operating under the 1994 Operating Guidelines during low flow periods on the Highwood River would provide insufficient water to meet all demands in the Little Bow basin were they to occur simultaneously.

During low flow events, the Panel concludes that the existing licence commitments cannot be met. Under the priority system, this means that some irrigators would experience serious deficits and social and economic hardships. In extreme cases, even domestic and municipal water requirements could be placed at some risk. This is evident from the deficits predicted by the WRMM model for low flow years (see Section 4.3.1.1).

If licence commitments were honoured under the current operating guidelines, instream flows would have to be sacrificed. Under low flow conditions the IFN essentially requires all of the natural flow. If flows in the Highwood River were 3.96 cms (140 cfs), operating according to current guidelines would mean that the actual flow in the Highwood above Sheep Creek could be less than 1.42 cms (50 cfs). This would leave a very substantial IFN deficit of 2.55 cms (90 cfs), so that only 36 per cent of the minimum IFN would be achieved. Thus, major deficits to the IFN during critical low flow periods would occur even with the protection provided by the 1994 Operating Guidelines. However, meeting the IFN under these low flow periods technically means that no water would be available for diversion for any purpose, including human consumption. Meeting basic domestic and human consumption requirements and other licence obligations makes it impossible to meet the minimum IFN requirements. The Panel believes failure to meet the IFN is not acceptable in the context of sustainable development or the Fisheries Act. It also believes that meeting basic human consumption needs is essential.

Past resource allocations require current resource managers to meet basic human requirements for drinking water and to honour licensed water and riparian rights, even though this means knowingly risking the habitat that supports a world class sport fishery. In the view of the Panel, the imposition of the moratorium on further licences by the Controller in 1977 and again in 1983 reflected a belated recognition that the resource had been over-allocated. Without the moratorium, the situation would have become even worse. Without remedial action in the basins, the Panel sees no possibility of lifting the moratorium. The Panel adopts the view that the existing situation in the event of an extremely dry year is intolerable and does not reflect sound management of these important resources.

The need to remediate the existing situation was recognised in 1990 when the Technical Sub-Committee started its work. In his 1991 letter (see Figure 4.4), MacLock highlighted the situation:

> *"The analysis undertaken by the TSC and government staff indicated that because of the great variability of Highwood river flows over the course of a year and from one year to another, it is not possible, with existing management capability, to simultaneously meet the IFN in the lower Highwood and the demands of consumptive uses licensed to withdraw water from the river….. To alleviate these problems the TSC recommended the following supplemental measures:*
>
> 1. *the implementation of measures to reduce the water supply deficits of existing uses reliant on the Little Bow River or Mosquito Creek that are located above and thus not supplied from the proposed Little Bow Reservoir, and,*
>
> 2. *the development of a plan for water management in the Highwood Basin that would seek means to improve flow and quality conditions in the lower Highwood and reduce the water supply deficits of existing licensed irrigation uses."*

The Panel believes that the two conditions contained in the MacLock letter were a clear and accurate expression of public views, and those views were repeated in the hearings held by the Panel six years later. The Panel believes that these consistently articulated views from the community are the hallmarks of the basic project that the community expected and still expects to be developed. The Panel concludes that steps need to be taken to remediate the existing situation, irrespective of the current Application.

The Panel characterizes the current situation as unsustainable and potentially serious should the region experience drought conditions that are the same as or worse than those experienced in the 1980s. In very dry years, when flows of 3.96 cms (140 cfs) or less would be experienced in the Highwood River during August, the basic criteria of sustainable resource management are not met. The current circumstances in the Highwood basin stand as an example of what can happen when a resource is over-allocated.

In the Panel's opinion, recent attempts to resolve the water shortages by compromising licenced consumptive uses and instream requirements, were fundamentally flawed. Specifically, the Panel does not believe that it is appropriate to attempt to trade-off water rights protected in law, domestic water requirements, and an IFN supported by federal laws and provincial policies.

4.4.2.2 The Proposed Diversion Plan is not Sustainable

As noted earlier, the Panel has adopted a sustainable development frame of reference for the consideration of the proposed project and diversion plans. This frame of reference is based on three basic principles (meeting licensing, IFN, and present and future water requirements) that are strongly supported by the residents of the basin. The Panel takes the view that the proposed water management project must meet these environmental, social, and economic considerations because they are basic to the determination of the public interest.

The Panel has examined the diversion plans to determine whether or not they will respect existing riparian rights and water licences so that there will not be a loss or injury to existing water rights.

This criterion is particularly important to the Panel since it was fundamental to the consensus reached in 1991 when it was recognised that water rights and licences must be respected, particularly for those people in the lower Highwood River and along the upper Little Bow rivers. Despite having been identified as a necessary requirement by the public and subsequently endorsed by the Minister in consultation with the MLA's from the area, the basic requirement of respecting existing water rights is not met by the diversion plans proposed in the Application.

The proposed diversion plans do not respect existing water rights and, as described in Table 4.8, the modelling predicts increased deficits to licensed water users. According to the Applicant, these higher irrigation deficits, particularly along the Highwood River, would occur as a result of the emphasis on IFN in the Diversion Plan. Higher irrigation deficits were also predicted in the Little Bow basin upstream of the proposed Little Bow River Reservoir. Irrigation deficits were discussed earlier in section 4.3.1.1. In the Panel's opinion, creating deficits larger than those experienced before the project for certain water users, while reducing or eliminating deficits for others and creating opportunities for irrigation expansion, is inappropriate.

With respect to meeting basic environmental requirements, the Panel has also considered whether or not this basic requirement of a sustainable water resource management project is met in the diversion plans proposed in the Application. As noted in Section 4.3.1.2, the Diversion Plan proposed by the Applicant does not meet the minimum Preliminary IFN used in the evaluation. If the evaluation had been based on the science-based IFN alone, the results would have been even worse. The Expanded Squaw Coulee was proposed to overcome these shortfalls in meeting the basic criteria of the Preliminary IFN. While the Expanded Diversion Plan is able to meet the minimum criteria successfully, it would still not meet the requirements of a more stringent science-based IFN.

Finally, the Panel has considered whether the proposed diversion plans would be able to meet current and future needs for water for domestic, riparian, and municipal needs, and other consumptive uses. By giving these uses highest priority, both the Diversion Plan and the Expanded Diversion Plan were designed to ensure that municipal/domestic/industrial demands are met.

During periods of low flow, the Diversion Plan allows diversions of water from the Highwood River to supply the total conveyance flow requirement of 0.57 cms (20 cfs). This conveyance flow plus the water needed for municipal, domestic, and industrial demands represent a combined demand of about 0.80 cms (28 cfs). These are considered to be the minimal flows required to deliver water to the Little Bow River and Mosquito Creek. Under the Diversion Plan, these flows are expected to occur relatively frequently.

Community reaction to these low flows is negative. Such low flows in the Little Bow River and Mosquito Creek are not acceptable except on an emergency basis. Even with the Expanded Diversion Plan and increased storage in Squaw Coulee there would be several weeks when conveyance flows in the upper Little Bow River could not be provided even with the expanded Squaw Coulee Reservoir.

In the opinion of the Panel, implementation of the Diversion Plan would result in poor quality water for domestic and municipal purposes because low flows in the upper Little Bow River and Mosquito Creek would be maintained over a significant period during the critical late July and August period. Meeting minimum water quantity criteria without regard to quality of water is inappropriate. This is of considerable concern in that overflows from Frank Lake represent a significant threat to water quality in the Little Bow River. The Panel does not view the combined diversion of 0.80 cms (28 cfs) through Squaw Coulee and down the Little Bow River as meeting the criteria of satisfying domestic and

municipal demands. The diversion plans also do not take into consideration any contingency for unforeseen demands. The Panel concludes that any diversion plan that fails in this regard is not prudent.

The Panel's conclusion is that the proposed Diversion Plan fails to remedy the current problems or meet future needs for water. It does not meet the basic criteria of a sustainable development: it assumes that existing licence commitments would not be met; it would not meet the minimum Preliminary IFN requirements; and it would not meet ecosystem and consumptive needs because of the poor water quality associated with low conveyance flows. The proposed Expanded Diversion Plan would be superior to the Diversion Plan in that it does meet the minimum Preliminary IFN used in the analysis. However, it does not meet the other basic criteria of a sustainable development because it would not meet existing licence commitments, and it would not meet ecosystem and consumptive needs because of poor water quality associated with low conveyance flows.

In summary, the Panel finds serious problems with the Diversion Plan and the Expanded Diversion plan and cannot support either of them.

APWSS and AEP recognized some of the problems with the diversion plans. They proposed using an interim operating plan as a means of moving toward implementation of the diversion plans. However, the Panel does not intend to examine this interim operating plan since the proposed diversion plans do not achieve the basic requirements for a sustainable water resource management project. The Panel simply notes that it agrees with those interveners who indicated that the steps proposed by APWSS and AEP to ultimately achieve the diversion plans were impractical and could not be relied upon.

4.4.3 The Need for Storage for the Highwood Basin

Given that the proposed diversion plans would not meet the criteria of sustainable development, the Panel explored various options for balancing water demand and supply. There are very limited alternatives to deal effectively with the demand for consumptive uses of water during low flows if withdrawals are precluded. Possible options include demand management by restricting diversions during periods of low flow and serving growing demand by creating more water storage.

Restricting all consumptive uses from the Highwood River during low flows would require the development of short-term storage for human consumption. It would also be necessary to adopt specific measures to restrict existing consumptive licences during low flow events, especially licences for irrigation and industrial purposes. There are other issues that would need to be addressed including the legal capacity to restrict diversions and the costs of any associated facilities and compensation. The level of public support among those directly affected would be questionable. It would also be necessary to assess the social, economic, and environmental effects of restrictions on consumption or withdrawals during low flows, and to compare these effects to those of other alternatives, such as storage. Cancelling existing licence commitments and paying compensation, and capping future growth and development in the basin would also be required. Evidence before the Panel suggests there is little or no support at this time for using restrictions on water consumption or withdrawals as a means of achieving IFN during periods of low flow in the Highwood River.

The Panel concludes that storage is the preferred approach for resolving currently unsustainable water management practices in the Highwood basin. The Panel believes that the first priority for consideration of storage for the basin is to remediate the current over-allocation of water during low flow events. This implies that natural flows in the Highwood River would be maintained to

meet IFN requirements, and existing consumptive demands (ignoring any future demands) would be met from storage. In the view of the Panel, the consumptive demands within the upper Little Bow basin and in the Squaw Coulee/Mosquito Creek area require summer flows of at least 0.85 and 0.75 cms (30 and 20 cfs) respectively and preferably 1.13 and 0.85 cms (40 and 30 cfs). These flows are required to provide sufficient conveyance flows, yield good quality water, and meet domestic, municipal and irrigation licensed demands. The proposed Expanded Squaw Coulee Reservoir project falls far short of having the capacity to meet these current demands. It can only meet the minimum Preliminary IFN used in the Application if combined flows in the upper Little Bow and Mosquito Creek are reduced to 0.79 cms (28 cfs) and some licensed water users incur various levels of deficit.

The inherent limitations of the proposed diversion plans created interest in alternative plans predicated on the development of additional storage for the Highwood basin. Attention focussed on the existing Squaw Coulee Reservoir, but with an even greater storage capacity than the proposed Expanded Squaw Coulee Reservoir. In its review of the Application and its Report on the Pre-Hearing Conference, the Panel directed APWSS to explore alternatives that could be viewed as sustainable development. Such alternatives would be predicated on compliance with instream flow needs, meeting licence requirements and conveyance flows, and meeting identified future demands for water.

The Panel has already described in Section 4.3.2 the additional scenarios and modelling provided by APWSS in response to the Panel's request for supplemental information concerning a substantial increase in storage at the Squaw Coulee Reservoir. This alternative came to be known as the "Super Expanded Squaw Coulee Project". The Panel concludes that the modelling shows that the development of storage equivalent to the Super Expanded Squaw Coulee Reservoir would likely meet most current water needs while providing sufficient protection to the environment. The model predicts that the IFN would be observed, and that flows would reliably be at least 0.71 cms (25 cfs) in the upper Little Bow River and 0.50 cms (17.6 cfs) in lower Mosquito Creek. This would serve to substantially correct the current situation where the Panel concludes that the water resource has been over-allocated.

The Panel tentatively concludes that the available modelling shows that, although the development of storage equivalent to the Super Expanded Squaw Coulee Reservoir would provide sufficient protection to the environment, this amount of storage would fall short of entirely meeting most future water need. The Panel believes that, with some further work to optimize the use of stored water, the model might predict that most currently identified future needs could almost be realized. Some future expansion of irrigation on the lower Highwood River and along the upper Little Bow River would not be possible, however.

Since there is not enough water to meet current requirements during low flow events, the Panel takes the view that low flow events could be managed effectively with additional storage for the Highwood basin. The Panel has already stated that the need for storage for the Highwood basin is independent of the consideration of the expansion of irrigation at and below the Little Bow River Reservoir and around Clear Lake, as these rely on water diverted and stored during high flow events. The Panel will examine the effects of the works required to facilitate this irrigation expansion in more detail later in this report. The unsustainable current situation on the Highwood River and upper Little Bow River stills needs to be addressed regardless of whether or not the three-component project proceeds.

The need to provide for winter IFN has not been considered in the above discussion, nor has any provision been made for other unforeseen contingencies. This evaluation has also not considered the effects of an updated IFN that is solely science based. If these additional demands are considered, the combined requirements for storage might exceed the capacity of the Super Expanded Squaw Coulee Reservoir.

The Panel believes that there is a need to consider a continuum of storage and other options to meet current and future needs for the Highwood basin. In the view of the Panel, the question is not whether or not the expanded or the Super Expanded project should be built. The more appropriate question is whether the development of storage such as or equivalent to the Super Expanded Squaw Coulee plus other storage options will be required to meet the long-term needs in the basin.

4.4.3.1 Storage Options in the Highwood Basin

The Panel received and has considered evidence regarding the opportunities for storage in the Highwood basin. The following discussion summarizes the evidence concerning storage in the Highwood basin and was taken from the Application and the supporting reports, and other evidence presented during the hearing. For the Panel's purposes, the available evidence gives sufficient information for reaching preliminary conclusions.

The Application includes a review of the effects of increased storage at Squaw Coulee, including a full Environmental Impact Assessment of the Expanded Project. This assessment was considered acceptable to the Director of Environmental Assessment for Alberta. The Panel also received written and oral submissions from area residents regarding the nature of the effects of Squaw Coulee expansion. The Panel believes that it has sufficient information before it regarding the nature and extent of those effects to give them appropriate consideration.

The Panel requested and received additional information regarding an alternative to constructing the enlarged Squaw Coulee Reservoir that involved further expanding the capacity of the Reservoir from 6,380 dam3 to 16,200 dam3 (5,175 ac-ft. to 13,140 ac-ft). The Super Expanded Squaw Coulee Reservoir would be located in the same coulee that was examined in some detail in the Application filed initially with the Panel. It would have the same basic design as the Expanded Squaw Coulee Reservoir, with a north and south embankment dam. Outlet structures at either end would enable releases of stored water to either Mosquito Creek or to the Highwood River. Development of the Super Expanded Squaw Coulee would require flooding more land, increasing the height of the dams, and increasing the size of the inlet and outlet canals. A comparison of the project data is found in Table 4.12.

APWSS undertook an office feasibility level study of the Super Expanded Squaw Coulee Reservoir based on the engineering completed for the expanded Squaw Coulee. This feasibility study examined reservoir topography and storage, design flood selection and hydrology, land requirements, impacts on roads and utilities, and estimated costs. APWSS also conducted additional environmental investigations of the Super Expanded Squaw Coulee Reservoir. Specific areas examined included water quality assessment, fish habitat, soils, vegetation and wildlife. Additional historical resources impact assessments were completed. An economic analysis of the Super Expanded Squaw Coulee Reservoir was also prepared.

Limited public consultations on the Expanded and Super Expanded Squaw Coulee reservoir occurred prior to the commencement of the public hearing conducted by the Panel. Local residents presented written submissions and oral evidence to the Panel. Much of this evidence described the potential effects of the Expanded and Super Expanded project on area residents. Panel views on the adequacy of this public participation are found in Section 6.

TABLE 4.12
OPTIONS FOR EXPANSION OF STORAGE AT SQUAW COULEE

DESCRIPTION	SUPER EXPANDED	EXPANDED
1. Reservoir		
Full Supply Level (FSL)	1074.0 m (3,523.6 ft)	1073.6 m (3,523 ft)
Total Storage at FSL	16,200 dam^3 (13,125 ac ft)	6380 dam^3 (5,175 ac ft)
Flooded Area at FSL	210 ha (519 acres)	115 ha (284 acres)
Length	7.3 km (4.5 mi)	4.7 km (2.9 mi)
2. North Embankment		
Top of Dam Elevation	1077.0 m (3,533.5 ft)	1075.7 m (3,529,2 ft)
Length	290 m (950 ft.)	280 m (920 ft)
Maximum Height	12 m (40 ft)	10.7 m (35 ft)
Outlet Structure Capacity	2.3 cms (80 cfs)	0.7 cms (23 cfs)
3. South Embankment		
Top of Dam Elevation	1077.0 m (3,533.5 ft)	1075.7 m (3,529.2 ft)
Length	500 m (1,640 ft)	450 m (1,475 ft)
Maximum Height	20 m (65 ft)	19 m (62 ft)
Outlet Structure Capacity	1.7 cms (60 cfs)	1.7 cms (60 cfs)
4. Diversion Canal		
Length	4.6 km (2.9 mi)	4.6 km (2.9 mi)
Design Capacity	3.4 cms (120 cfs)	1.7 cms (60 cfs)
5. Return Canal		
Length	2.8 km (1.7 mi)	2.8 km (1.7 mi)
Design Capacity	2.3 cms (80 cfs)	0.7 cms (23 cfs)
6. Cost Estimate	$15.7 million	$8.2 million

The Panel recognises that more information would have been forthcoming if additional time and effort had been devoted to the identification and assessment of project effects, including the development of mitigation measures with consultation with the local public. Data collected over a longer period of time would have increased confidence in predictions of the precise nature of project effects.

Based on the evidence currently available, the Panel does not see much difference in the nature of the environmental effects of the Expanded Squaw Coulee Reservoir, and the Super Expanded Squaw Coulee Reservoir. Clearly there are differences in the extent and degree of effect since more area of a similar nature is being affected. For example, additional land would be flooded and the size of the dams and related works would be changed. Development of a diversion plan that would optimize use of the additional water stored in the Reservoir could be conducted through additional computer simulations. However, experts in various areas of environmental effects all indicated that they did not expect to see any significant differences in the nature of project impacts were the amount of storage in Squaw Coulee increased from 6,380 dam3 to 16,200 dam3 (5,175 ac-ft. to 13,140 ac-ft). There would be increased social and economic effects and these were partly identified by local residents and aboriginal interveners at the hearing.

Overall, the Panel believes that it has a good understanding of the general nature of the effects of both the Expanded and the Super Expanded Squaw Coulee reservoirs. The Panel recognises that there is some possibility that additional information could lead the Panel to reach different conclusions. However, the Panel believes that, based on community and expert testimony in the hearing, the probability of receiving significantly different new information is small. The Panel believes a more comprehensive public consultation process is required to more fully understand the effects of increased storage in Squaw Coulee (See Appendix C, Article 7). Most parties indicated their willingness to study this and other water issues.

The Panel has already expressed its opinion that, to accommodate future needs, additional storage capacity will be needed for the Highwood basin. In the opinion of the Panel, the Super Expanded Squaw Coulee Reservoir presents a feasible option that appears to meet most project objectives. Further evidence is needed for a panel to come to a final conclusion regarding whether the Super Expanded Squaw Coulee Reservoir is the best way of resolving storage needs in the Highwood basin.

The Panel agrees with the residents of the Squaw Coulee and Baker Creek area that alternative sites to the proposed Super Expanded Squaw Coulee Reservoir require further investigation and consideration. The Panel also agrees that a more in depth analysis of other water conservation practices also needs to be done.

4.4.3.2 Alternatives to the Super Expanded Squaw Coulee Reservoir

The examination of potential storage sites in the Highwood basin is not a new idea. Potential sites for water storage in the Highwood River basin have been previously identified in four separate reports beginning in 1923:

- Highwood River Irrigation Project (Government of Canada, 1923)
- Highwood River Study (A.G. Underhill, 1964)
- Structural Options, Pekisko-Stimson Water Management Study (Alberta Environment, 1987)
- Selection and Evaluation of Potential Dam and Storage Sites, Bull Creek and Tongue Creek - Highwood River Basin (J.D. Mollard and Associates Ltd. 1991)

Each of these reports contains some information about some potential reservoir sites. No report covers all potential sites and the amount of information varies from report to report.

The Application, in a section entitled *Potential Storage Sites-Highwood River Basin,* and various supporting reports, provides a list of previously identified potential reservoir sites (see Map 4.1) in the Highwood River basin (onstream and offstream). These reports also provide preliminary information on cost, engineering feasibility and environmental considerations for sites selected as having the greatest potential for future development. The following is a summary of the information received from the Applicant regarding alternative storage sites in the Highwood basin.

The Fish and Wildlife Division of AEP undertook an environmental pre-screening of all identified sites. This review determined that the three Highwood River sites (1, 2 and 3), the Pekisko Creek site (6) and the Cataract Creek site (11) were unacceptable. A dam at any of these locations would obstruct migration patterns of local and Bow River trout populations. The Highwood River valley and south Pekisko area also provide significant wildlife habitat and are also two of the province's most important ranges for elk. Cataract Creek is considered a unique watershed with high environmental and fishery values. The pre-screening review also determined that the lower Stimson Creek site (7), the

Sheppard Creek site (10), and the Baril Creek site (13) are unfavourable because of potential negative impacts these storage reservoirs would have on wildlife and fish habitats.

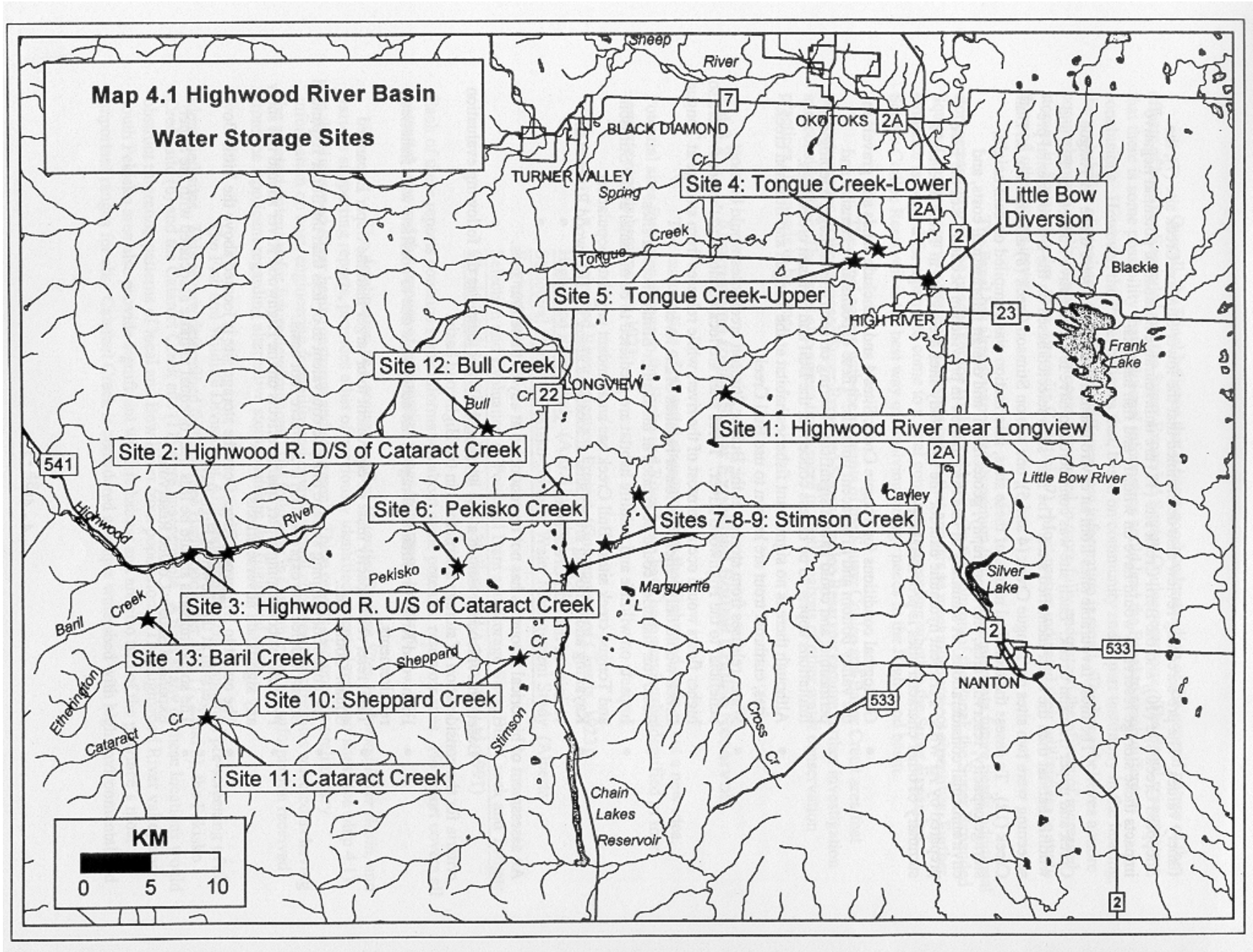
The most favourable sites from an environmental perspective were those on Tongue Creek and upper Stimson Creek. Each site was considered to have fewer negative impacts on fish and wildlife habitat than the other identified sites. The four sites selected based on the environmental pre-screening were two sites on Tongue Creek (4 and 5), one site on Stimson Creek (8) and one site on Bull Creek (12). To assess the technical merits of these sites, information was compiled on dam height, storage capacity, reservoir area, site topography, geotechnical and design information, costs, and environmental considerations. A summary of this information in provided in Section 18 of the EIA prepared by APWSS. Pertinent hydraulic data for the four study sites are shown in Table 4.13 and a summary of other characteristics is provided below.

- Geological conditions for Tongue Creek Sites 4 and 5 include sands and gravels in the valley bottom and in adjacent uplands. These deposits are extensive and permeable, and could have a significant bearing on reservoir leakage. Geological limitations appear to be of less concern at the Bull and Stimson creek sites.
- Although there is no significant fisheries habitat at the Tongue and Stimson creek sites, cutthroat trout are known to use Bull Creek.
- Water releases from storage at the Bull or Stimson creek sites would be most beneficial to the Highwood River. These sites are located closer to the headwaters so higher flows would occur on most of the river, while releases from storage at Tongue Creek would only benefit the lower reaches of the river.
- Reservoir fisheries could be created at the Bull or Stimson creek sites.
- Impacts on wildlife and wildlife habitat are predicted to be minimal at the Stimson and Tongue creek sites. Bull Creek has an abundant ungulate population.
- Kayaking and canoeing are popular at locations along the Highwood River in the vicinity of the Bull Creek sites.

An assessment of historical resources has not be conducted at any of these four sites.

Based on evidence presented at the hearing, the Panel identifies the following evaluation criteria for the consideration of storage alternatives in the Highwood basin.

- Highwood River on-stream storage is not acceptable due to conflicts with fisheries requirements.
- Total reservoir capacity must be equivalent to or larger than the Super Expanded Squaw Coulee site.
- The cost of developing storage must be equivalent to or less than the Super Expanded Squaw Coulee site expressed on a cost/acre foot basis.
- Predictions concerning water quality effects on the Highwood River should not show any significant adverse effects.
- The outlet to Highwood River from the storage site is located above the Little Bow diversion at the Town of High River.
- The social impacts should be less than or equal to those associated with the Super Expanded Squaw Coulee Reservoir.


Map 4.1 Highwood River Basin
Water Storage Sites
Site 4: Tongue Creek-Lower
Little Bow Diversion
Site 5: Tongue Creek-Upper
Site 12: Bull Creek
Site 1: Highwood River near Longview
Site 2: Highwood R. D/S of Cataract Creek
Site 6: Pekisko Creek
Sites 7-8-9: Stimson Creek
Site 3: Highwood R. U/S of Cataract Creek
Site 13: Baril Creek
Site 10: Sheppard Creek
Site 11: Cataract Creek
KM
0 5 10
Sheep River
BLACK DIAMOND
OKOTOKS
TURNER VALLEY
Spring Creek
Tongue Cr
HIGH RIVER
Blackie
Frank Lake
LONGVIEW
Bull Cr
Cayley
Little Bow River
Highwood River
Pekisko
Marguerite L
Silver Lake
NANTON
Baril Creek
Sheppard Cr
Etherington Cr
Cataract Cr
Stimson
Cross Cr
Chain Lakes Reservoir
7
2A
2
22
23
541
533

Map 4.1

TABLE 4.13
PERTINENT HYDRAULIC DATA FOR ALTERNATIVE STORAGE SITES IN THE HIGHWOOD BASIN

Dam	Tongue Creek Site 5	Tongue Creek Site 4	Bull Creek Site 12	Stimson Creek Site 8
Storage Capacity dam^3 (acre feet)	9,800 (7,900)	20,000 (16,200)	20,000 (16,200)	8,700 (7,100)
Firm Annual Yield dam^3 (acre feet)	10,000 (8,100)	18,000 (14,600)	17,000 (13,800)	4,050 (3,300)
Top of Dam Elevation (m)	1,063.7	1,063.7	1,313.5	1,237.0
Full Supply Level (m)	1,060.7	1,060.7	1,310.5	1,234.0
Service Spillway Design Flood cms (cfs)	98 (PMF) (3,450)	85 (1:1000) (3,000)	218 (PMF) (7,700)	90 (1:1000) (3,150)
Emergency Spillway Design Flood cms (cfs)	N/A	800 (PMF) (28,200)	N/A	380 (0.5 PMF) (13,400)
Low Level Capacity cms (cfs)	4.2 (150)	4.2 (150)	4.2 (150)	4.2 (150)
Diversion From Highwood River To Fill Reservoir cms (cfs)	5.7 (200)	8.5 (300)	8.5 (300) (Pumping)	N/A

PMF refers to flows expected at probable maximum flood. Source: APWSS

The Panel makes the following observations regarding the sites presented as alternatives for storage in the application (See Table 4.1.4). The Panel recognizes that these observations are based on preliminary data.

TABLE 4.14
COMPARISON OF ALTERNATIVE STORAGE SITES IN THE HIGHWOOD BASIN

Dam Site Description	Tongue Creek Site 5	Tongue Creek Site 4	Bull Creek Site 12	Stimson Creek Site 8	Squaw Coulee Expanded	Squaw Coulee Super Expanded
Approximate Dam Height m (feet)	17 (56)	17 (56)	35 (115)	18 (59)	19 (62)	20 (65)
Reservoir Area ha (acres)	160 (395)	265 (655)	220 (545)	180 (445)	115 (284)	210 (519)
Storage Capacity dam^3 (acre feet)	9,800 (7,900	20,000 (16,200)	20,000 (16,200)	8,700 (7,100)	6,380 (5,175)	16,200 (13,125)
Firm Annual Yield dam^3(acre feet)	10,000 (8,100)	18,000 (14,600)	17,000 (13,800)	4,050 (3,300)	9,872 (8,003)	19,928 (16,156)
Capital Cost (million 1991 $)	$12.5	$22.1	$57.0	$17.5	$7.1	$15.7
Annual Operation and Maintenance Cost (thousand $)	$125	$221	$570	$175	$71	$157
Cost per Unit of Storage $/$dam^3$ ($/ac-ft)	$1,275 ($1,570)	$1,105 ($1,360)	$2,850 ($3,515)	$2,010 ($2,480)	$1,113 ($1,372)	$969 ($1,196)
Cost per Unit of Firm Annual Yield $/$dam^3$ ($/ac-ft)	$1,250 ($1,540)	$1,228 ($1,515)	$3,353 ($4,135)	$4,321 ($5,330)	$719 ($887)	$788 ($972)

Source: APWSS

The Panel notes that, as presented, the development of storage at the Tongue Creek sites would involve diverting and storing water from the Highwood River and then returning it to the Highwood via Tongue Creek. Tongue Creek enters the Highwood River below the Town of High River and downstream of the Little Bow diversion works. APWSS indicated that Tongue Creek sites would only be useful for supplementing the flows in the Highwood River downstream of High River.

It was the Applicant's opinion that the water stored at Tongue Creek Site 4 could not be returned to the Highwood above the point of diversion to the Little Bow River or to Squaw Coulee. Therefore, no conceptual plans or cost estimates for a return canal or pipeline to the Highwood River above or at High River were provided. Further, APWSS acknowledged that, because return flows from the Tongue Creek sites would enter the Highwood River below the existing diversion works, they are not as attractive as the Squaw Coulee site for water management purposes. Storage at the Squaw Coulee site provides more flexibility because stored water can be directly released to Mosquito Creek and the Highwood River. However, the citizens of Baker Creek felt that the APWSS had undertaken insufficient investigation of the location of return canal facilities to the Highwood River. Further investigation of this matter is required.

There are other reasons why Squaw Coulee storage may be preferable to the other sites. Geotechnical issues at the Tongue Creek sites may make them less desirable than the Squaw Coulee site. As shown in Table 4.14, Tongue Creek Site 4 is slightly larger than the Squaw Coulee site in terms of total storage but the costs per unit of storage are 14 per cent higher at $1,360 versus $1,198 per acre-foot of storage. The storage capacity at both Tongue Creek Site 5 and Stimson Creek Site 8 appears to be too small unless they are considered in combination with another reservoir. Bull Creek appears to have some significant environmental constraints and its capital costs appear to be prohibitive. It is the opinion of APWSS that, of all the alternative sites identified in the Highwood basin, the Stimson Creek Site 8 presents the best alternative to the Squaw Coulee Reservoir. However, Squaw Coulee is capable of storing almost twice as much water and costs almost half as much on a dollar per acre-foot of storage.

From the evidence currently available to the Panel, it appears that Squaw Coulee is the best single site for creating storage for the Highwood basin, taking into consideration storage capacity, location, environmental effects, cost, and water management flexibility. The major drawback with the Super Expanded Squaw Coulee Reservoir, as identified by the various interveners, was its social and environmental impacts.

The Panel has already concluded that additional storage is required for the Highwood basin. The Panel also concludes that, after having considered the available storage sites in the basin, it is possible to develop additional storage for the Highwood basin. The Panel concludes that the Super Expanded Squaw Coulee Reservoir would provide sufficient storage to remedy the current over-allocation of water during low flow events. This site would also meet the basic principles of the development of a sustainable water resource project, having regard to waters rights, environmental effects, and capacity to meet almost all currently identified future demands for water. Having accepted the need for additional storage for the Highwood basin to meet current water demand, the Panel adopts a perspective that a series of storage opportunities may ultimately evolve in the basin over the long term to meet future water demands. In this context, the Super Expanded Squaw Coulee Project and other storage options, such as at Tongue Creek and Stimson Creek Site 8, are all possibilities that need to be examined now.

4.4.3.3 Further Investigations of Storage Options Required

The Panel acknowledges that information deficiencies regarding alternative sites and the Super Expanded Squaw Coulee Reservoir are sufficient to preclude this Panel from coming to a definitive conclusion at this time regarding the expansion of the Squaw Coulee Reservoir. The Panel directs APWSS to update the comparative analysis of the sites available for meeting the storage needed (Note Board Order 9601-1). This analysis should include the Super Expanded Squaw Coulee site, the Tongue Creek Site 4, and Stimson Creek Site 8, and show comparative data regarding environmental, social and economic effects. This assessment must be conducted in sufficient detail to allow a Panel to conclude whether or not the Super Expanded Squaw Coulee Project is in the public interest. Therefore, the Panel further directs APWSS to complete the assessment of the environmental, social and economic effects of the Super Expanded Squaw Coulee project. Public consultation is required as an integral part of the further analysis and assessment. Particular attention should be directed toward finding appropriate routes for return flows to the Highwood using pipelines, since the Panel sees little merit in the further consideration of a large canal through a country residential development when less disruptive, equivalent alternatives may exist.

4.4.5 Highwood River Basin Water Management Plan

The need for the Highwood River Basin Water Management Plan (HMP) was recognized in January of 1991. The evidence before the Panel indicates that, at that time, AEP made a commitment to develop a water management plan for the Highwood River basin that would seek means to improve flow and quality in the lower Highwood River and reduce water supply deficits to existing, licensed irrigation users.

In December 1993, AEP released draft terms of reference for a HMP. The draft terms of reference were intended to serve two purposes. In the short-term they were to provide information to the NRCB on the scope of basin planning that AEP would undertake in the basin. In the longer-term the draft terms of reference were intended to provide the basis for a public discussion of how to develop a basin plan. The draft terms of reference described the nature and extent of planning that AEP would undertake in response to the recommendation for a Highwood basin plan. AEP clearly indicated in 1993 that the HMP would not proceed until the NRCB had made its recommendations on the Little Bow Project/Highwood Diversion Plan and public comments on the terms of reference were taken into account.

The draft terms of reference for the HMP identified a number of objectives. These objectives included identification and assessment of methods for improving management of surface and groundwater in the Highwood River basin, sustaining healthy aquatic and riparian ecosystems, and ensuring an adequate supply of good quality water for all uses. The proposed terms of reference were based on a key assumption that a plan for diverting water to the Little Bow River basin would be adopted and implemented. It was also recognized that it would be desirable to examine some water management issues in the Little Bow River basin as part of the Highwood basin plan. Again it was indicated that this would depend on the results of the NRCB's review of the Little Bow Project/Highwood Diversion Plan.

The draft terms of reference identified a number of water management issues and concerns that need to be addressed in the HMP. These issues and concerns were identified during the Highwood River IFN study and the development of the Little Bow Project/Highwood Diversion Plan. These issues included: water supplies for irrigation in the Highwood River basin; instream flow needs for fish, recreation and environmental protection; physical alteration of fish habitat including restoration and

improvement of habitat; water quality maintenance; impacts of future industrial development; impacts of population growth; institutional changes for allocating water; water conservation; and impacts of changes in management of the Highwood River basin on the Bow River.

AEP indicted that it would initiate the HMP after the NRCB had made its recommendations regarding the Little Bow Project/Highwood Diversion Plan and would take a minimum of two years to complete. Development of water management planning for the Highwood River basin would require the co-operation and participation of numerous individuals, organizations and government agencies, so AEP proposed that a management structure would be established at the beginning of the planning process. The roles, responsibilities and linkages among the various participants would be defined to ensure workable solutions, effective public consultation, and open and co-operative communications. AEP envisioned that the HMP would include: guidelines for water conservation in the basin; reach-specific water quality objectives; water allocation guidelines; instream flow needs and allocations for critical reaches; guidelines for maintaining and enhancing recreational opportunities; and land use guidelines as they relate to water management.

Throughout the public hearing conducted by the Panel, various parties made extensive reference to the HMP. When the Highwood River Basin Water Management Plan was first proposed in 1991, there was an expectation that the Application for the Little Bow Project/Highwood Diversion Plan would have been reviewed by the NRCB within a year or two. It was also expected that the NRCB review process would determine the diversion plans for works on the Highwood River and would assess the acceptability of the development of off stream storage in the Highwood River basin at Squaw Coulee. No one anticipated that the NRCB hearings would begin years later in the fall of 1997 with a decision report presented in 1998.

During the course of the hearing it became evident that most parties believed that APWSS had not provided an acceptable diversion plan. It also became evident that most parties believed further investigation of storage opportunities within the Highwood River basin was required before an acceptable diversion plan could be approved. Because APWSS failed to resolve the issue of the diversion plan and to provide a conclusive solution in response to the need for additional storage for the Highwood River basin, many parties viewed the HMP as a possible means of resolving these outstanding issues.

However, prior to the hearing, AEP clearly indicated that it expected the Panel to deal with the diversion plan and the need for storage in the Highwood River basin before it would initiate the HMP. AEP acknowledged that the terms of reference for the HMP would be altered substantially if the Application is or is not approved. In their closing remarks, AEP indicated that specific water supply issues raised in the hearing would be considered in the proposed basin plan. These specific water supply issues included: fully meeting the Highwood River summer instream objective; establishing and meeting the Highwood River winter instream objective; providing additional flows in the Little Bow basin to benefit water quality in the Little Bow River and Mosquito Creek; and supplying future uses along the Highwood River. AEP identified some measures that could address these issues within the context of the HMP, specifically: the expansion of storage at Squaw Coulee and other storage opportunities in the Highwood River basin; instream works to improve fish habitat; and non-structural measures such as water right transfers.

The Panel has a number of concerns about deferring decisions on diversion plans and additional storage to the HMP. The Panel believes that the operation of the proposed diversion works on the Highwood River is fundamental. The evidence before the Panel is compelling with respect to the need to resolve water management issues associated with low flow events in the Highwood River. Diversion plans compatible with the concept of sustainable development are required and fully satisfying

the three criteria adopted by the Panel (namely, respecting existing water rights, observing IFN, and meeting current and future needs) will require the development of storage for the Highwood basin.

The Panel believes that these matters are relevant within the context of the current Application. Therefore, the Panel has decided that it will not defer consideration of the need for storage and associated diversion plans during low flow periods to the HMP. The Panel will require APWSS to work on these storage alternatives now. In doing so, the Panel fully recognizes that it is adopting an approach to these matters that is contrary to the recommendations made by some parties during the hearing. The Panel also recognizes that there is a public interest in the early resolution of these matters since lengthy delays have already occurred and all parties have made a significant investment in bringing these issues and the project before the Panel.

4.4.6 Panel Directions for Future Work

The Panel has decided to defer consideration of the Diversion Plan and Expanded Diversion Plan. However, the Panel further requires that the diversion plans for the management of water in the Highwood be developed to meet the basic criteria of a sound water management project. Specifically, the Panel believes that the objectives of a revised diversion plan should ensure that:

- The IFN is observed at all times in the Highwood.
- Existing licence commitments are upheld.
- Adequate conveyance flows are maintained in both the upper Little Bow River (0.85 to 1.13 cms or 30 to 40 cfs) and Lower Mosquito Creek (0.57 to 0.85 cms or 20 to 30 cfs).
- Known future demands are met.
- Consideration is given for possibly reserving water for future requirements.

The Panel requires that the diversion plans for the Highwood diversion works be revised to reflect the improved flexibility that would result from developing storage for the Highwood basin. Additional modelling is required to demonstrate the degree to which the above criteria can be met under various low flow scenarios.

The Panel requires that the completed assessment of the environmental, economic and social effects of the Super Expanded Squaw Coulee Reservoir, including the comparative analysis of alternative storage sites and a revised diversion plan, be filed with the NRCB/CEAA within 12 months of the release of this decision report. This information is required so that a Panel can complete the review and issue a decision on the Expanded Squaw Coulee Reservoir, and the diversion plans for the Highwood River. The Panel also requests that the Highwood Preliminary IFN be updated at an early date so that the consideration of the Super Expanded Squaw Coulee Reservoir or other alternatives is undertaken in the most current scientific context.

The Panel requests that the additional information required to complete their review be filed with the NRCB/CEAA and Alberta Environmental Protection. The Alberta Director of Environmental Assessment will then be in a position to confirm that the supplemental information filed with the NRCB is, in his opinion, suitable for the purposes of further public review of this component of the Application. The Board has issued an Order regarding this supplemental information. A copy of the Order is found in Appendix C.

The Panel also requires that the detailed process plan for completing the HMP be filed with the NRCB/CEAA for public discussion and consideration at a public hearing that will be needed when the additional information to complete the review is filed. The process plan for the HMP should be developed recognising the need for storage. The Panel believes that the three criteria should be considered in developing the detailed HMP process plan:

Additional criteria to be considered include:

- The Highwood River Basin Management Plan must include the upper Little Bow and lower Mosquito Creek basin.
- The planning process must strive for balanced and representative public consultation with an independent facilitated process.
- The plan must address all sources of pollutants including non-point agricultural sources and Frank Lake outflows.
- Significant future development in the basin and associated growth and demand for water must be anticipated.
- Fisheries management considerations, including the need for habitat improvement, must be addressed.
- The winter IFN requirements must be addressed.
- The need for IFN for the Little Bow River and Mosquito Creek must be re-examined.
- Flood protection and planning must be considered.
- The role of the Highwood River basin must be considered in the context of the Bow River basin.

4.4.7 Concluding Comments

The Panel has given detailed consideration to the overall nature of water management in the Highwood River and Little Bow River basins. The three-component project, which consists of the Highwood diversion works and canal, Little Bow River Reservoir and Clear Lake diversion works and canal, appears to respect riparian rights and water licenses, meet basic environmental criteria, and meet current and future demands for water. On a preliminary basis, the Panel concludes that the three-component project does meet the three basic criteria of sustainability adopted by the Panel. Therefore, in the opinion of the Panel, the Highwood diversion works and canal, Little Bow River Reservoir and Clear Lake diversion works and canal, warrant detailed consideration of their social, economic, and environmental effects.

The proposed diversion plans, however, do not meet the three basic sustainability criteria adopted by the Panel. The Panel has serious concerns about the Diversion Plan and the Expanded Diversion Plan, and has concluded that the plans, as proposed, would not be in the public interest.

The Panel has also concluded that storage is required in the Highwood River basin in order to achieve sustainable water resources development. The Panel has considered the potential role of the Expanded Squaw Coulee Reservoir in meeting the need for storage. The Panel has concluded that the amount of storage offered by this alternative would be insufficient to meet current demands. Consequently, the Panel has decided not to give further consideration to the social, economic, and environmental effects of Expanded Squaw Coulee Reservoir described in the Application.

The Panel has also concluded that, having considered available sites in the basin, additional storage can be developed in the Highwood basin. The Panel further concludes that the Super Expanded Squaw Coulee Reservoir would provide sufficient storage to remedy the current over-allocation of water during periods of low flow in the Highwood River. The Super Expanded Squaw Coulee would meet the basic principles of the development of a sustainable water resource project, having regard to water rights, environmental effects, and capacity to meet almost all currently identified future demands for water. However, at this time, the Panel acknowledges that there are information deficiencies in the evidence and deficiencies in the public process. These deficiencies preclude this Panel from coming to a definitive conclusion regarding the potential impacts of expanding water storage in Squaw Coulee Reservoir.

The Panel has deferred consideration of the public interest with respect to the Squaw Coulee component of the Application pending the receipt of additional information which assesses the environmental, social, and economic effects of a Super Expanded Squaw Coulee Reservoir and other alternatives. The Panel has also deferred further consideration of the public interest regarding the diversion plans, pending receipt of a revised diversion plan that may be more flexible as a result of developing storage for the Highwood basin. The Panel requires that a completed assessment of the social, economic, and environmental effects for the Super Expanded Squaw Coulee Reservoir, including a comparative analysis with alternative storage sites, and a revised diversion plan be filed with the NRCB/CEAA within 12 months of the release of the Panel's decision report. The assessment should include a balanced and representative public consultation process plan involving an independent facilitated consensus building and decision-making process.

5. ENVIRONMENTAL EFFECTS

The proposed three-component Project is intended to improve water supply by diverting and storing water in the proposed Little Bow River Reservoir and Clear Lake. It would also result in a variety of environmental effects, some of which are positive and some of which are negative. This section of the report discusses the environmental effects of the proposed three-component project that are relevant to the Panel's deliberations, particularly water quantity and quality, fisheries, vegetation and wildlife, and soils and lands.

The Panel recognizes that the nature and extent of impacts of proposed developments depend on the state of ecosystems and their components at the time a development takes place. During the hearing, the Panel heard of evidence about historical, current and possible future states of the lower Highwood River, the upper Little Bow River and Mosquito Creek basins. As discussed in Section 4, the Panel understands that these basins have been subject to numerous impacts since settlement and that some of the impacts have been severe. The riverine ecosystems have not always returned to a state similar to that which existed at the time of impact. Increasing water demands have placed the aquatic environment of the lower Highwood River, the upper Little Bow River and Mosquito Creek basins under pressure.

In past decisions, the NRCB has taken the view that examination of potential environmental effects of a project must include consideration of cumulative effects because project impacts do not occur in isolation from the many other effects influencing ecosystems and their components. This approach is clearly warranted in the current joint review, given the historical development of the lower Highwood River, the upper Little Bow River and lower Mosquito Creek basins, and the relatively high water demands to which the aquatic ecosystems are subjected. The Panel is also aware that most development projects give rise to indirect or secondary impacts in addition to the direct or primary impacts.

In past decisions, the NRCB has recognized that the fundamental properties of ecosystems and populations of living organisms make predicting responses to impacts difficult or impossible. The Panel has dealt with this problem by concentrating on the potential response of ecosystem components about which more is known, by examining evidence before it about the historical record of the ecosystem under consideration and similar ecosystems elsewhere, and by making conservative assumptions in the face of uncertainty. By these means, the Panel has arrived at qualitative assessments of the risk that ecosystems will undergo changes of state and has examined the potential of management measures to control or avoid unwanted changes. Naturally, the Panel is most concerned about the risk of large, potentially undesirable changes that may be difficult or impossible to reverse. The Panel believes that the approach the NRCB has adopted in past decisions is appropriate to its examination of that risk.

The Panel intends to examine the effects of the proposed three-component project on the various components of the regional ecosystem that would be most affected by the project. The discussion will also highlight the environmental consequences of the current situation in which the scarce water resource has been over-allocated. It will then consider the effects of the project as a whole in terms of cumulative effects of the proposed project in the Little Bow River, lower Mosquito Creek, and lower Highwood River basins.

In assessing environmental effects the Panel has put its mind to the significance of the residual environmental effects after having considered mitigation measures. The CEAA requires the Panel to consider measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project. Whenever the Panel concludes the project would

cause a significant adverse environmental effect, this report will clearly state that conclusion and assess mitigation measures along with habitat compensation plans that are technically and economically feasible.

This environmental section of the decision report will focus on the concerns expressed throughout the public hearing regarding water quality and aquatic ecosystems with special emphasis on fisheries. It will also focus on prairie terrestrial ecosystems including vegetation, wildlife, soils and land capability. In examining environmental effects the Panel will have regard for the need to enhance water supply while maintaining water quality; the need to conserve existing aquatic, riparian, grassland, wetland, and terrestrial ecosystems; and the need to retain and maintain the support and involvement of the area community in achieving environmental protection.

5.1 Water Quality

In the following discussion the Panel will attempt to assess the effects of the three-component project on surface and groundwater water quality. Surface waters include the Little Bow River, the Little Bow River Reservoir, Mosquito Creek, Clear Lake, and the Highwood River. Groundwater includes surficial aquifers adjacent to and hydraulically connected to the identified surface water bodies, with emphasis on the upper Little Bow region, Clear Lake, and Little Bow River Reservoir.

The Diversion Plan proposed by the Applicant contemplated reducing flows in the upper Little Bow River to the minimum required for conveyance, domestic and municipal purposes. The Panel believes that such flows are inadequate and inappropriate. Earlier in this report the Panel requested that revised diversion plans be filed with the Panel. Therefore, effects of the Diversion Plan and the Expanded Diversion Plan will not be considered at this time. The Panel defers review of environmental effects associated with the revised diversion plan until the requested information is received. The Panel expects that a panel review of these matters will be completed before the enlarged 8.50 cms (300 cfs) diversion works on the Highwood River are ready to operate.

The Panel expects that the revised diversion plans will provide a stable and adequate flow in the upper Little Bow River during low flows. There may be a period (while additional storage is being developed for the Highwood River basin) during which it may be necessary to operate the expanded Highwood River diversion works under the current (1994) guidelines during low flows. The Panel will therefore make certain assumptions in reviewing the effects of operating the three-component project during low flows. The Panel will assume that the most serious water quality impacts in the Little Bow River will occur during low flows while the Highwood River diversion works are operated in accordance with the 1994 guidelines. These effects would be similar to those predicted by the Applicant in the Environmental Impact Assessment within the accuracy of model predictions. Water quality during low flows may improve when a revised diversion plan is implemented.

The 1994 guidelines provide higher flows in the Little Bow River during low flows than the minimum flow proposed by the Diversion Plan. The beneficial freshening effects of higher flows in the Little Bow River may be accompanied by a proportionately increased transport of nutrient and sediment loads into the Little Bow River Reservoir, thereby slightly altering predicted eutrophication levels. The Panel notes that reservoir modelling was not done to predict the net water quality effects resulting from higher summer flows in the upper Little Bow River in conjunction with the flushing impacts expected from tripling the diversion rate during the spring freshet. The Panel accepts that modelling this scenario would likely not provide definitive information on water quality, but would predict a range of expected outcomes that would be indistinguishable within the context of annual variations. The Panel expects that water quality monitoring will continue throughout the project

implementation phase and that AEP would make any necessary operational adjustments to ensure that any risk associated with the somewhat higher flows during the low flow season is addressed.

The Panel believes that adopting the 1994 guidelines as the basis for its assessment of water quality effects during low flow events reflects a cautious approach to assessing these effects in the Little Bow River, and a risk-managed approach to assessing these effects in the Little Bow River Reservoir. A panel would be in a position to confirm the assessment of the nature and magnitude of these effects when the future review of the revised diversion plans has been completed. Depending on the information available at that later stage a panel may draw similar or different conclusions, but this Panel does not expect the nature and magnitude of those effects to be as great as those assumed in the current assessment.

5.1.1 Water Quality Criteria

The Applicant evaluated water quality by comparing predicted results to use-specific water quality objectives defined by the Bow River Water Quality Task Force (1991) and current provincial and federal guidelines. The multipurpose uses considered were municipal and domestic drinking water supply, agricultural and industrial supply, recreational contact, and environmental / ecosystem conservation. Negative impacts were reported as major if results exceeded water quality criteria and minor if results degraded water quality but did not exceed water quality criteria. The water quality criteria used in the Applicant's assessment are described below.

5.1.1.1 Drinking Water Criteria

It is generally acknowledged that good quality drinking water can be produced from almost any water source provided the appropriate purification technology is used. As a result, the drinking water criteria used by the Applicant were based on the technical definition of levels of raw water quality for domestic and municipal supply. Three levels of raw water quality were defined: Level 1 - high quality, Level II - good to moderate quality, Level III - poor quality. Each successive level indicates that there may be a need for more advanced and costly treatment to bring the quality up to Canadian Drinking Water Guidelines.

5.1.1.2 Environmental Criteria

The Applicant used different environmental criteria in the Highwood River and within the Little Bow River basin reflecting the higher priority given to the Highwood fishery by AEP. In the Highwood River, criteria were defined for cold-water sport fish by the Fish and Wildlife Division of AEP. Aquatic plant development was also considered. Analyses in the Little Bow River basin included criteria for cold water and warm water ecosystems, wildlife, recreation and aesthetic enjoyment as defined by the Bow River Water Quality Task Force. Selected objectives are summarized in Table 5.1.

In the Highwood River, water quality results were evaluated against temperature and dissolved oxygen criteria for two life-stages of rainbow trout and mountain whitefish that are present during July and August (Table 5.2). Acute criteria protect against short term or sudden events which could result in death, and chronic criteria protect against longer term events which could result in slowed growth or stress.

TABLE 5.1
SUMMARY OF SELECTED WATER QUALITY OBJECTIVES FROM BOW RIVER WATER QUALITY TASK FORCE

Water Quality Parameter	Domestic Supply	Cold Water Ecosystem	Warm Water Ecosystem	Contact Recreation	Aesthetic Enjoyment	Irrigation	Livestock Watering	Industrial
Temperature (º C)		22	29					
Dissolved Oxygen (mg/L)		>6.5	>5.0					
Total Phosphorus TP (mg/L)	<0.010, <0.055, >0.055			0.040	0.055	0.025	0.100	
Ammonia (mg/L)		0.32	0.11					
Nitrate (mg/L)	<10, >10						100	
River Aquatic Plants (g/m^2 dry wt.)		200	200	75	200	200		200
River Benthic Chlorophyll (mg/m^2)		100	100	50	100	100		100
Lake/Reservoir Chlorophyll (mg/m^3)	<2, <25, >25			15	25			
Total Dissolved Solids TDS (mg/L)	<500, >500					700	1500	
Fecal Coliforms (counts/100mL)	<10, 10-100, >100			200				
PH	>6.5-8.5, <6.5-8.5	9.0	9.0	8.5				
Turbidity (JTU, NTU)	<10, >10			50				
Conductivity (mS/cm)						1.0		
Sodium Adsorption Ratio						4		

Source: Adapted from APWSS Application

TABLE 5.2
SUMMARY OF JULY/AUGUST WATER QUALITY CRITERIA
FOR PROTECTION OF HIGHWOOD RIVER FISHERIES

TEMPERATURE	
Rainbow Trout	
Acute - adult and fry	daily maximum 24 º C
Chronic - adult and fry	7-day mean < 19 º C
Mountain Whitefish	
Acute - adult	daily maximum 22 º C
Acute - fry	daily maximum 24 º C
Chronic - adult and fry	7-day mean < 18 º C
DISSOLVED OXYGEN	
Rainbow Trout and Mountain Whitefish	
Acute - adult	daily minimum 4.0 mg/L
Acute - fry	daily minimum 5.0 mg/L
Chronic - adult and fry	7-day mean minimum 5.0 mg/L

Source: Adapted from APWSS Application

In the Little Bow River basin, predicted water quality results were compared with criteria for ecosystems, and recreation and aesthetic enjoyment. Ecosystem objectives are intended to protect aquatic life and maintain ecosystem integrity by:

- Maintaining background water conditions within the range conducive to organism survival and to which the local species are adapted;
- Preventing toxic effects of heavy metals, industrial chemicals and other human-caused pollutants; and
- Controlling nutrients, principally nitrogen and phosphorus, to levels that do not promote rapid growth of algae and aquatic plants and associated changes in ecosystem structure (i.e. eutrophication).

Two goals of these objectives are a diverse plant and aquatic invertebrate community, and fish tissue with no unpleasant taste or odour which complies with guidelines for human consumption. Wildlife criteria are the same as aquatic ecosystem criteria.

The objectives for recreation included: small risk of bacterial or viral infection, high degree of water clarity, no excessive weed or algal growth that is unsightly, no odour or oily sheen, and no hazardous chemicals.

5.1.1.3 Criteria for Agricultural and Industrial Use

Water quality criteria for agricultural use were taken from the Bow River Water Quality Task Force. Good irrigation water has low salt and trace metal content, herbicide levels that are non-toxic to plant growth, no bioaccumulative contaminants or pathogenic organisms, low to moderate algal growth, and nutrient levels which do not stimulate nuisance plant growth in conveyance canals or irrigation pumpworks.

Salt content is an important variable impacting crop yields and soil productivity. It is evaluated via a number of complementary measurements, including Total Dissolved Solids (TDS) in solution, expressed as mg/L; ionic conductivity expressed as mS/cm; and Sodium Adsorption Ratio (SAR), expressed as a calculated ratio of sodium to magnesium and calcium. High levels of dissolved minerals and salts (TDS) inhibit water uptake by plant roots and can cause scale deposits on equipment. High SAR values can cause nearly irreversible damage to soil structure with concomitant loss of productivity. Some crops are more tolerant to salts than others. Soil type will also determine the relative susceptibility of crops to harmful effects. Surface waters available for irrigation usually have significantly elevated levels of TDS, conductivity, and SAR compared with natural rainfall which is "soft" with very low levels of dissolved minerals and salts.

The goals for livestock watering are no bioaccumulative contaminants or pathogenic bacteria, low to moderate salt content, non-toxic levels of nitrogen, pesticides and trace metals, and nutrient levels which do not stimulate growth of toxic blue-green algae.

Industrial water quality criteria were designed to maintain low to moderate weed and algal growth so water withdrawal is not physically impaired. Maximum permissible concentrations of river benthic chlorophyll and aquatic plants are the same as those for irrigation.

5.1.2 Water Quality Modelling

Surface water quality data for the EIA were gathered in 1982, 1990, and 1991 and taken from historical AEP NAQUADAT records. Some new evidence and updated modelling results were also received at the hearings regarding 1996 and 1997 water quality data. Predicting water quality in the Little Bow River basin required a succession of computer models. Expected weekly flow predictions from one model (WRMM) were fed into another model for water quality (WQRRS); these were then fed into another model for reservoir water quality (BETTER) and then into another for verification of trophic status (BATHTUB)2.

A WQRRS configuration of the Little Bow River (from the Highwood River to Travers Reservoir) and of Mosquito Creek (from the Squaw Coulee outlet to the confluence with the Little Bow River) was calibrated to 1990 conditions. Water quality modelling of the Little Bow River using

2The acronyms are explained in Appendix E

WQRRS was done for a single year using 1986 flow rate data to represent a recent average flow year, and 1990 meteorological data. APWSS felt it was impractical to simulate river water quality for the entire 38-year period of record processed by the distribution model WRMM. A continuous 10-year period from 1979 to 1988 was selected for BETTER and BATHTUB reservoir simulations to cover the normal range of reservoir levels and inflow-outflow regimes affecting water quality. In addition to the use of the BETTER model in the EIA, Clear Lake was also re-evaluated in 1997 using another model (WASP) and 1997 water quality data, modelled over a 10-year simulation period of 1969-1979.

The Panel recognizes that the sequential linkage of models generates results that can be useful indicators of trends. However, with an accuracy of about ± 25-30 per cent, specific outcomes cannot be determined with certainty. Errors are introduced by gaps in the mathematical description of complex biological processes, the use of literature values, surrogate reservoir data for calibration, estimates for some input variables (such as biological reaction rates), numerous assumptions regarding the physical configuration and operation of the project, and the propagation of error through the sequential linkage of models. The Panel observes that since the modelling results are based on input data averages they indicate average conditions that can be expected. Sensitivity analysis on water quality variables was not done. Therefore situations that are significantly better and significantly worse are expected within the natural variability of seasons and years.

The focus of the Applicant's water quality assessment in the Highwood River was water temperature and dissolved oxygen as they affect the fisheries in July and August, and to a lesser extent, the plant community because of its effect on dissolved oxygen. The Applicant used regression models, developed from simulation modelling, to predict daily water temperatures and dissolved oxygen concentrations from air temperature, river discharge and aquatic plant biomass. The predictors were derived from measured meteorological conditions, estimated weekly average natural flows from 1950 to 1988, and recent aquatic biomass measurements.

To evaluate impacts, these results were compared with the water quality criteria as defined in Table 5.2. To provide a baseline, temperature and dissolved oxygen levels under natural flow conditions were also evaluated against the criteria. The degree of impact was measured in relative terms as the incremental exceedence of water quality criteria (the increase in the number of July/August days when water quality criteria were predicted to be exceeded compared to the number under natural flow conditions) and in absolute terms as the magnitude of the exceedence.

In the Little Bow River key variables evaluated included temperature, dissolved oxygen, nutrients and total dissolved solids. Temperature and dissolved oxygen results were presented daily from May to October. Nutrient and total dissolved solids results were presented as seasonal average values for spring and summer/fall. Riverine pH, aquatic plants, coliform bacteria, suspended solids, pesticides/herbicides and heavy metals such as mercury were not explicitly modelled; instead predictions for the Little Bow River were based upon scientific understanding of aquatic ecosystems.

The simulation models BETTER and BATHTUB were configured to the Little Bow River Reservoir and Clear Lake and calibrated with information from Crawling Valley Reservoir, an irrigation reservoir near Bassano. These models were used to predict temperature, dissolved oxygen, nutrients, algal biomass (reported as chlorophyll production) and total dissolved solids. Empirical models were used to supplement this information in the prediction of algal biomass. Mercury was predicted from a qualitative analysis of current water conditions in the region, particularly from observations made at the Glennifer and Oldman reservoirs. Qualitative predictions were used to evaluate coliforms.

Groundwater modelling was not done for any of the project components because impacts were judged to be unlikely and/or minor and/or readily mitigable. This was based on available regional hydrogeological data from well–drilling logs supplemented with professional judgement regarding surface-groundwater interactions. Predictions of possible impacts were of a qualitative nature only.

In the Panel's view evidence presented during the hearing confirmed the selected models are likely the most appropriate available predictors of project effects on surface water quality under southern Alberta climatic conditions. Notwithstanding some variation in results among different experts (which reflected different assumptions regarding input variables), the predictions varied in degree, but delivered consistent trends.

5.1.3 Baseline Conditions

5.1.3.1 Water Quality in the Little Bow River

New evidence consisting of 1996 and 1997 water quality samples and updated reservoir modelling showed that water quality in the Little Bow basin has deteriorated significantly since the original EIA. Adverse impacts were reported along the full course of the Little Bow River and Mosquito Creek down to and including Travers Reservoir. The Panel has considered the revised predictions of project effects for this new environmental baseline, and then identified and assessed those effects arising from the three-component project. The Panel heard that if the project is approved, the Applicant intends to proceed with construction because it expects AEP to solve these regional water quality problems. Numerous interveners expressed grave concern if regional water quality problems are not addressed and urged the Panel to address this issue. Table 5.3 summarizes key indicators at twelve sampling points in the Little Bow basin, illustrating the progressive degradation of Highwood water as it travels down Mosquito Creek and the Little Bow River to Travers Reservoir.

The Applicant states that current water quality in the Little Bow River is hard (median 188 mg/L $CaCO_3$), alkaline (pH 8.17), and strongly buffered and rich in dissolved solids. Historically, upstream water quality reflected the excellent water quality of the Highwood River diversions, and downstream water quality reflected cumulative pollution inputs from many point and non-point sources. Loadings from Mosquito Creek, (a tributary to the Little Bow River), which receives municipal sewage discharged from Nanton via Nanton Creek, were considered in the original modelling. Other historic influences are the erosion of soil banks, and agricultural operations including inputs from cattle manure from feedlot and ranching operations.

Concentrations of total dissolved solids and alkalinity are highly variable both seasonally and longitudinally. Concentrations generally increase in a downstream direction, especially downstream of Mosquito Creek, and the lowest concentrations are measured in summer. Suspended solids are low and variable in most seasons, though they are higher in spring. Historically phosphorus and nitrogen concentrations were sufficient to support a high level of plant production indicative of moderate enrichment. More recently, phosphorus levels in the Little Bow River upstream of the Frank Lake outlet already exceed the phosphorus goal for domestic water supply. Bacteriological quality is quite poor, with the highest coliform counts being found in the spring.

TABLE 5.3
TOTAL PHOSPHORUS LEVELS (MG/L) IN THE HIGHWOOD/LITTLE BOW BASIN AND SELECTED WATER QUALITY OBJECTIVES

Sampling Site	Spring	Summer/ Fall	Winter	Annual Mean*	+/- SD
Highwood River					
Reach 3-5 from High River to Bow River confluence	0.04	0.03	0.11	0.05	+/- 0.11
Upstream of High River	0.03	0.01	0.005	0.01	
Squaw Coulee Reservoir**					
Inflow from diversion canal	0.04	0.02			
Open water reservoir samples				0.03	+/- 0.01
Mosquito Creek					
M1 upstream at #534	0.06	0.04	0.16	0.07	+/- 0.08
M2 Squaw Coulee tributary inflow	0.17	0.06	0.57	0.17	+/- 0.26
M3 upstream of Nanton	0.25	0.08	0.33	0.16	+/- 1.41
N1 Nanton Creek at Hwy. #2	0.16	0.13	0.31	0.17	+/- 0.06
M4 at Nanton	0.32	0.18	3.55	0.83	+/- 2.5
M5 at #529 upstream of LB Confluence	0.25	0.09	0.68	0.22	+/- 0.27
Little Bow River Above proposed reservoir					
LB1 at Little Bow Canal	0.17	0.02	0.01	0.06	+/- 0.15
LB2 at Hwy. #2	0.09	0.02	0.10	0.06	+/- 0.07
LB3 south of Frank Lake inflow near #540	0.07	0.03	0.05	0.04	+/- 0.3
LB4 downstream at #533	0.07	0.03	0.09	0.06	+/- 0.05
Below proposed reservoir LB 5 at Carmangay	0.10	0.05	0.09	0.07	+/- 0.07
LB6 at inlet to Travers Reservoir	0.06	0.05	0.04	0.05	+/- 0.03
Little Bow River Exhibit 146* **				**1996-97 Data**	
LB2 at Hwy #2				0.02	
Upstream of Frank Lake				0.03	
Frank Lake discharge				2.70	
South of Frank Lake				1.13	
LB4 downstream at #533				0.54	

Water Quality Objectives for Total Phosphorus (mg/L)	
Livestock Watering	< 0.100
Domestic Supply (3 levels)	< 0.010, < 0.055, > 0.055
Aesthetic Enjoyment	< 0.055
Alberta Ambient Surface WQ	< 0.05
Contact Recreation	< 0.040
Irrigation	< 0.025

Total Phosphorus levels above 0.1 mg/L indicate a hypereutrophic water body (EIA)

*****Mean values taken from EIA containing primarily 1982, 1990, 1991, 1992, and some 1994 data
****** Exhibit 18 Response to Federal Government Jan. 6, 1997 Request for Supplemental Information
***Exhibit 146 Submission of AEP regarding Frank Lake Water Quality Strategy Progress Report Nov. 7, 1997
Spring = April, May, June; Summer/Fall = Jul, Aug., Sept., Oct., Nov. ;Winter = Dec., Jan., Feb., Mar.
SD = reported standard deviation

A major new impact on water quality in the Little Bow River has been identified as unlicensed outflow from the Frank Lake wetlands treatment system. Discharges into the Little Bow River from Frank Lake were observed in 1993, 1994, 1996, 1997, all considered wet, high runoff years. The Frank Lake conservation area is an important wildlife preserve maintaining diversity in the prairie region. It is host to 194 species of vascular plants, one reptile, two amphibians, 168 bird, 16 mammal and two fish species. Ducks Unlimited is licenced to operate the wetlands which receive treated agro-industrial effluent from Cargill, treated municipal effluent from High River, and inflow from the local tributary streams named Blackie and Mazeppa creeks.

The Town of High River contributes a higher annual volume than Cargill, but the more concentrated Cargill effluent contributes five times the phosphorus load as the town and is the single largest source of phosphorus in Frank Lake. The local tributaries typically contribute about 15 per cent of the incoming phosphorus. Ducks Unlimited is licensed to dilute the combined influent to maintain conditions suitable for wildlife by diverting of Highwood River water of up to 2467 dam^3/yr (2000 ac-ft/year). Diversions during July and August are not permitted (see Section 6.4).

The main cause for concern regarding water quality is excess phosphorus. Normally a limiting nutrient, increasing phosphorus levels rapidly stimulate algal and aquatic plant growth, accelerating eutrophication. Phosphorus levels greater than 0.1 mg/L create hypereutrophic conditions in lakes. The resulting rapid and prolific weed and algal growth would increase diurnal fluctuations in dissolved oxygen, causing stress to fish. Because the Frank Lake wastes are organic in origin, the phosphorus is in a readily assimilated form, as confirmed by the high ratio of dissolved to total phosphorus at 0.85. Measurements downstream of Frank Lake show phosphorus concentrations in the Little Bow River have increased 32 times over concentrations reported in the EIA and total loading has increased by a factor of 40 times (Table 5.4).

TABLE 5.4
COMPARISON OF FRANK LAKE OUTFLOW AND LITTLE BOW RIVER AVERAGE NUTRIENT LOADING

Water	Total Phosphorus		Total Nitrogen	
	Concentration mg/L	Load kg/day	Concentration mg/L	Load kg/day
Little Bow River	0.02	2	0.28	27
Frank Lake	2.90	78	3.05	83
Little Bow R. downstream of Frank L.	0.65	80	0.88	110
Increase due to Frank L.	32 times	40 times	3 times	4 times

Source: Exhibit 146: Submission of AEP regarding Frank Lake Water Quality Strategy Progress Report, Nov. 7, 1997

Hearing evidence confirmed that discharges from Frank Lake occur naturally and are expected to continue on a periodic basis, on average about once every three years when net inflow from precipitation and runoff exceeds net evaporation. Downstream impacts include greater difficulty and cost in water treatment at Vulcan and Carmangay, and noticeable adverse changes in water quality in the lower Little Bow River and in Travers Reservoir. These chemical effects appear to have been intensified by daily diversion cycling practices in which summer diversions from the Highwood River occur at night and are shut off during the day. The fluctuating water levels in the Little Bow River cause aquatic plants

to die off, and the decomposing vegetation feeds further eutrophication. Historic conditions indicated no impairment of aquatic life in terms of ammonia in the lower Little Bow River, while present conditions do indicate this impairment.

During the hearing some of the recently increased water treatment costs reported by Vulcan were attributed by AEP to improving chronically insufficient clarification treatment rather than a specific response to treating the effects of Frank Lake overflow. Carmangay has had to install a new raw water settling pond to pre-treat its drinking water supply (water presently withdrawn from the Little Bow River), unable to wait any longer for an alternative water supply from the proposed Little Bow River Reservoir. Both situations reflect ongoing difficulties with turbidity, algae and suspended solids in treating Little Bow water prior to any new effects caused by Frank Lake overflow, and any possible effects caused by the project. Added health risks arise since the disinfection processes to kill bacteria and parasites in drinking water are less efficient in the presence of suspended solids, and if organochlorine carcinogens are generated by chlorination of water containing high levels of dissolved organic compounds released by algae and decomposing vegetation.

Data gathered in 1997 in the upper Little Bow basin also detected nitrate concentrations in groundwater that exceed the Maximum Contaminant Level (MCL) for drinking water. Nitrates are common indicators for human sewage, fertilizer runoff, and animal manure. Measurements of depth to groundwater suggested many of these shallow groundwater wells near the Little Bow River were hydraulically connected to the Little Bow River and anecdotal stories reported seasonally fluctuating water quality coincident with changes in river flows.

Average water quality conditions in the Little Bow River may already impair water use during the open-water season. The Applicant identified a variety of factors that contribute to this observation. Domestic and municipal water supply are affected by fecal coliforms and suspended solids found throughout the basin, and by dissolved phosphorus in the lower Little Bow River. Livestock watering does not appear to be impaired by current water quality conditions. The use of water for irrigation is affected by aquatic plants, algae, and fecal coliforms found in the entire basin. Maximum water temperature, minimum dissolved oxygen, and aquatic plants and algal growth affect cool water aquatic species. Contact recreation and esthetic enjoyment are also affected by aquatic plants, algae, fecal coliforms and suspended solids throughout the basin.

In determining the baseline conditions, the Panel observes that numerous point and non-point sources have combined to create the present state of environmental degradation in the Little Bow basin. There are no firm indications that this trend will reverse before Clear Lake and Little Bow River Reservoirs would be filled. This poses a potential threat to the long-term success of the three-component project. The present state of environmental degradation in the Little Bow basin remains a concern even if the project does not proceed. Expectations for population and other growth in the region would suggest that the effects of municipal sewage and stormwater discharges and runoff from intensive agricultural practices would not abate unless corrective actions are taken. This is environmentally unsustainable, similar to the current unsustainable situation with over-allocation of water.

There is a great temptation to focus on known point sources such as Cargill effluent, High River sewage, High River stormwater, Nanton sewage, and Frank Lake discharges as discrete targets which can be regulated and require no change in general public behaviour. The Panel heard extensive evidence in this regard. Although the Panel appreciates and considers necessary AEP's commitment to resolving Frank Lake discharges, it also observes from hearing evidence that the nutrient load from Nanton, another point source widely recognized as significant, is approximately 1/3 of the annual nutrient load conveyed in Mosquito Creek. Obviously the cumulative effects of non-point source agricultural

contaminants are also significant in this region. The Panel heard numerous public statements of concern reflecting growing recognition of these effects and willingness to begin addressing them. The Panel concurs that this is necessary. The Panel is of the firm view that these other opportunities for improving the baseline conditions merit serious immediate consideration: community remedial action in non-point source management is required in addition to any AEP regulatory directives addressing the point sources and any AAFRD educational programs such as "Cows and Fish" or other environmental programs. Basin communities and associations will need to work together to protect their local public interest in water quality.

5.1.3.2 Water Quality in Squaw Coulee Reservoir and Mosquito Creek

Water in the existing Squaw Coulee Reservoir is moderately turbid and oligotrophic with respect to algal growth, reflecting the high quality of diverted Highwood River water. The reservoir is well mixed with little thermal stratification, high summer oxygen levels and low salinity levels. Levels of total phosphorus (0.032 mg/L) exceed those found in the Highwood inflow water (0.016 mg/L) suggesting re-classification as mesotrophic based on nutrient levels. The combined effects of light-attenuating turbidity and relatively low nitrogen levels are thought to limit algal growth in this small water body and help to maintain the oligotrophic status. However downstream interveners with irrigation systems near the confluence of Mosquito Creek and the Little Bow River reported chronic and severe equipment plugging problems due to prolific algal and plant growth, reflecting high nutrient levels in Mosquito Creek downstream of Squaw Coulee.

Current water quality in Mosquito Creek reflects its prairie origin - extremely hard, alkaline (pH 8.1) and rich in dissolved solids. Water quality is highly variable seasonally and changes downstream because of a number of influences, including discharge from Squaw Coulee and inflow from Nanton Creek. Water quality is improved by Squaw Coulee discharges during the irrigation season and degraded in winter by Nanton municipal sewage effluent. During the spring and summer (April – September) water quality routinely meets irrigation criteria, with conductivity less than .8 mS/cm and SAR less than 2. This includes the time frame during which proposed diversions into Clear Lake would occur. A spring flush in April/May gives rise to a short-term spike in total dissolved solids, phosphorus, nitrogen and fecal coliforms from Nanton sewage discharge. Bacterial contamination is moderate and organic enrichment is moderate to severe.

Municipal sewage discharge from the Town of Nanton is a recognized contributor to this situation. During winter there is no natural flow in Mosquito Creek and Nanton's sewage discharge is undiluted. In spring and summer there is supplemental flow diluting Nanton's sewage by up to 125 times so that there is no apparent change in downstream measured concentrations. During this time Nanton's relative contribution is 1/3 of the total phosphorus load moving downstream. Phosphorus levels in Mosquito Creek are consistently higher than irrigation guidelines (Table 5.3). The Panel observes that baseline impacts from intensive livestock and agricultural runoff are already significant, with potential adverse impacts on downstream water quality in Clear Lake and Little Bow River Reservoir.

The Applicant presented evidence that average water quality conditions in Mosquito Creek currently impair water use during the open-water season in a manner similar to that found in the Little Bow River. Factors limiting water use include fecal coliforms, suspended solids, dissolved phosphorus, aquatic plants, algae, water temperature, and dissolved oxygen.

5.1.3.3 Water Quality in Clear Lake

The Applicant indicated that Clear Lake is subject to high evaporative losses and negligible flushing. Inputs consist of precipitation, runoff, and inflow from Clear Brook and groundwater discharge into Clear Lake from the north, east and west. Runoff and Clear Brook inflow are typically short term, during snowmelt in February and March. There are no stream outlets to Clear Lake except seepage into local surficial aquifers to the south. Historically Clear Lake has experienced wide fluctuations in water levels, from flooding adjacent farmland to a dry-out in 1985 with 100 per cent fish mortality. Hearing evidence attributed the dry-out to a combination of extreme drought and changing local patterns of water withdrawal and use, suggesting this was not a natural state for Clear Lake.

Water quality data gathered in April 1997 confirmed historic data that Clear Lake and adjacent wetlands are extremely hypereutrophic with high salt levels, caused by natural processes of evaporative concentration. Conductivity and SAR in the lake were 1.25 mS/cm and 4.2 respectively, which is just above Alberta Agriculture's typical "safe" thresholds of 1.0 mS/cm and 4.0 for irrigation. Water in the adjacent wetlands ranged from similar values to much higher values with conductivity of 8.5 mS/cm and salinity at 43.9. Despite the high trophic status of Clear Lake, sufficient dissolved oxygen can be present to support a cool-water fishery because the shallow lake is well mixed in the open water season.

Clear Lake was described as the most important and only local area for recreation and wildlife. Groundwater near Clear Lake was reported to be excellent by local residents.

5.1.3.4 Water Quality in the Highwood River Downstream of High River

The Applicant stated that the Highwood River reach of concern from a water quality perspective extends from just below High River to the Bow River confluence. Currently, water quality in this reach of the Highwood River is similar to other southern Alberta rivers draining the Rocky Mountains, in that the water is alkaline and very hard. The water is well buffered by dissolved carbonates with mean annual pH of 8.2. If surface runoff, municipal stormwater or effluent containing urea or ammonia enter the river, this pH value shifts the aqueous ammonia-ammonium equilibrium to the un-ionized ammonia form, which is toxic to fish at very low levels. The warm water aquatic ecosystem objective is less than 0.1 mg/L ammonia. Total dissolved solids (minerals and salts in solution) are highest in winter and late summer and lowest during spring freshet, ranging from 167 – 235 mg/L. Suspended solids (fine particles of sediments, silts) are low except during spring freshet.

Prior to July 1989, water quality in the Highwood River was affected by the discharge of treated sewage from High River, resulting in moderate enrichment with organic matter, nitrogen, phosphorus and fecal coliforms. After the removal of treated sewage discharges, nutrient concentrations and bacterial contamination are low and indistinguishable from upstream levels, with the exception of nutrients downstream of the input from Sheep River.

The aquatic plant community is dominated by species typical of the enriched, hardwater rivers of the prairies. Aquatic plants are particularly prolific in the reach from downstream of High River to Highway 2, averaging from 20 per cent to 30 per cent coverage. Conspicuous growth of macrophytes is confined to near-shore areas and in low-flow years, the river flow in shallow areas may be reduced to a network of small channels wending through macrophyte beds.

Water temperature, dissolved oxygen and pH fluctuate on a daily basis in summer. Water temperature responds rapidly to solar radiation and although average temperatures are cool, warm weather promotes rapid increases in water temperatures. The highest water temperatures in the Highwood River tend to occur upstream of the confluence with the Sheep River. Dissolved oxygen and pH respond to photosynthesis and respiration of the aquatic plant community. As a result, when plant beds are fully developed in summer, the daily extremes of dissolved oxygen can produce supersaturation of the water column in daylight, and concentrations that threaten fish and other aquatic life at night.

Significant fish mortality was reported in the Highwood River in the mid-1980s. When historical water quality conditions were reconstructed using recorded flows in the predictive regression model, a period of elevated water temperatures, very low dissolved oxygen concentrations, and elevated ammonia levels coincided with the episodes of fish mortality. Dissolved oxygen has not dropped below 6.5 mg/L since the diversion of High River sewage in 1989. However, the potential exists for an isolated excursion, as the licensed emergency overflow for High River sewage treatment is into the Highwood River, not Frank Lake.

Concentrations of metals are well within their natural ranges and except for a few individual measurements of iron during spring freshet and aluminum and zinc in summer, are well below levels known to be harmful to aquatic life.

5.1.4 Project Effects on Water Quality

5.1.4.1 Effects on the Little Bow River and Reservoir

The Applicant stated that there is a potential impact in the Little Bow River from the introduction of sediment or toxic materials during construction. Possible toxic materials include hydrocarbon fuels, lubricants, hydraulic fluids and other fluids necessary for heavy equipment operations. This potential would be minimized through the development of special provisions, a code of good construction practice including waste management, monitoring to ensure compliance with the established standards, and prompt spill containment or recovery. The introduction of sediments could have minor, negative and short-term impacts on water quality for aquatic life.

Operating the diversion canal works would cause significant changes in Little Bow River flows over recent experience. Upstream of the proposed reservoir, maximum diversion flows can be at the canal capacity of 8.50 cms (300 cfs) during the freshet, decreasing to normal conveyance flows in summer and winter. The Applicant plans for the 8.50 cms (300 cfs) flow to occur 50 per cent of the time between mid-April and mid-June, then about 1/3 to 1/4 of the time from mid-June to mid-July. The increased flow rates would cause the river to rise about 0.5 m (20 in). Analysis of channel erosion processes shows that below flow rates of 17.00 cms (600 cfs) the river slope would not be changed due to the presence of coarse materials in the riverbed. Flows above 8.50 cms (300 cfs) would not be normal but could arise temporarily during severe storm flooding. As an operational procedure, if high flows from local runoff in the Little Bow River were occurring, diversions would be reduced to lessen the downstream flood potential. During natural flood conditions the gates at the diversion structure on the Highwood River would be closed altogether.

Concerns were raised during the hearing that decreases in the level of the Little Bow River in summer could adversely impact local groundwater in shallow wells near the river. These adverse impacts were associated with the proposed Diversion Plan minimum conveyance flows of about 0.28 cms (10 cfs) that theoretically could permit a more rapid flow of contaminated upland groundwater towards the river. Until additional storage is developed for the Highwood River basin and diversions are operating according to revised plans, the current (1994) diversion guidelines will remain in force. No changes in natural transport processes should occur over the seasonal fluctuations that are characteristic of this basin.

High flow events during spring diversion of up to 8.50 cms (300 cfs) could have the opposite beneficial effect of changing the local hydraulic gradient to favour the movement of fresh surface water to groundwater. Technical arguments and submissions of historical groundwater surveys suggested that the Little Bow River and nearby shallow groundwater wells are hydraulically connected. The Panel accepts the Applicant's final argument that the seasonal reversal of the hydraulic gradient would likely have a net neutral effect on shallow adjacent wells. Because the direction of slow-moving groundwater flow may reverse, the net transport of contaminants or freshwater in either direction is expected to be minimal. The Panel supports the Applicant's indication that groundwater monitoring would be undertaken in the upper Little Bow River as a precaution.

Downstream of the proposed reservoir, peak spring flows would be dampened, reducing erosion risk. Flows through most of summer and early fall would be augmented and stabilized, though still lower than historical peak flows. Further downstream, flows would be more like Base Case flows as water is withdrawn to meet irrigation demands.

The Applicant predicted negative and long-term potential impacts upstream of the proposed Little Bow River Reservoir. One major negative and long-term potential impact was associated with increases in the summer water temperatures to the extent that they could inhibit the fishery. A variety of minor negative and long-term potential impacts were identified. These included: an increase in the frequency and duration of summer dissolved oxygen concentrations below critical levels for aquatic life; increases in suspended solids that may further impair domestic water supply and contact recreation; periodic modest increases in concentrations of heavy metals; and increases in bacterial contamination during summer which would further impair domestic water supply, contact recreation and the irrigation of vegetable crops.

The Applicant predicted positive and negative long-term potential impacts downstream of the proposed reservoir. Positive minor long-term effects were associated with decreasing water temperatures for about 40 to 50 km (25 to 31 mi) below the reservoir; reductions in bacterial contamination; and phosphorus reduction resulting in the marginal reduction in aquatic plant biomass and significant reduction in benthic algae. The benefit in phosphorus reduction is contingent on achieving a eutrophic (not hypereutrophic) Little Bow River Reservoir.

Negative minor long-term effects were identified due to ammonia levels periodically elevated to levels toxic to aquatic life and periodic modest increases in concentrations of heavy metals. Predicted effects associated with dissolved oxygen are expected to be mitigated.

Downstream water in the Little Bow flowing at 8.50 cms (300 cfs) would have the characteristics of Highwood freshet water: it would be low in nutrients and turbid, carrying sediments that would gradually deposit along the Little Bow River and eventually in the proposed reservoir. In addition to this primarily inorganic sediment load, Frank Lake effluent will also be swept down the river and into

the proposed reservoir. Frank Lake overflow is a recent occurrence in the basin and was not previously considered in any project description.

Hearing evidence regarding Frank Lake outflow included recent reservoir water quality modelling. Introducing additional organic matter and nutrients adversely impacts reservoir water quality by causing an upward shift to severely hypereutrophic. The degree of this shift was argued at the hearings, based on different modelling runs by various experts. However, the direction of the impact was clear and consistent. Increased nutrients will increase eutrophication and aggravate the current weed and algal growth issues in the Little Bow River. A hypereutrophic Little Bow River Reservoir would increase several adverse effects: the cost of domestic and municipal water treatment, nuisance plugging of irrigation equipment, bacterial levels and recreational health risk, unpleasant tastes and odours in the treated water, and the frequency and intensity of anoxia and fish kills. They are also likely to increase the rate of heavy metals release and bioaccumulation, notably of mercury, requiring public consumption advisories. Levels of carcinogens generated by chlorinating drinking water could exceed threshold risk levels and constitute a more serious risk than nuisance taste and odour problems. The quality of released water from the Little Bow River Reservoir would also deteriorate, particularly with respect to increased levels of ammonia and heavy metals, increasing the frequency of both acute and chronic exposure risks for fish downstream of the proposed reservoir.

The project impacts of changing the Little Bow River Reservoir from eutrophic, as indicated in the EIA, to hypereutrophic under current baseline conditions are thus significant adverse environmental effects. Updated modelling of the Little Bow River Reservoir using current water quality is summarized in Table 5.5.

Nothing can be done in terms of project operations or dam design to mitigate these effects. AEP submissions described fourteen remediation options to deal with the nutrient loading from Frank Lake. The options fall within three general categories:

1. diverting natural local streams around Frank Lake and directly into the Little Bow River (essentially replacing spills out of the Frank Lake wetlands with natural creek water);

2. redesigning flow patterns and lake operations to improve the nutrient removal efficiency of wetland processes; and

3. implementing source elimination or reduction technologies.

AEP indicated they were confident from their preliminary analysis of remedial options that a satisfactory resolution or combination of technical approaches would be found. Testimony at the hearings indicated a strong public preference for implementing source elimination or reduction technologies and a regulatory preference for some combination of runoff diversion and wetland management. Neither the town of High River nor Cargill Ltd. presented their views regarding ultimate disposition of their effluents into Frank Lake. The Applicant stated that, in their view, it was not their responsibility to resolve this issue or to pay for its future resolution as part of the project.

TABLE 5.5
COMPARISON OF REPORTED ESTIMATED PHOSPHORUS LOADINGS TO THE LITTLE BOW RIVER RESERVOIR VS. EIA BASELINE LOADS

Reference	Phosphorus Load into Little Bow River Reservoir P_{tot} kg/year	Load Comparison (multiples of EIA baseline load)	Predicted Reservoir Trophic Status
EIA (1995)	1200 – 1365 Little Bow River and Mosquito Creek	1.0 (EIA baseline load)	Upper Eutrophic/ Hypereutrophic
Exhibit 87 (Hardin-Davis, Inc.)	940 Nanton sewage (measured value) 1000 High River stormwater ***** 670 Nanton stormwater 7,390 Frank Lake '96 18,610 Frank Lake '97	0.7 x EIA 0.7 x EIA 0.5 x EIA 5.4 x EIA 13.6 x EIA	 Severely Hypereutrophic
Exhibit 98 (AEP)	2940 Mosquito Creek upstream non-point sources******	2.2 x EIA	This quantity was not modelled in the 1995 EIA
Exhibit 171 (Golder)	1365 EIA baseline + 2250 Frank Lake 3615 total	 2.7 x EIA	 Hypereutrophic
Exhibit 171 (Golder, Referencing Exhibit 93 Sched. A (E&S))	1365 EIA baseline + 4473 Frank Lake 5838 total	 4.3 x EIA	 Hypereutrophic
Exhibit 140 (PWSS)	787 Little Bow River + 398 Mosquito Creek ~ 1200 EIA baseline + 12,000 Frank L. avg. 96-97 13,200 total	 11 x EIA	 Severely Hypereutrophic
Exhibit 171 (Golder)	1365 EIA baseline + 528 natural Frank Lake 1893 total	 1.4 x EIA	 Upper Eutrophic/ Hypereutrophic
Exhibit 171 (Golder)	1365 LBR baseline + 495 mitigated Frank Lake 1860 total	 1.4 x EIA	 Upper Eutrophic/ Hypereutrophic
Exhibit 347 (AEP)*******	Mitigated Frank Lake *and* 60% reduced Little Bow River loads 80% reduced Mosquito Creek loads	< original EIA baseline	Mesotrophic/ Lower Eutrophic

***** reduced by 50% from 2000 kg/yr to reflect hearing testimony
****** 6 month load from 1997 monthly average data for open-water season in Mosquito Creek
*** mass loads not reported, only % changes

The Panel does not find it necessary to canvass the various methods available to mitigate point source pollution from Frank Lake. Such a review is unreasonable since the remediation studies are still in progress. The Panel notes with concern that should one of the apparently preferred less costly runoff diversion options be implemented, the Little Bow River and Reservoir would still be in poorer overall condition than initially modelled and presented in the EIA (Table 5.5). The predicted result *after* implementing the proposed Frank Lake mitigation is that net phosphorous loading to the reservoir would still be approximately 1.36 times the values modelled in the EIA, approximately a 40 per cent increase. The Applicant supported this as acceptable remediation with additional phosphorus "levels comparable to natural background loading" such that no water quality thresholds would be exceeded in the reservoir. However, the Applicant's claim that drinking water quality in the Little Bow River Reservoir would be improved over historical Little Bow River conditions is now questionable.

The Panel observes that this prediction is based on models of *average* conditions, and given that seasonal extremes occur, average conditions are likely to be exceeded with no guarantees that water quality criteria would be consistently met. The Panel is therefore in the position of reviewing a much desired water supply project with a much less favourable and less certain outcome with regard to water quality for multi-purpose uses. The Panel is mindful of public comments to the effect that "even bad water is better than no water". It is the Panel's view that where options for improvement are known and available, it is in the public interest to pursue them. The Panel will identify the outcome that meets the public interest test, and allow the regulators the flexibility to achieve that outcome in consultation with the local communities.

The Panel concludes that the creation of a hypereutrophic water body is undesirable, and directs that mitigation targets shall be sufficient to achieve, as a minimum, the eutrophic status originally proposed in the environmental impact assessment. Even this state is not considered entirely desirable, and would create a new water body ranking in the higher end of eutrophic water bodies in Alberta.

The Panel accepts the Applicant's proposal to monitor reservoir water quality, including sampling fish for mercury bioaccumulation. It is the Panel's understanding that while the rates of mercury release and uptake cannot be estimated accurately, the gradual development of this phenomenon permits sufficient lead-time to analyze results and issue public health advisories if necessary.

Technical evidence received at the hearing suggested that an achievable 60-80 per cent reduction in nutrient loads in the Little Bow River and Mosquito Creek respectively could attain a significantly improved reservoir water quality – mesotrophic. Long term goals of water quality improvement to a mesotrophic state would further enhance the social, economic, and environmental values of the project, and create a unique regional asset. If the Panel approves the three-component project, it would direct that basin communities, associations, and regulators begin developing a phased schedule on a quantitative, prioritized basis to achieve this target. Ideally this schedule would be in place for public review to coincide with any commencement of operations in the Little Bow River Reservoir.

Other predicted changes in water quality were not significant enough to cause an impact. These include lower water temperatures in the upper Little Bow River during the spring freshet diversion flows and higher nutrient concentrations upstream of the proposed reservoir during periods of low flow. Providing that Frank Lake discharges are mitigated, these and the related summer effects of lower

dissolved oxygen and higher bacteria levels upstream of the reservoir are less likely to occur under the approval for 1994 Operating Conditions or under the expected revised operating plan. Mitigation is possible with flushing flows to scour aquatic plants in July and August, subject to the Highwood IFN.

The project would have minor positive and negative impacts on the lower Little Bow River. Minor improvements in downstream water quality would include a decrease in bacterial levels and lower water temperatures. Minor negative impacts would include intermittent increases in ammonia and metal concentrations and a decrease in oxygen levels for several kilometres downstream of the reservoir.

The Applicant stated that of the water quality variables that can be compared with objectives, only ammonia at the reservoir outlet and elevated summer temperature in the upper Little Bow River could cause new water use impairment under Diversion Plan flows. Again, the summer temperature effects are unlikely to occur under the approval for 1994 operating conditions or under the expected revised operating plan. According to the Applicant, aeration of outlet water downstream of the reservoir would mitigate the impacts of ammonia on aquatic life by allowing the ammonia to volatilize, and dissolved oxygen levels to increase.

The Applicant provided evidence that the proposed Little Bow River Reservoir would be subject to intermittent summer thermal stratification only when the reservoir is near full supply level and wind-generated wave action combined with inflows and outflows are insufficient to provide complete mixing. The reservoir would likely be in the hypereutrophic category, subject to substantial summer algal blooms and reduced water clarity. Provided that Frank Lake discharges are mitigated, relatively better conditions would be expected at the north end of the reservoir than adjacent to the dam, where the nutrient enriched waters of Mosquito Creek enter. Anoxic conditions would be expected in winter, with the potential for fish kills during extreme winter drawdowns. Intermittent oxygen depletion in the depths of the reservoir and sediments (hypolimnetic anoxia) would also shift chemical equilibria to favour undesired releases of phosphorus and ammonia from sediments.

Retention time in the reservoir could also reduce concentrations of herbicides and pesticides that may enter via agricultural runoff or aerial spraying. These reductions in concentration of complex organic molecules would be achieved through the combined natural processes of bacterial degradation, hydrolysis, photochemical weathering, and adsorption to plant and sediment surfaces. Ultimate degradation products include carbon dioxide and water with additional nitrogen and phosphorus entering the reservoirs nutrient cycles.

Reservoir shoreline erosion and sloughing would reduce water clarity for an undefined period. Total dissolved salts would remain low. Seepage impact on local property is not expected because the full supply level of the reservoir would be below the level of neighbouring lands. In the initial impact assessment, the potential impacts on local groundwater of such seepage, should it occur, was expected to be positive in terms of water quality. Downward seepage may also occur through the reservoir bottom. The low permeability of geologic formations should prevent significant volumetric losses. The Applicant has indicated that geotechnical seepage control measures would be implemented and that local monitoring would be done as a precautionary measure.

Water uses would be impaired. Fishery resources would be affected due to summer intermittent hypolimnetic oxygen depletion, potential winter kills in extreme low water years, and predicted mercury contamination. Recreation use would be limited by hypereutrophic conditions due to summer algal blooms and low water clarity. Municipal water supply would be affected by high algal growth which affects water treatment requirements and increases the risk of taste and odour problems.

There may also be possible health risks due to incomplete disinfection of turbid waters or the generation of by-product carcinogens from the chlorination of dissolved organic materials.

5.1.4.2 Effects on Squaw Coulee Reservoir and Mosquito Creek

Diversion flows into Squaw Coulee would increase during spring and early summer. Water quality in Squaw Coulee is expected to remain as under current conditions dominated by the input of Highwood water. Depending on the extent of possible reservoir expansion, increases in eutrophication, surface water temperatures, phosphorus, nitrogen and algal biomass, mercury methylation and decreases in dissolved oxygen concentrations in the lower parts of the reservoir were predicted. However, consideration of the nature and scope of such possible effects is deferred pending the review of Highwood storage options and the creation of an operating plan if this location is selected.

The project would not affect water quality in Mosquito Creek except for a minor improvement in late spring. Flows would be somewhat higher in the later spring and early summer. As a result, water quality in spring would be most improved while water is being diverted to the wetlands and Clear Lake. Water temperatures, total dissolved solids and fecal coliforms would all be lower or diluted during the spring flush, as are nutrients downstream of Nanton Creek inflow. Higher spring flows may reduce the biomass of aquatic plants and algae but changes would be small. Minimum flows in Mosquito Creek would not change.

5.1.4.3 Effects on Clear Lake

The purposes of the Clear Lake and wetlands restoration are to provide irrigation, a cool-water fishery, contact recreation, and waterfowl habitat. Evidence showed that the water quality of a restored Clear Lake and adjacent wetlands would reflect the balance between two key variables: evaporative concentration vs. flushing. Flushing consists of diverting freshet water from Mosquito Creek into Clear Lake, and removing "mixed" water via irrigation. Water from Mosquito Creek would not be diverted into Clear Lake during the winter when it consists of Nanton sewage effluent.

The Applicant has purchased adjacent lands that are most likely to be affected by seepage. Potential seepage from the diversion canal would be mitigated during the construction process by localized lining in permeable formations when they are encountered. The Panel expects the Applicant and their contractors to refer to relevant AAFRD guidelines regarding minimizing seepage from irrigation canals and water distribution works.

The Applicant evaluated two possible routing designs for the canal, consisting of the original design and alternative #1, in which different flow patterns into Clear Lake and adjacent wetlands were considered. The routes are in very close proximity. In the original design, diversions flow down the canal directly into Clear Lake, with takeoffs into the 12 existing wetland basins. In alternative #1, flow proceeds sequentially through seven of the twelve wetlands en route to Clear Lake. In both cases some wetland basins receive water out of Clear Lake. Depending on the flow patterns developed, different water quality and habitat situations would arise in these basins, primarily relating to varying flushing rates and salinity. No significant social or economic difference was reported between the two routes; the final environmental effects of both scenarios appeared equivalent with regard to water quality in Clear Lake, with some offsetting gains and losses in wetland water quality.

The trophic status of Clear Lake would stabilize at eutrophic with irrigation withdrawals, and at hypereutrophic without irrigation withdrawals. Both full scale and phased in irrigation schedules achieved the same final result, with more rapid improvement in the full-scale withdrawals. Severe algal blooms in summer and winter anoxia causing fish kills are anticipated. Anoxia is not expected to be a problem during the open water season due to effective wind-mixing action. The potential exists for ammonia levels to exceed chronic guidelines. This result emerged from modelling in which ammonia was modelled as a stable compound that would not undergo any physical or biological conversion. In reality there would be a very active nitrification/denitrification cycle, minimizing the risk of ammonia toxicity to fish.

Salinity is expected to peak after initial spring filling when previously deposited mineral salts redissolve in the introduced freshwater. Salinity measurements of the sediments in Clear Lake indicate an accumulated reservoir of salts is available. Immediate annual withdrawal of water sufficient for 1416 ha (3500 acres) per year of irrigation is required to provide sufficient turnover with freshwater to stabilize long term salinity levels within the normal range for prairie fresh waters (Table 5.6). It was estimated that 5 to 6 years would be required for stabilization. Water quality in the off-stream wetlands would continue to deteriorate with time, with salinity reaching maximum saturation equilibrium unsuitable for irrigation. Water quality in the flow-through wetlands under alternative #1 would be acceptable for all intended purposes.

TABLE 5. 6
SALINITY OF CLEAR LAKE BED SEDIMENTS, INFLUENT AND RESTORED WATERS

Sample	Conductivity, mS/cm	SAR
Clear Lake sediment surface	6.5	13.5
2-3 m depth	4.2	17.9
Mosquito Creek Influent (April – July)	0.70	1.4
Modelled stabilized Clear Lake	0.75	1.2
Irrigation guidelines for “safe”	<1.0	<4
Irrigation guidelines for “possibly safe”	1.0 - 2.5	4-9

Data adapted from Exhibit 202: Report on Water Quality Assessment for Clear Lake Stabilization Project dated September 1997submitted by APWSS.

Results from WASP modelling also revised the original expectation that fecal coliform levels might exceed objectives for contact recreation. Although increased flushing or flow may induce higher bacterial levels (by replacing dead organisms with live ones); maximum counts were modelled to become 50 counts/100 ml, which is within the ASWQ guidelines of 200 counts/100 ml.

Water levels in Clear Lake have a FSL upper design limit at 967.0 m. Levels above 965.0 m would induce lateral seepage losses of 5.4 cms per day (191 cfs per day). Local groundwater may be impacted, however the effects are expected to be localized, minor and positive. There has been no residential development in this area since the EIA, and hence no public impacts are likely. The Panel requires that water conservation measures, through monitoring and controlling lake levels, be undertaken as part of routine operations to minimize seepage losses and their consequences. Hearing testimony from APWSS confirmed this was feasible. The Panel recognizes some operating flexibility will be required to provide seasonably adjusted lake levels to meet fisheries and irrigation needs.

The Panel's view is that restoring Clear Lake and neighbouring wetlands would not have major negative environmental effects on water quality, provided the Applicant's proposed level controls are implemented and provided that irrigation is promptly implemented.

5.1.4.4 Effects on the Highwood River

The proposed project would reduce flows in the Highwood River during the spring freshet. Resulting downstream water quality is not expected to materially change, as the relative magnitude of diverted flows is insufficient to cause increased siltation. Periodic flushing flows would provide scouring action necessary to maintain aquatic habitat.

Maintaining current operating guidelines until implementation of the Panel's requested revised diversion plans would leave conditions as they are in the Highwood River and Little Bow River. The Panel has required that a stable and effective flow be maintained in the upper Little Bow River to the extent permitted by the 1994 operating guidelines. There may be opportunities for favourable increases in Highwood River flows in summer if the demand for diversions into the Little Bow is partially curtailed as a result of downstream irrigation needs being met by the new reservoir. As a result, water temperatures in July/August could decrease and dissolved oxygen levels could increase. However the Highwood River fish community would still be frequently stressed during the summer months in some years even if no water were diverted (natural flows). The interim effects would be similar to the Base Case and not exceed the benefits modelled for the rejected Diversion Plan (Table 5. 7).

Future storage development in the Highwood basin could cause environmental impacts with regard to the quality of return water discharged from a reservoir back into the Highwood River. Possible effects raised during the hearings include elevated nutrient loads, mercury, and suspended solids and lower temperatures and dissolved oxygen. Mitigation is possible to provide oxygenation of returned water. The possible extent and duration of any such effects balanced against the benefits of improved supply would require a detailed site-specific analysis. Hearing evidence recognized that while a quality deficit might reduce the value of the make-up water for some aspects of in-stream uses, such as fisheries interests, such effects might be beneficially offset by substantial gains in habitat. Detailed evaluation of net and cumulative effects is deferred until the review of the revised storage and operating plans.

TABLE 5.7

PER CENT OF TIME IN JULY AND AUGUST THAT WATER TEMPERATURE AND DISSOLVED OXYGEN CRITERIA FOR FISH ARE MET (1950 - 1988)

	Per cent of Time Criteria Met		
	Acute	Chronic	Both
Natural Flows	61.5%	59.3%	52.0%
Base Case	48.8%	47.8%	40.5%
Diversion Plan	56.3%	52.2%	44.7%

Source: Adapted from APWSS Application

5.1.4.5 Overall Assessment of Project Effects on Water Quality

The Panel's summary of water quality impacts for the Project is presented in Table 5.8, updated to reflect hearing evidence and the Panel's consideration of the effects of the three-component project.

During construction there is potential for impacts due to the introduction of sediment or the accidental introduction of toxic materials. The Panel believes that the Applicant can successfully mitigate these potential impacts. Operating the three-component project under current 1994 guidelines should result in no material changes in water quality in the Highwood River, Squaw Coulee Reservoir, Little Bow River, or Mosquito Creek. There may be a seasonal positive impact on water quality in these streams associated with freshet flushing. Clear Lake is expected to be restored in one to two years, depending on the availability of Mosquito Creek and Highwood freshet water for diversion. Water quality in Clear Lake is expected to improve over a three to five year time frame as residual salinity is reduced through irrigation withdrawals. Hypereutrophic conditions may impair its use for a fishery and recreation.

Water quality downstream of the Little Bow River Reservoir would experience minor improvements for temperature, suspended solids, bacteria and aquatic biomass. The Applicant's proposed mitigative measures could prevent deterioration in dissolved oxygen and ammonia levels. Minor increases are expected in levels of heavy metals and an appropriate monitoring program would be required. The Little Bow River Reservoir itself was not given an impact rating, but the predicted hypereutrophic water quality would impair its intended multi-purposes uses for a fishery, recreation, and municipal water supply, and irrigation. The reservoir water quality could be improved to a mesotrophic level, if the Panel's recommendations regarding other sources of pollution are implemented.

Significant adverse impacts to local groundwater are not expected in the vicinity of the reservoir, Clear Lake, or upper Little Bow River. Project implementation includes monitoring for groundwater effects in potentially susceptible areas.

TABLE 5.8
SUMMARY OF WATER QUALITY IMPACTS OF THE THREE-COMPONENT LITTLE BOW PROJECT

Water Quality Issue	Potential Impact	Rating
Highwood River		
Water temperature and dissolved oxygen impacts on fish	No change now	Neutral, short term until implementation of revised operating plan
Little Bow Canal, Little Bow River, Little Bow River Reservoir - construction phase		
Sediment introduction	Construction of diversion canal, banks, dam could introduce sediment that could harm incubating northern pike eggs. Mitigation through timing of instream construction activity, minimize sediment loading in spring, stabilize disturbed surfaces.	Negative, minor, long term
Introduction of toxic materials	Construction-related activities could accidentally introduce toxic materials into watercourses. Mitigation through code of good construction practices.	Negative, minor, short term
Little Bow River Reservoir		
Trophic status	Hypereutrophic, even with mitigation of Frank Lake discharges; high algal growth and turbidity	Negative, major, long term
Drinking water treatment	More extensive treatment to remove noxious tastes and odours	Negative, moderate, long term
Low dissolved oxygen impacts on aquatic life	Periodic hypolimnetic anoxia giving rise to both winter and summer fish kills, increased release of internal phosphorus and metals	Negative, major, long term
Mercury bioaccumulation	Increased rate of mercury uptake by fish, requiring monitoring and public health advisories	Negative, major, long term
Contact recreation	Impaired by diminished aesthetic value	Negative, major, long term
Adjacent groundwater	Seepage from reservoir	Negative, unlikely, minor

Table 5.8 (cont'd)

SUMMARY OF WATER QUALITY IMPACTS OF THE THREE-COMPONENT LITTLE BOW PROJECT

Water Quality Issue	Potential Impact	Rating
Little Bow River Upstream of Proposed Reservoir		
Water temperature impacts on aquatic life	No change	Neutral, short term until implementation of revised operating plan
Suspended solids impacts on aquatic life	Elevated suspended solids levels during freshet	Negative, minor, seasonal
Low dissolved oxygen impacts on aquatic life	Increased frequency and severity resulting from Frank Lake discharges if not mitigated before project is completed	Negative, major, short term
Bacteria levels	Possible increases resulting from Frank Lake discharges if not mitigated before project is completed	Negative, minor, long term
Heavy metals	Increased rate of mercury methylation and bioaccumulation in fish, due to eutrophication processes	Negative, moderate, long term
Aquatic plants and algae	Increased biomass fertilized by nutrient loading from Frank Lake may further impair aquatic life, irrigation and domestic/municipal water supply (baseline condition)	Negative, major, short term
Adjacent groundwater	Seasonal fluctuation in level and possibly quality related to changing diversion rates	Neutral, cyclical, long term
Little Bow River Downstream of Proposed Reservoir		
Water temperature impacts on aquatic life	Decreases in water temperature up to 4º C for 40 to 50 km.	Positive, minor, long term
Ammonia impacts on aquatic life	Ammonia concentrations could be periodically elevated to levels toxic to aquatic life. Mitigation through physical aeration of reservoir outlet water.	Negative, minor, long term
Bacteria levels	Significantly lower bacteria concentrations.	Positive, minor, long term
Heavy metals	Periodic modest increases in concentrations of heavy metals, including mercury. Mitigation through restricted timing for filling of municipal drinking water reservoirs.	Negative, minor, long term

Table 5.8 (cont'd)

SUMMARY OF WATER QUALITY IMPACTS OF THE THREE- COMPONENT LITTLE BOW PROJECT

Water Quality Issue	Potential Impact	Rating
Little Bow River Downstream of Proposed Reservoir (cont'd)		
Suspended solids	Sediment settling in reservoir	Positive, minor, long term
Aquatic plants and algae	Marginal reduction in aquatic plant biomass and significant reduction in benthic algae.	Positive, minor, long term
Clear Lake		
Salinity impacts for irrigation	Gradual reduction in total dissolved solids.	Positive, major, long term
Salinity impacts for aquatic wildlife	Possible adverse impacts for hatchlings	Negative, moderate, undetermined
Trophic status	Reduced nutrient concentrations.	Positive, minor, long term
Adjacent groundwater	Seepage from Clear Lake may induce local salinization	Negative, minor, long term

5.2 Habitat and Fish

The Little Bow project area encompasses a wide range of aquatic habitats from the foothills coldwater reaches of the Highwood River to the coolwater riverine environment of the Little Bow to the ephemeral shallow lake habitat of Clear Lake. The proposal to change the magnitude and seasonal timing of diversions from the Highwood into the Little Bow would alter the aquatic environments of those rivers and the waterbodies that receive their flow: the Bow River and Travers Reservoir. Construction of a 61,675 dam3 (50,000 ac-ft) reservoir on the Little Bow River would eliminate riverine habitat, but create reservoir habitat. The new reservoir would have an impact on the aquatic environment downstream to Travers Reservoir. The diversion of water from Mosquito Creek into Clear Lake would alter flows in Mosquito Creek below the diversion and stabilize a lake and wetlands.

This part of the report begins with a description of the historical development of current aquatic habitat conditions in the region. This is followed by a description of the anticipated impacts of each of the project components in turn: the Highwood and Bow rivers, the Little Bow River and Reservoir, and Clear Lake. Section 4 dealt with some aspects of the instream flow needs study in the context of the Panel's discussion of sustainable water management. These matters will not be repeated here. The reader will be referred to the appropriate parts of that section. The Panel has requested further information about the feasibility of upstream storage at Squaw Coulee or alternative site(s), and has asked APWSS to rework the diversion plan. The evaluation of these project components will be deferred until the new information is available.

5.2.1 Historical and Baseline Conditions in the Highwood - Little Bow - Clear Lake Region

5.2.1.1 The Highwood and Bow Rivers

From its origin in the east slopes of the Rocky Mountains, to its confluence with the Bow River, the Highwood River is 178 km (111 mi) in length. In its upper reaches, in the foothills, the river is swift and turbulent, with a steep, narrow, gravel-bottomed channel with occasional islands, rock outcrops, and boulders. Where it leaves the foothills near the mouth of Pekisko Creek, the nature of the river changes. The slope is reduced, velocity declines, pools alternate with riffles, gravel substrates predominate, but areas of bedrock and fine substrates do occur. The Highwood's major tributary, the Sheep River, joins the mainstem approximately 10 km (6 mi) from the Highwood - Bow confluence.

The Highwood River and its tributaries support primarily coldwater salmonid species. Historically, the system probably supported a fauna dominated by migratory mountain whitefish (*Prosopium williamsoni*) together with small numbers of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and bull trout (*Salvelinus confluentus*). The latter two species would likely have included both resident and migratory components with residents relatively more common in headwater reaches and tributaries.

At present, mountain whitefish still dominate the fish fauna of the system, but rainbow trout (*O. mykiss*), an introduced species, is now second in abundance. The world-renowned Bow River rainbow trout sport-fishing industry relies on the Highwood River. Approximately ninety per cent of Bow River rainbow trout spawn in the Highwood River. Bull trout are rare, and cutthroat trout are virtually absent from the drainage downstream of Pekisko Creek. Many headwater streams are dominated by a second introduced species, the brook trout (*S. fontinalis*).

The assessment of the effects of the project on fish in the Highwood and Bow rivers focused on mountain whitefish and rainbow trout, though some consideration was given to the bull trout, a species in serious decline in Alberta and elsewhere. The impacts of diversions on these species must be understood in the context of their life histories and the differing habitat requirements of their life stages. The following are brief life histories of each of these three species.

Mountain Whitefish

Mountain whitefish are the most abundant of the coldwater salmonid species in the Highwood River. There are, however, neither data describing population size nor any indices that might be used to indicate long-term population trends.

Whitefish spawn in October throughout the Highwood River downstream of Pekisko Creek, except in Reach 3 immediately below the Town of High River. Since eggs and larvae incubate over winter, spawning habitat must have flowing water throughout the winter. Suitable habitat has water depths ranging from 0.12 to 1.12 m; mean column velocities from 0.15 to 1.31 m/s; and substrate sizes ranging from 5 to 50 cm diameters (small rock to large rubble). After spawning, mountain whitefish move downstream to overwinter in the lower reaches of the Highwood and Sheep rivers and in the Bow.

In the spring, mountain whitefish fry emerge from the stream substrates and drift passively downstream until they encounter suitable rearing habitat, either in the Highwood itself or in the

Bow River. Emergence can occur from early April to early May, depending on conditions, with a peak usually occurring between 15 and 21 April. At emergence, mountain whitefish fry are relatively small. While rearing, fry occupy a variety of habitats with water depths of 0.09 to 1.46 m; mean column velocities of 0.0 to 1.1 m/s; and substrates ranging from small gravel to bedrock. In the Highwood River, rearing fry are widely distributed downstream of the mouth of Pekisko Creek, though they rarely occur in Reach 3 immediately downstream of the Town of High River.

Older juvenile mountain whitefish are also widely distributed in the Highwood River though, like fry and adults, they are rarely found in Reach 3. In comparison with fry, juveniles tend to occupy slightly deeper (0.27 to 1.46 m) and faster water (mean column velocity 0.09 to 1.46 m/s) with coarser substrates (large gravel, cobble, and bedrock).

Rainbow Trout

The rainbow trout is the second most abundant coldwater salmonid species in the Highwood drainage. It is an introduced species, not native to the drainage, and may have contributed to the decline in the numbers of native cutthroat trout in the middle and lower reaches of the Highwood River.

The rainbow trout utilizing the Highwood drainage (including the Sheep River) spend most of their lives in the Bow River. In the spring, typically mid-April, adult fish leave the Bow River on their way to spawn in the upper reaches of the Highwood River (in the mainstem, primarily upstream of Pekisko Creek as well as in Pekisko and Sullivan creeks) and the Sheep River (in Ware, Threepoint, and Fisher creeks). Unlike broadcast spawners such as mountain whitefish, rainbow trout build nests, known as redds, for their eggs. Habitats selected for nest-building and spawning have water depths ranging from 0.18 to 0.64 m; mean column velocities from 0.46 to 1.01 m/s; and substrates from large gravel to cobble.

Mainstem spawning in the Highwood River constitutes from 23 per cent (1983) to 33 per cent (1984) of the total number of spawning redds. Sosiak (1984) enumerated a total of 321 redds in the mainstem Highwood: 264 (82 per cent) upstream of the Pekisko Creek confluence; 22 (7 per cent) between the Pekisko Creek confluence and the Squaw Coulee Diversion; 21 (7 per cent) between the Squaw Coulee Diversion and High River; and 14 (4 per cent) downstream of High River. The redds downstream of High River were generally rather small and may have been dug by small resident fish rather than by larger migrating fish.

Since rainbow trout spawn in the spring, water temperatures are relatively high in their spawning areas, and the rate of development of eggs and larvae is rapid. Rainbow trout fry emerge from the spawning gravel in early summer and take up residence in rearing habitats in tributaries and along the mainstem of the Highwood River. These habitats are characterized by water depths between 0.09 and 0.91 m; mean column velocities 0.0 to 1.0 m/s; and a variety of substrates from silts to bedrock, where cover in the form of cobble and boulders is typically present. Rearing rainbow trout fry are common upstream of High River and in the river segment upstream of the Sheep River confluence, though they are rare in the segment downstream of the Sheep Creek confluence.

In the fall, rainbow trout fry in the Highwood drainage move downstream from tributaries to overwintering areas on the mainstem. The following spring, during mid-April to late June floods, most of these fish (now age 1+ juveniles) migrate out of the drainage to the Bow River where they grow and mature for several years before returning to the Highwood to spawn. A few juveniles remain for an additional year or more before migrating to the Bow River as 2+ juveniles. During the period that juveniles remain in the Highwood River and its tributaries, they occupy habitats where water depths are

greater (0.18 to 1.19 m) and mean column velocities are greater (0.0 to 1.37 m/s) than for fry. Juvenile habitat substrates range from small gravel to bedrock. If cover is present, it usually consists of cobble and boulders.

In general, spawning and rearing rainbow trout (both fry and juveniles) tend to be concentrated in headwater tributaries and in the upper reaches of the mainstem of the Highwood River. Densities in the middle and lower reaches of the mainstem are generally lower.

Other Coldwater Salmonid Species

Two native coldwater salmonid species (bull trout and cutthroat trout) and one introduced species (brook trout) occur in the Highwood River.

The bull trout probably includes a migratory component, which spawns and rears in the drainage then migrates to the Bow River as juveniles to grow and mature. This migratory population is now rare in the drainage, decimated by overfishing and interactions with introduced species, especially the brook trout, with which it competes and interbreeds.

Native cutthroat trout may also have had a migratory component at one time. At present, they occur only as resident populations in the headwaters of the drainage. Again, overfishing and the introduction of exotic species have probably been involved in the decline of the cutthroat trout. They compete and interbreed with rainbow trout, and it is likely that the success of the latter has been a major factor in the decline.

Brook trout, an introduced species, is almost entirely confined to headwater locations in the Highwood Drainage. As indicated above, where their distributions overlap, brook trout tend to exclude bull trout by competition and interbreeding.

In the past, water withdrawals from the Highwood River for irrigation and domestic use have sometimes had adverse effects on fish habitat (see Section 4). These effects have been largely the result of low water levels during the summer, leading to high water temperatures and low oxygen concentrations, which cause distress or mortality to fish. Mortalities were observed in 1977, 1979, 1983, 1984, and 1985. Computer simulations comparing fish habitats that would have existed without any water withdrawals with those under a regime of water management, indicate that, for the period 1950 through 1988, most exceedences of temperature and oxygen criteria were not severe and did not result in fish mortalities. The analysis did reveal, however, an apparent cyclical trend in the number of days of poor water quality in July and August when the criteria for juvenile and adult rainbow trout were exceeded. Such days were particularly common from 1981 to 1988. There is some indication that poor summer habitat conditions in the Highwood River are correlated with reduced populations of rainbow trout in the Bow River. This would occur because this species utilizes the Highwood River during its early life history and poor habitat conditions there may affect year-class survival. There is not enough information to assess the cumulative effects of historic or existing water withdrawals during the winter months on fish habitat or fish of the Highwood River.

5.2.1.2 The Little Bow River

Until the last century when settlers began diverting water from the Highwood River (see Section 4), the Little Bow River drained an area entirely in the prairie. There is some evidence that the Highwood River may have diverted into the Little Bow since the last ice age, but any flows between the two basins within historical memory were limited to spillage during high flood events on the Highwood River and to deliberate diversions.

The mainstem of the Little Bow rises near the Town of High River and meanders to the Travers Reservoir. Mosquito Creek is the Little Bow's major tributary and the source of most of the flow downstream of the confluence with the mainstem. It rises southwest of High River and joins the mainstem just west of Champion. Shallow gradients and fine substrates characterize both streams.

At present, several coldwater sports species (rainbow trout, mountain whitefish and, rarely, bull trout) are found in the upper reaches of the Little Bow drainage, including the diversion channel. These species are all likely entrained as fry and juveniles from the Highwood River, and would not have been among the native fish of the Little Bow. One coolwater sports species, the northern pike, is distributed throughout the length of stream from its headwaters to Travers Reservoir. Burbot, a species of occasional interest to fishermen, is also widely distributed. Three other species of interest to fishermen (walleye, yellow perch and lake whitefish) are associated with Travers Reservoir, and only occur in the Little Bow River in the reach from Travers Reservoir to the Carmangay Weir, which is a barrier to further upstream movement. Of these, the lake whitefish is the only one that is common.

5.2.1.3 Clear Lake

Clear Lake is described in the application as a broad shallow basin of approximately 300 ha (740 acres) with no defined natural outlet. The lake experiences wide fluctuations in water levels and has a history of periodic flooding followed by gradually declining water levels. The lake dried up in 1985 due to the prolonged drought and is still nearly dry.

Clear Lake supported populations of yellow perch and northern pike as late as the 1970s. Between 1979 and 1981, winter fish kills were reported, primarily the result of declining water levels. In 1981, a fish kill occurred in the summer. Since that time there have been no fish in Clear Lake.

5.2.2 Impacts of the Project on Aquatic Habitat and Fish of the Highwood and Little Bow Rivers

5.2.2.1 Project Effects on Highwood River Fish Habitat

The potential impacts of the Little Bow project on fish and fish habitat in the Highwood River are primarily related to proposed changes in the magnitude and timing of diversions to the Little Bow River. The Squaw Coulee component of the project, which is not assessed at this time, would affect water quality as well.

Little current information is available about fish populations in the Highwood River and no quantitative estimate of the impact of the project on fish populations was provided in the EIA. Instead, the EIA modelled the impact of the project on fish habitat. The rationale for this approach is that the current productivity and baseline population size may not reflect the productive capacity of the habitat. Both are potentially influenced by factors other than the amount of habitat, such as angling pressure or recent exceptionally poor or exceptionally favourable natural flow conditions. The long-term productivity of a stream may not be greatly influenced by these transient conditions, but will be affected by the productive capacity of the habitat.

A potential drawback of this approach is that predicted changes in the amount of habitat (for better or worse) should reflect the Highwood River's 'carrying capacities', that is, the potential populations that could exist if factors other than habitat are not limiting. If factors other than summer habitat limit the fish populations of the Highwood River, there is no reason to anticipate that populations will respond very directly to changes in habitat. APWSS recognized in its fisheries assessment that the relationship between habitat and the productivity of the fishery is uncertain. Yet this caution was forgotten in the economic assessment where a direct relationship between habitat gains, population size and economic benefits was assumed (see Section 6.3.4).

The method used to assess changes in habitat was the Instream Flow Incremental Methodology or IFIM (Bovee 1982). In general, the method involves:

- Determining the physical habitat preferences of the various life history stages of fish under consideration;
- Establishing study sites that are representative of each river segment under consideration and then measuring the distribution of habitat characteristics (depth, velocity, substrate type, and cover) at a variety of stream discharge levels; and
- Comparing the habitat preferences of the target species with the distribution of physical habitat at selected stream discharge levels.

In this way, changes in habitat availability can be quantified for a wide range of natural and man-made flow regimes.

Rainbow trout and mountain whitefish were selected as the target species for study. Habitat preference curves were developed for five life history stages of rainbow trout (fry, coldwater juvenile, juvenile, adult, and spawning); and four of mountain whitefish (fry, juvenile, adult, and spawning) based on their observed distribution with regard to depth, velocity, substrate type, and cover. Three river segments were selected for detailed consideration of the effects of discharge differences on

habitat availability. These were Reach 2 (Squaw Coulee Diversion to High River); Reach 4 (Aldersyde to Sheep River Confluence); and Reach 5 (Sheep River Confluence to Bow River Confluence). Reach 1 was not considered because it is upstream of any direct impacts of the project on discharge and stream habitat; Reach 3 was not considered because it is considered to be relatively poor habitat where there are few fish that would be affected by the project.

For each river segment, the amount of habitat present for each life history stage of the two target species was determined for discharges characterizing the natural, recorded (historic), base case, Diversion Plan, and Expanded Diversion Plan.

A fully quantitative analysis based on the procedures described above would have been unworkable for purposes of impact assessment. For this purpose, a less rigorous, qualitative approach was used which combined quantitative prediction with professional judgement (Golder 1994). To simplify the analysis for the environmental assessment, changes in habitat were classified as either “minor” (5 to 9.9 per cent change), "moderate" (10 to 19.9 per cent) or “major” (20.0 per cent or greater change), and either “positive” (habitat area increases) or “negative” (habitat area is reduced). Habitat changes less than 5 per cent were considered to be within the model confidence limits of the method and considered “very minor” or “insignificant”.

Impacts on Habitat: Recorded (Historical) and Estimated Natural Flows

Table 4.5 in the Section 4 showed the modelled effect of historical withdrawals on rainbow trout and whitefish habitat. Rainbow trout spawning is largely unaffected because the majority of spawning in the mainstem Highwood is upstream of the confluence with Pekisko Creek and hence upstream of most withdrawals. The overall effect of water management in the Highwood River to date has been a substantial decline in habitat for rainbow trout and mountain whitefish. Considerable caution is warranted in interpreting this comparison because the analysis treats the 39-year historical record as though the data were not ordered, when in fact they are (i.e. a non-stationary data set is treated as though it were stationary). Water consumption increased dramatically over that period (see Section 4.1.2). Hence, the amount of habitat change suggested by this comparison would underestimate the impact of current development on fish habitat.

Impacts on Habitat: Base Case and Natural Flows

A more realistic assessment of the impact of the current level of consumptive water use on fish habitat is available by comparing the 1986 base case to natural flows. The 1986 base case models flows that would have occurred if the 1986 operating guidelines and current licensed demands had been in place over the 39-year period of record.

The comparison of base case and natural flows in Table 5.9 shows that current water withdrawals have caused a major (i.e. > 20 per cent) overall reduction in habitat for the two species in all three study reaches of the Highwood River.

Caution must be exercised in the interpretation of qualitative data of this kind. For example, the increases in rainbow trout spawning habitat in Reaches 4 and 5 must be understood in context. There is very little spawning habitat in Reach 4 and it is 'virtually non-existent' in Reach 5. The gains are therefore largely hypothetical.

TABLE 5.9
EFFECTS OF HISTORICAL WATER MANAGEMENT ON RAINBOW TROUT AND MOUNTAIN WHITEFISH HABITAT IN THE HIGHWOOD RIVER: COMPARISON OF BASE CASE AND NATURAL FLOWS

Species	Life Stage	Reach		
		2	4	5
Rainbow Trout	Fry			▲
	Juvenile			
	Cold Water Juvenile			
	Adult			
	Spawning	▲	▲	▲
	Overall			
Mountain Whitefish	Fry			
	Juvenile			
	Adult			
	Spawning			
	Overall			

Adapted from Exhibit 58: Technical Fisheries Evaluation of the Highwood River Diversion Plans, Golder Associates Ltd., 1994.

Reach 2: Squaw Coulee Diversion to the Little Bow Diversion
Reach 4: Downstream from Hwy 2 to the Sheep River confluence
Reach 5: Sheep River confluence to the Bow River

Shaded areas indicate a ***decline*** in habitat from the natural to the base case, except where indicated by an upward triangle. The magnitude of the change in habitat is indicated by the shading:

	5-9.9%
	10-19.9%
	> 20%

Impacts on Habitat: Diversion Plan and Base Case Flows

One of the conceptual advantages of the project is that water stored in the proposed reservoir during the freshet would supply irrigators, reducing the need to divert from the Highwood River during the critical late summer period. Although some 10 per cent of upper Little Bow irrigators would still be dependent on diversion from the Highwood during this period, the overall demand for diversion should be less than at present. The results suggest that, in comparison with the Base Case, the Diversion Plan flows would provide rainbow trout with about the same amount of habitat in Reach 2; minor to major increases in Reach 4; and minor increases in Reach 5. For mountain whitefish, changes in habitat would be minimal in Reaches 2 and 4 with a minor increase in Reach 5. The EIA predicts an overall minor increase in rainbow trout habitat and very little change in mountain whitefish habitat if Diversion Plan flows replace those under the Base Case (See Table 5.10).

TABLE 5.10
EFFECTS OF THE PROPOSED DIVERSION PLAN: COMPARISON OF THE DIVERSION PLAN AND BASE CASE

Species	Life Stage	Reach		
		2	4	5
Rainbow Trout	Fry			
	Juvenile			
	Cold Water Juvenile			
	Adult			
	Spawning			
	Overall			
Mountain Whitefish	Fry			
	Juvenile	▼	▼	
	Adult			
	Spawning	▼	▼	
	Overall			

Adapted from Exhibit 58: Technical Fisheries Evaluation of the Highwood River Diversion Plans, Golder Associates Ltd., 1994.

Reach 2: Squaw Coulee Diversion to the Little Bow Diversion
Reach 4: Downstream from Hwy 2 to the Sheep River confluence
Reach 5: Sheep River confluence to the Bow River

Shaded areas indicate a ***increase*** in habitat from the base case to the Diversion Plan case, except where indicated by a downward triangle. The magnitude of the change in habitat is indicated by the shading:

	5-9.9%
	10-19.9%
	> 20%

Overall, the new flow regime under the Diversion Plan would have "minor benefits" for the rainbow trout and mountain whitefish populations of both the Highwood River and Bow River. The Expanded Diversion Plan would be marginally better.

The Panel rejected the Diversion Plan (see Section 4) and asked APWSS to provide an operating plan that includes expanded upstream storage, either in Squaw Coulee or elsewhere. The Panel anticipates receiving a diversion plan capable of providing an assured supply of water to the Upper Little Bow while improving summer flows and fish habitat in the Highwood River. Until that plan is available, the post-freshet operations of the diversion will not change from current practice. The potential benefits to fish habitat in the Highwood River will not be realized at this time.

5.2.2.2 Impacts of Diversions on Water Quality Requirements of Fish

Under the Diversion Plan, real-time monitoring of temperature and dissolved oxygen would be implemented when water temperature in the Highwood River at Aldersyde exceeded 22.5º C or dissolved oxygen was less than 5.5 mg/L. Irrigation diversions would be temporarily suspended if water temperature reaches 24º C.

The Fisheries Coalition said the proposed temperature criteria were too high to protect the target salmonids from lethal or near-lethal temperatures. The acute temperature criteria for mountain whitefish and rainbow trout are 22º C and 24º C; the chronic criteria are 18º C and 19º C respectively. Thus the proposed operating plan would not respond to water temperatures until the acute temperature limit for one of the target species is exceeded and the chronic criteria for both species have been exceeded by several degrees. Chronic criteria are relevant in view of the anticipated frequency of exceedences (see Table 5.7). Chronic exposure to sub-lethal high temperatures and low oxygen induces stress that could impair reproduction or curtail growth. The Coalition also noted that other species such as the native bull trout require colder temperatures.

> "In order for reductions in diversions to have any significant effect on temperature the diversions have to not only begin to be reduced at a lower temperature threshold but have to be eliminated at a lower temperature. A more reasonable value in terms of fish protection would be to reduce diversions beginning at 20º C and eliminating them at 21.5º C."

The Fisheries Coalition also questioned whether the proposed operating method would be effective given that it takes roughly 12 hours for water to travel between High River and the sod farm at Aldersyde. The long delay means that any effect of curtailing diversions at High River in the morning would not be felt at Aldersyde until well after temperatures peak in the late afternoon. Moreover, the Fisheries Coalition noted, actual operations include delays in responding to stress conditions resulting in poorer than expected performance. The Coalition pointed to specific details of 1994 operations to illustrate the problem.

Representatives of AEP said at the hearing that the rules for curtailing diversions described in the Application, which were in used as recently as 1994, are no longer in use. Instead, AEP relies on a model to predict high stream temperatures. When the temperature reaches 21º C in the morning and the model predicts water temperatures of 24º C, diversions would be curtailed.

During the hearing there was debate as to whether curtailing diversions would have any significant effect on the water temperature in the Highwood River and secondly, whether poor conditions in the lower Highwood would have any significant impact on fish populations. On the first issue, the Applicant conceded that the empirical evidence to support curtailing diversions was equivocal. APWSS proposed to resolve the matter by gathering better information. While there also appears to be agreement that flow does not have a great influence on temperatures in the Highwood River, the actual magnitude and significance of the effect seems to be unresolved.

> "Rather than continuing the process of dueling computer models, we would suggest undertaking actual controlled experiments to determine the effect of reducing diversions on Highwood River temperature. These could hopefully be undertaken during periods of sub-lethal temperature."

The Panel agrees with the Applicant's proposal to experiment with diversions to obtain better data.

On the issue of whether poor water quality conditions in the lower reaches of the Highwood would affect fish, the Panel heard evidence from several sources that fish do use the lower Highwood reaches both for habitat and for seasonal movements between habitats. The Panel is persuaded that there is merit in preserving the water quality conditions of the lower Highwood.

The Fisheries Coalition also questioned the dissolved oxygen limit and stated its preference for a criterion of 6.5 mg/L. APWSS responded that dissolved oxygen levels have been consistently favourable since the Town of High River began diverting its wastewater away from the river. As encouraging as this development is for water quality in the Highwood River, the Panel is convinced that dissolved oxygen must continue to be monitored. The Panel notes that effluent from the town would enter the river when there is a problem with the waste treatment plant. It is one source among the many sources of pollution that may intermittently affect dissolved oxygen levels in the Highwood River.

The Panel stated elsewhere in this decision report that the management objective for the Highwood River should be to achieve water quality conditions no worse than would have occurred under natural conditions. To the extent that curtailing diversions may influence water quality in the Highwood River, the specific management goal should be to prevent temperature and dissolved oxygen excursions beyond those that would have occurred under natural conditions.

Meanwhile there are management implications of the uncertainty surrounding the model's ability to reliably predict high temperature events and of the knowledge that curtailing diversions has at best a minor affect on lowering stream temperatures. A model prediction that water temperatures will reach or exceed 24º C implies some range of actual values that may deviate from the prediction. Actual water temperatures may exceed the acute temperature criterion by such a margin that curtailing diversions will be totally ineffective at preventing exceedences. The stress alert threshold of 24º C is too high for an effective and timely response. The Panel recommends that the operator develop an estimate of the error associated with its temperature predictions and adopt a lower temperature management response threshold. The Panel believes the operator should be prepared to demonstrate that curtailing diversions in response to predicted high water temperatures will be effective in preventing acute temperatures conditions.

5.2.2.3 Projected Effects on Fry and Juvenile Entrainment

Water diversion down the Little Bow Canal would be increased under the Diversion Plan from a maximum of 2.8 to 8.5 cms (100 to 300 cfs), i.e. by a factor of 3. Without a fish exclusion structure, this would result in a substantial increase in the numbers of fish (primarily the young of mountain whitefish and rainbow trout, together with some young bull trout) lost from the Highwood River. Without the structure, losses of the first two species would be categorized as "long-term, negative and likely minor", while losses of bull trout, a species that has suffered drastic declines in the Highwood and other Alberta drainages, would suffer "long-term, negative and major declines." With a fish exclusion structure, the impact would be "major and positive" for the fish populations of both the Highwood and Bow rivers, since the structure would not only prevent an increase in fish losses at this location, but would reverse losses that now occur.

Several designs for fish exclusion structures look promising for fish 25 mm (1 in) fork length or larger. This would include the fry of rainbow trout and bull trout, but not mountain whitefish fry, which are much smaller. No site-specific design for an exclusion structure has been prepared for the Little Bow Canal Diversion. Under the circumstances it is difficult to assess the likely efficiency of the exclusion device.

The Panel heard considerable evidence that the numbers of trout and whitefish found in the upper reaches of Mosquito Creek and the upper Little Bow represent only a fraction of those entrained. Many succumb to predation by herons and kingfishers that congregate to fish in the canals. Participants at the hearing described efforts to count and rescue entrained fish.

The Panel agrees with all participants that the entrainment of fish in the diversions as they currently exist is a problem and one that could be made worse if the enlarged canal were built without an effective screening device. Although the magnitudes of the impacts of current and incremental mortalities are unknown, the Panel concludes that this source of mortality on rainbow trout, bull trout and whitefish should be mitigated.

5.2.2.4 Impacts of the Project on Aquatic Habitat and Fish in the Little Bow River and Reservoir

The impact assessment for fisheries in the Little Bow River was also a habitat-based assessment, though the technique used, Habitat Evaluation Procedures (HEP), was different. HEP analysis expresses available habitat as habitat units (HUs), which are derived by multiplying a Habitat Suitability Index (HSI) rating (habitat quality) by the area of available habitat (habitat quantity). HEP models for rainbow trout, walleye, northern pike and yellow perch were used to assess the losses of riverine habitat and gains in reservoir habitat.

The potential impacts of the project upstream of the reservoir would be primarily due to the operations of the Little Bow Diversion. The primary impact in the reservoir area is inundation. The primary impact on the lower Little Bow is the replacement of the current regime by one dominated by the operations of the reservoir.

Little Bow River--Upstream of the New Reservoir

Two contrasting impacts were predicted for northern pike in the Little Bow River upstream of the new reservoir under the Diversion Plan. The first was a “long-term minor positive” impact resulting from increased growth of aquatic vegetation in this reach, which pike would use for spawning. The second was a “long-term minor negative” impact of reduced summer flows, which would cause higher temperatures and lower oxygen concentrations than under the Base Case. The Panel's rejection of the Diversion Plan, its recommendation that the 1994 guidelines be applied in the interim and its requirement for a revised diversion plan should provide something closer to 1.13 cms (40 cfs) in summer should remove the second impact. The overall effect, which was expected to result in no change in habitat quality under the diversion plan in this reach, could be improved to a minor benefit. Fish habitat in the upper Little Bow could be improved further if the riparian zone were managed to encourage woody vegetation.

Little Bow River Reservoir

The HEP analysis indicated that the newly created reservoir habitat would be poor for northern pike, walleye and yellow perch and non-existent for rainbow trout. Yellow perch and walleye habitat of any quality would represent a net gain for these species, neither of which lives in the reach of the Little Bow River where the reservoir would be built. However, the positive impact for yellow perch was discounted because this species requires aquatic macrophytes for spawning and these are unlikely to develop in the new reservoir because of the extent of water level fluctuations. Whether the reservoir would provide useful habitat for walleye was and remains controversial. APWSS recognized that spawning habitat would be limiting, unless they construct rocky spawning reefs in the reservoir, or immediately upstream.

The Department of Fisheries and Oceans questioned whether fluctuations in the reservoir would render reservoir reefs useless for spawning. APWSS responded that water level fluctuations would not have an adverse effect on walleye reproduction because levels would be stable or rising in spring during spawning. DFO pointed out that the reservoir might not be completely filled if there were a succession of dry years. Under these circumstances, reservoir reef habitat could be unavailable depending on its elevation.

The Panel notes that if spawning habitat were developed upstream of the reservoir, it would not be affected by reservoir fluctuations. Since, according to APWSS, walleye exhibit a strong preference for spawning in tributary streams, the development of stream spawning habitat should be considered, if the remaining concerns about walleye habitat can be satisfied. DFO also doubted walleye would live in the reservoir because they are usually associated with yellow perch. APWSS responded that of twelve reservoirs in southern Alberta that support walleye, only one also supports perch. Other prey species can support a walleye population. Yet another concern is the trophic status of the reservoir. Walleye are generally most abundant in mesotrophic lakes and reservoirs. The elevated trophic status of the proposed reservoir could reduce its habitat value for walleye unless phosphorous loadings from Frank Lake and non-point source agricultural runoff in the Little Bow basin are lowered substantially (see Section 5.1).

Unlike walleye, pike live in the Little Bow River. Thus any gain in reservoir habitat is at the expense of lost riverine habitat. Pike prefer to spawn and hunt in flooded vegetation in tributary streams or vegetation near lake shorelines. After the initial inundation of the reservoir, there would be an abundance of flooded vegetation and spawning habitat for pike. As the vegetation decomposes, this spawning habitat would be lost. Aquatic macrophytes and emergent vegetation would not establish near the shoreline of the reservoir due to the large fluctuations in the reservoir's level. Consequently, spawning habitat would be limiting, except in the first few years, unless suitable habitat can be established upstream. APWSS concluded that the reservoir habitat would be of low quality relative to the lost riverine habitat, but would be more abundant.

The reservoir's trophic status would affect the likelihood of winter fish kills for all species. The Applicant's initial water quality modelling, which discounted any input of nutrients from Frank Lake, estimated that winter anoxic conditions, i.e. dissolved oxygen less than 3 mg/l at the dam, would occur on average in two of forty years. Later, APWSS revised its estimate to three years in thirty-nine. The second estimate was obtained by a linear interpolation of phosphorous loading used in the EIA and those estimated by the Upper Little Bow Water Users Association. It assumes that the Frank Lake problem could be mitigated so that total phosphorous loading would increase by 1.36 times the value used in the EIA. The Panel recognizes the difficulties entailed in predicting the frequency of winter anoxic conditions in the reservoir based on a short (10 year) simulation of water quality conditions. Under the circumstances, the Panel is not prepared to rely too heavily on the quantitative accuracy of these

predictions. What is clear is that higher than anticipated phosphorous loading would increase the trophic status of the reservoir and with it the frequency of winter anoxia causing fish kills. Whether fish populations can be sustained in the reservoir will depend on the frequency and duration of anoxic conditions, which in turn will depend on the successful mitigation of upstream nutrient loading.

APWSS concluded, on the basis of the HEP modelling, that there would be a net gain in habitat for two species, northern pike and walleye, which would be "positive, major, and long-term." Predictions based on models entail a substantial degree of uncertainty. The HEP models used in the assessment of the Little Bow River Reservoir are open to questions about the input data; the transferability of habitat suitability indices developed elsewhere to southern Alberta; and the reliability of the pike regression model and the walleye lacustrine model. Moreover, the total number of habitat units was calculated at full supply level and would therefore overestimate the amount of habitat that would be available when the reservoir was drawn down.

The Panel is confident pike would live in the reservoir and reasonably confident that walleye would live in the reservoir if water quality concerns are addressed and spawning habitat is provided. In line with APWSS's own assessment of the potential value of the Clear Lake fishery, the Panel believes that a self-sustaining fishery would be described as a major positive impact, whereas an intermittent fishery requiring restocking would be a minor positive impact. With the information at hand, the Panel cannot be sure which scenario would unfold. The Panel believes it would be necessary to monitor dissolved oxygen and fish kills to decide if the expense of creating winter oxygenation is warranted.

Little Bow River--Downstream of the New Reservoir

Under the Diversion Plan, impacts on the Little Bow River downstream of the new reservoir would be more varied than upstream impacts. In the spring, maximum flows between the reservoir and the Carmangay Weir would be less than under the Base Case due to water withdrawals over the length of this reach. This would reduce the availability of northern pike spawning habitat between the reservoir and the Carmangay Weir, and eliminate it entirely downstream of the weir to Travers Reservoir.

Warming of the river would be delayed in the spring due to the influence of reservoir storage. This would delay the onset of northern pike spawning downstream of the reservoir. On the other hand, this might be beneficial to northern pike, since stream flows, and therefore the availability of pike spawning area, would increase later in the spring.

From mid-June to mid-September, as a result of water withdrawals, primarily for irrigation, more water would be released from the new reservoir than enters Travers Reservoir. In the upper reaches of this segment, the increased flows would result in lower water temperatures and higher oxygen concentrations than under the Base Case. These factors would enhance fish feeding habitat in the upper segment of this reach near the reservoir.

Without mitigation, the project is expected to be have little overall effect on the availability of northern pike habitat in the Little Bow River downstream of the new reservoir. The EIA classifies the overall impact on northern pike habitat as "minor, long-term, and negative." In absolute terms, however, the impact would be small, since there is little habitat there now, and there would be little after project development, primarily because of the limited availability of pools and backwaters during the summer months.

Predicted impacts on fish populations downstream of the Little Bow River Reservoir would include the effects of sedimentation during construction and the early period of operation, disruption of upstream movements as the result of dam construction, and the subsequent isolation of populations by the impassable barrier of the dam.

5.2.2.5 Impacts of the Clear Lake Component

The Clear Lake component of the project would introduce water from Mosquito Creek during the spring freshet via a 10 km (6 mi) long canal to stabilize Clear Lake. The resulting water body is expected to be hypereutrophic with elevated salinity that should decline with irrigation withdrawals (see Section 5.1.3.4).

Since the lake previously supported yellow perch and northern pike, at least on an intermittent basis, APWSS suggested that fish populations could be re-established. Northern pike would likely enter Clear Lake via the canal from Mosquito Creek. The reintroduction could be expedited by transporting fish. Yellow perch were not observed upstream of Travers Reservoir in net and electrofishing surveys conducted between October 1990 and October 1991. Hence, this species would have to be artificially stocked in Clear Lake.

There is some doubt as to whether Clear Lake would support populations of these fish, except on an intermittent basis under the proposed operating plan. The lake's shallowness and expected high trophic status would expose fish to high water temperatures and algal blooms in summer and low oxygen, even anoxia, in winter. A 1988 study of the potential for re-establishing a fishery in Clear Lake recommended minimum summer and winter lake levels based on observations that winter and summer kills occurred when the maximum lake depth were 3 m (lake elevation 964.5 m) and 2 m (963.5 m) respectively. The minimum levels recommended by AEP Fish and Wildlife to ensure fish survival were 965.5 m in summer and 964.5 m in winter. The operating parameters assumed for the application would allow winter levels as low as 964.5 m, the level at which winter fish kills were observed in 1979-80. APWSS's simulated elevations of Clear Lake operations show that winter elevations would exceed 965.0 m 90 per cent of the time.

The Panel believes the Applicant's proposal to operate the reservoir close to the level at which winter kills have been observed in the past makes the sustainability of the northern pike fish population uncertain. It concurs with the Applicant's conclusions on this matter:

> "The restoration of a self-sustaining fishery in Clear Lake would be considered a major, long-term positive impact of the project. If winter kill necessitates occasional or frequent stocking of the lake, the resultant impact would be reduced to minor, long-term and positive."

The Panel notes that if a Squaw Coulee expansion option is adopted, there may be an opportunity to re-examine the minimum operating level for Clear Lake to secure a self-sustaining fishery.

5.2.3 Overall Assessment of Project Impacts on Aquatic Environments and Fish

The federal Department of Fisheries and Ocean's *Policy for the Management of Fish Habitat* provides general guidance on the application of the habitat protection provisions of the *Fisheries Act*, and applies to all projects that have the potential to harmfully affect fish and fish habitats that contribute to a fishery. The policy requires that losses to the productive capacity of habitat caused by a project must be avoided if possible or balanced by gains elsewhere to ensure no net loss of habitat. The long-term objective of the policy is to achieve an overall net gain in the productive capacity of fisheries habitats.

APWSS stated that the three-component project would result in a net increase in fish habitat; the inclusion of a Squaw Coulee expansion would result in a further marginal improvement. The Panel believes there is enough uncertainty about the Applicant's predictions to warrant a careful assessment of the claim.

The minor increase in rainbow trout habitat that was predicted for the Highwood River under the Diversion Plan would be very minor indeed. Only 4 per cent of rainbow spawning occurs downstream of High River; the remainder would be unaffected. Fry and juveniles tend to be concentrated in the headwater tributaries and upper reaches of the mainstem Highwood. The majority of adult Highwood rainbows live in the Bow River, except during spawning. The predicted increases in northern pike and walleye habitat in the Little Bow drainage may be obviated by winter kills unless the predicted trophic status of the stream and reservoir can be improved. The success of measures to control point source pollution, particularly from Frank Lake and non-point source pollution from agriculture in the basins is not a foregone conclusion. The proposed management of Clear Lake for pike would subject the population to periodic winter kills. It is not clear whether Clear Lake would be habitat for a self-sustaining or intermittent pike population.

APWSS's economic analysis (see Section 7) of the fishery assumes that there would be increased fish habitat, that this increase would result in an increase in fish numbers and that increased numbers would be an economic benefit to the fishery. The uncertainty about the first of these three assumptions has already been described. If there is an increase in summer habitat in the Highwood River, it would not necessarily be translated into more fish, simply because other factors, such as angling pressure and winter habitat, may limit the population. In general, we have very little information about the relative limitations of the available habitat for the various life stages. The third assumption, that increased fish numbers would be a benefit to the fishery, would only be true if current fish numbers are unsatisfactory and impose some limit on the success of commercial guides.

Some riverine pike habitat in the Little Bow River and Mosquito Creek basins would be replaced by lower quality reservoir habitat. The quality of the remaining riverine habitat would also decline under the Diversion Plan, but this operating regime has been rejected by the Panel. Overall, the loss of aquatic habitat quality could be more than offset by gains in the amount of habitat created by inundation of land in the reservoir area. The Panel recognizes that the substitutability of habitat area for habitat quality implied in HEP modelling is controversial and expects that this assumption would be critically examined when the impacts of a new operating plan are assessed.

The gain in aquatic habitat area implies a corresponding loss in terrestrial habitat. The Applicant's proposal to offset the loss of terrestrial habitat with gains in habitat quality reverses the quantity for quality substitution in the aquatic habitats.

5.3 Prairie Environments

The Highwood River rises in the Rocky Mountain subalpine and then flows south-east, then east through aspen parkland to Longview, where the fescue grassland begins. The river continues north-east toward its confluence with the Bow through fescue grassland. To the east of the fescue grassland is the mixed grass ecoregion. The Little Bow River meanders south-east from High River, traversing the boundary between the fescue grassland and the mixed grassland ecoregions. Mosquito Creek (as far south as Nanton), Frank Lake and the upper Little Bow River to the outlet of Frank Lake are in the fescue grassland ecoregion. The remainder of the project, Clear Lake, the lower reaches of Mosquito Creek and the Little Bow River, including the reservoir site, are in the mixed grass ecoregion.

The native vegetation of the two grassland ecoregions depends on the availability of moisture and on soil type. The sub-humid fescue grass ecoregion is characterized by grass species such as rough fescue (*Festuca scabrella*), Parry oat grass (*Danthonia parryi*), June grass (*Koeleria macrantha*), and by herb species such as chickweed (*Stellaria spp*.), golden bean (*Thermopsis rhombifolia*), common yarrow (*Achillea millefolium*) and fleabanes (*Erigeron spp.*). Needlegrass (*Stipa spp*.) blue grama (*Boutelaua gracilis*) and wheatgrass (*Agropyron spp*.) dominate the semi-arid mixed grass ecoregion. The boundaries between the two ecoregions are not sharply defined. Moister sites in the mixed grass region may be dominated by rough fescue; drier sites in the fescue region may be dominated by needle-grama-wheatgrass mixes. In both grassland regions deciduous shrub and tree communities develop where water is locally more abundant, particularly along the rivers, around the margins of lakes and on north-facing slopes.

Native grasslands in the project area support a community of native mammals and birds, many of which are threatened or endangered at least in part because the grassland ecoregions have been appropriated for agriculture and other forms of development. Among the species of concern in the project area are the long-tailed weasel, Baird's sparrow, the ferruginous hawk and the burrowing owl, all considered threatened in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Much of the upland native vegetation along the Highwood River downstream of Squaw Coulee and in the Little Bow basin has been displaced by agriculture. According to APWSS, cultivated pasture and crops now comprise 77 per cent of the Highwood basin’s plant communities. Native vegetation remains on approximately 20 per cent of the land that is either unsuitable for or not accessible to agriculture. The remnants of upland plant communities that remain on the steeply sloped sides of coulees are not typical of fescue grassland. Cultivated land and pasture have also replaced native vegetation in the Little Bow basin. Only 7.5 per cent of the Applicant's study area was occupied by native grass communities and, of that, more than half of those communities were atypical of the ecoregion.

Within the Highwood River valley, vegetation communities are shaped by the river's channel morphology. Extensive stands of mature cottonwood (*Populus balsamifera*) and mixed grass-shrub communities occupy an expansive floodplain with a braided, gravel-bed channel between Squaw Coulee and High River. Downstream of High River to Highway 547 the nearly linear channel restricts riparian vegetation to a narrow mixed shrub fringe of silverberry, willow (*Salix spp*.) and bromegrass (*Bromus spp*.). Croplands and pasture extend to the channel margins. North of Highway 547 to the Bow River, the Highwood meanders in a deeply incised channel. Cottonwood-bromegrass and cottonwood-mixed shrub communities occupy the larger point bars and levees. Upland communities include mixed spruce and aspen.

APWSS provided evidence that these communities declined between the 1950's and late 1980's with the greatest impact between 1983 and 1989. Some areas that were native grassland were cultivated. Cottonwood stands were removed for roads, new subdivisions and recreational developments including a golf course at the Town of High River and campsites at the confluence with the Bow River. Some of the remaining riparian forest shows evidence of livestock grazing and trampling, which may prevent recruitment in mature stands.

The Little Bow River supports a narrow fringe of emergent vegetation including sedges (*Carex spp*.) and cattails (*Typha latifolia*). Cattails are the most significant emergent vegetation in terms of wildlife habitat, providing nesting cover for waterfowl and other marsh birds. APWSS found that cattails had increased dramatically in the basin since the 1950's, presently occupying about 15.5 km (9.6 mi) of the streambed upstream of the confluence of the Little Bow River and Mosquito Creek. They attributed the change to higher water levels and increased sediment loads from the Highwood River. Below the Mosquito-Little Bow confluence, cattails are less numerous, apparently because of higher stream velocities and lower sediment loads.

Clear Lake is an ephemeral alkali lake surrounded by smaller ephemeral ponds. The area was identified as an environmentally significant area even though cultivated land and pastureland have replaced much of the native mixed grassland. The alkali wetlands and associated native grasslands are considered important habitat for waterfowl, shorebirds and burrowing owl. Three pairs of ferruginous hawks nest in the area.

Meteorological Effects

Some public concerns were raised regarding local weather patterns (thunderstorms, hailstorms, and tornadoes) that might be worsened by the creation of the Little Bow River Reservoir. The Panel accepts Environment Canada's submission in this regard, that natural meteorological processes in southern Alberta are of sufficient geographic scale, frequency, and magnitude that they would not be measurably influenced by the project works. The Panel also notes Environment Canada's long-range weather models indicating that warming may occur in the prairies as part of global warming processes. While such effects are uncertain, the consequences would create even greater public need for well-managed water resources.

5.3.1 Impacts of the Project on Vegetation and Wildlife

5.3.1.1 Vegetation and Wildlife in the Highwood River Basin

Riparian poplar forests are valued for their aesthetic appeal and recreational potential. They are also essential habitat for certain birds and mammals. The loss of riparian communities is to be avoided if possible. Construction of the enlarged diversion and Little Bow Canal would directly remove *some* riparian poplar. The project could potentially alter the stream's hydrology and fluvial geomorphology, which could influence the conditions for riparian poplar survival and reproduction.

Consultants for the Applicant sought to determine whether altering the amount and timing of diversions from the Highwood River could adversely affect poplar survival and recruitment. They concluded that a quantitative instream flow needs assessment for riparian vegetation would entail a level of complexity not encountered in the comparable modelling of physical habitat for fish and might not produce results that could be reliably applied to all sections of the river. Instead, they suggested a qualitative analysis based on the physiological and ecological requirements of balsam poplar for water.

Established balsam poplar trees require adequate groundwater to survive and to grow. Even in riparian habitats, however, there needn't be a direct relationship between stream flows and adequate groundwater levels. Groundwater originating away from the stream could provide sufficient water for tree survival independent of stream flow. Alternatively, groundwater levels may respond to changes in stream flow. The significance of stream flows to groundwater levels and tree survival cannot be assumed; it must be assessed.

Consultants for the Applicant initiated a groundwater monitoring study to assess the potential effects of stream flows on groundwater levels. Their 1990 data showed a clear linkage between streamflow and groundwater levels within 50 m (165 ft) of the river. Investigations by another consultant showed that shallow groundwater within a kilometre of the Highwood River flows laterally toward the river and that groundwater below and adjacent to the river flows upwards. The same study confirmed a strong interaction between stream flow and shallow groundwater levels in alluvial sand and gravel within 150 m (490 ft) of the river.

These observations suggest that both surface water infiltration and lateral and upward shallow groundwater movements influence the groundwater levels in the alluvium of the Highwood River valley. No site-specific data exist on the relationship between streamflow, groundwater and riparian vegetation. The relationship between cottonwood survival and stream flow is therefore uncertain in the absence of data monitoring the effect of stream flow on groundwater levels in the riparian zone. The physiological and ecological requirements for recruitment of balsam poplar are more exacting than the requirements for survival of established trees. Balsam poplar reproduces vegetatively and sexually. Consultants for the Applicant concluded that poplar recruitment is more likely to be prevented by disturbances, particularly cattle grazing and trampling, than by hydrological changes in the Highwood River.

The Panel suspects that the diversion of 8.5 cms (300 cfs) at High River instead of the current 2.83 cms (100 cfs) during the freshet would have little effect on the survival of downstream poplars. It is the late summer low flows that might contribute to drought stress, if the lower Highwood poplars are influenced by stream flows. The enlarged Highwood Diversion, operated according to a revised diversion plan, would likely neither improve, nor worsen summer discharges since diversions in

low flows would be largely from stored water. In the interim, therefore, there could be no significant effect of the project on the lower Highwood poplars, even if poplar survival is influenced by late summer stream flows. The Panel anticipates that the revised diversion plan would augment late summer instream flows. The Panel expects APWSS to assess the impact of that change as part of its assessment of the revised diversion plan. No assessment of the potential impacts of withdrawals and return flows from an expanded Squaw Coulee can be made pending completion of additional work by APWSS.

5.3.1.2 Project Impacts on Vegetation and Wildlife in the Little Bow River Basin

Impacts of the proposed project on vegetation and associated wildlife in the Little Bow River valley would be due either directly or indirectly to inundation of the reservoir area and the alteration of the hydrological regime, both upstream and downstream of the reservoir. The Panel is considering the dam and reservoir as they were proposed. The impacts of construction and inundation can therefore be assessed at this time.

The Applicant's Diversion Plan, which would have seen a peak flow of 8.5 cms (300 cfs) during the freshet followed by flows as low as 0.51 cms (18 cfs) was rejected by the Panel because the summer flows were deemed to be too low. Earlier in this report the Panel requested that revised diversion plans be filed with the NRCB. The Panel defers the review of environmental effects associated with a revised diversion plan, particularly those in the Highwood River, until the requested information is received. The Panel expects that a final review of these matters would be completed before the enlarged 8.5 cms (300 cfs) diversion works are ready to operate. The Panel's approval of any proposed diversion structure means that the eventual regime of the Little Bow River would include the peak flows identified in the EIA.

The Panel expects that the revised diversion plan would provide stable and adequate flow down the upper Little Bow River during low flows. There may be a period (while additional storage is being developed for the Highwood River basin) during which it may be necessary to operate the expanded Highwood River diversion works under the current 1994 guidelines during low flow events. The Panel will, as it did when assessing the effects on water quality, make certain assumptions in reviewing the wildlife and vegetation effects of operating the three-component project during low flows. The Panel will assume that the most serious shoreline vegetation and wildlife impacts that might occur during low flows in the upper Little Bow River and along the proposed Little Bow River Reservoir would occur while the Highwood River diversion works are operated in accordance with the 1994 guidelines. These effects would be similar to those currently experienced during late summer and early fall when diversion rates are reduced from a peak of 2.83 cms (100 cfs) according to the 1994 guidelines.

Assuming the expanded Highwood River diversion works are operated in accordance with the 1994 guidelines implies higher flows in the Little Bow River during low flows than the minimum flow proposed by the Diversion Plan. The Panel expects that monitoring would continue throughout any project implementation phase and that AEP would make any necessary operational adjustments to insure that any risk to shoreline vegetation and wildlife associated with the somewhat higher flows during the low flow season is addressed.

The Panel believes that adopting the 1994 guidelines as the basis for its assessment of vegetation and associated wildlife effects during low flows reflects a cautious approach to assessing these effects in the Little Bow River. A panel would be in a position to confirm the assessment of the nature

and magnitude of these effects when it has completed the future review of the revised diversion plans. Depending on the information available at that later stage a panel may draw similar or different conclusions, but at this time the Panel does not expect the nature and magnitude of those effects to be as great as those assumed in the current assessment.

The post-peak flow under a revised operating plan is expected to be greater than proposed in the Application, but is unknown at this time. Accordingly, it is not possible to conclusively assess the ultimate effects of the eventual hydrological regime on emergent plant communities. Nor is it possible to precisely predict what species might occupy the narrow floodplain fringe of the Little Bow River. What can be addressed at this time is the effect on the existing emergent vegetation of tripling the peak flow and the effect of assuming Little Bow River flows during low flow events would be no less than those that have been experienced to date under the 1994 guidelines.

Vegetation would also be affected by nutrients, particularly phosphorous and nitrogen, entering the stream from agricultural run-off, municipal storm drainage and the outlet from Frank Lake. Efforts to mitigate the adverse impacts of pollution from these sources (see Section 5.1) would have to be factored into the final assessment of impacts of the operating regime on vegetation at the time a panel reviews the revised diversion plans.

Impacts of Building, Filling and Operating the 50,000 ac-ft Little Bow River Reservoir

The project would be constructed over a four-year period following approval and would be largely complete in three years. Disturbances related to the construction of the reservoir would include construction at the dam site, a borrow area 0.8 km (0.5 mi) from the dam site and potentially at offsite borrow areas, and temporary work yards and vehicle maintenance compounds. Roads between project work sites and in areas where roads and utilities would have to be relocated would also create disturbances. The reservoir would affect 133.4 ha (330 acres) of land, some of which is currently in a natural or semi-natural state. APWSS plans to reclaim some fraction of this total. Reclamation plans were not presented in the EIA; they would be prepared in accordance with the *AEPEA* regulations following approval. APWSS has stated that grading, overlaying stockpiled topsoil and seeding would reclaim all areas disturbed during construction. The value of reclaimed areas as mixed grass prairie and as wildlife habitat would depend on the reclamation methods used, the success achieved and the degree of ongoing disturbance in the dam site area. The Panel has conservatively counted the 133.4 ha (330 acres) as an unmitigated loss of the plant community and wildlife habitat.

Disturbances such as noise and the presence of workers during the construction could also affect some species. Mule deer, which apparently move seasonally from wintering habitat between Carmangay and Travers Reservoir to sites upstream of the proposed dam, could be diverted from their normal habitats. This impact might be mitigated to some extent by establishing a movement corridor around the dam construction site and reservoir where construction activity would be restricted, by providing cover in the form of native shrubs or by placing berms and buildings so as to minimize noise. Construction activities would likely displace tundra and trumpeter swans, which use the river valley during the spring migration. Turbidity downstream of construction disturbances could lower the stream's production of aquatic macrophytes and benthic invertebrates, reducing food for waterfowl. The impacts of construction on other species including raptors, songbirds, upland sandpipers and the long-tailed weasel were rated as minor or negligible.

Flooding the reservoir would inundate 885 ha (2,187 acres) of the Little Bow River valley. Just over half of the inundated land (456 ha or 1127 acres) is contiguous native mixed grass prairie and a further 5 per cent (44 ha or 109 acres) is dominated by shrubs. About a third of the area to be

flooded (291 ha or 719 acres) is now under cultivation. The permanent loss of these lands, their economic and ecological value, would be an unmitigated consequence of the decision to proceed with the project.

The Panel recognizes the loss of a contiguous block of mixed prairie grassland must be considered a significant adverse environmental effect because so little of this native ecoregion remains. By 1991 it was estimated that only 10 per cent of the mixed grassland was undisturbed. Consultants for the Applicant estimated that only 7.5 per cent of the 233,759 ha (577,620 acres) bounded on the west by Highway 2, on the north by Highway 540, on the east by Highway 820 and on the south by Highway 524 was still native grassland. They deemed any further loss to be highly significant. Flooding would remove about 33 km (21 mi) of riparian waterfowl staging and resting habitat, fawning habitat for mule deer, nesting habitat for ducks, ferruginous hawks and resident songbirds, in-transit habitat for neotropical migrant songbirds and small mammal habitat. It would reduce prey populations for raptors and mammalian predators such as the long-tailed weasel. Some limited mitigation of these adverse effects is possible if grassland sites surrounding the reservoir are managed to restore native flora and fauna. Specifically, it would be necessary to curtail ground squirrel control, cattle grazing and motorized access.

When the reservoir is filled for the first time, adult animals would be displaced and young of the year are likely to be drowned. The amount of mortality would depend on the timing and rate at which the reservoir is filled. In an ordinary year, the freshet coincides with the natal and early post-natal periods of many species of mammals and the nesting periods of songbirds and waterfowl.

The Panel concludes the loss of grassland and habitat provided by that grassland is a significant adverse environmental effect associated with the project. It is not possible to replace the grassland and habitat this project could destroy. To compensate for the loss, APWSS is proposing a grassland habitat compensation program. Areas of native grassland in the vicinity of the project would be conserved and enhanced. The management objective would be to restore native vegetation and cover.

The proposal for a habitat compensation program is similar to one the NRCB heard from APWSS on the Pine Coulee Project. The Panel heard some evidence at the hearing that progress on that effort was less-than-hoped-for. This raises some concern on the part of the Panel about whether the Applicant's plans for habitat compensation are realistic.

Environment Canada urged the proponent to ensure that the grassland compensation area mirror as much as possible not only the biological, but the topological features of the area to be lost. This would enhance the chances that a comparable variety of vegetation communities would be included. Environment Canada also recommended that the grassland areas be contiguous with the wetland development at Clear Lake, since some species use both wetland and upland habitats.

Impacts of Increasing the Peak Flow to 8.50 cms (300 cfs)

The Applicant's assessment of the channel capacity of the Little Bow was that the river could convey 8.50 cms (300 cfs) to the reservoir without significantly increasing bank slumping and without overtopping its banks except in a few locations:

> "Lands that might be flooded by increased diversion flow typically involve narrow, low-lying areas that are predominantly non-productive and covered by marsh grasses and small shrubs."

These 'non-productive' areas are precisely the narrow fringe of natural vegetation, which is potentially most productive from the perspective of wildlife. During peak discharge, about 54 ha (133

acres) of grass and low shrub would be affected by overbank flooding. Flooding of shoreline vegetation would reduce the amount and diversity of habitat available to riparian species such as long-tailed weasels. On the other hand, the wider flood zone could be managed to enhance shrub vegetation and cover to improve riparian habitat.

Established cattails require a stable water depth below about 0.5 m (20 in) and cannot tolerate flooding to a greater depth. The 8.50 cms (300 cfs) flow would flood some locations to a depth of over a meter. The established cattails would die from lack of oxygen. Cattails would also be adversely affected by the scouring of fine-grained alluvial deposits. The greater stream velocities between mid-May and early July could remove the substrate that higher summer flows have deposited over recent decades. It is doubtful that cattails would be successful in re-establishing comparable stands. Their requirements for fine substrates and a relatively constant depth are unlikely to be met in a significant part of the stream given the greater annual disparity between spring and summer flows in the new hydrological regime as compared to the present favourable regime. The loss of a substantial part of the cattails would reduce the suitability of the area for waterfowl nesting and brood rearing.

Higher current velocities and substrate scouring are also expected to adversely affect certain benthic invertebrates and to reduce the abundance of aquatic macrophytes. Species that feed on aquatic macrophytes (e.g. swans) and benthic invertebrates (ducks, certain fish) would be adversely affected.

The reservoir would further reduce sediment loading in the lower Little Bow, worsening the marginal cattail substrate there. The effect of reservoir operations on downstream emergent vegetation is not clear at this time.

Construction of the Clear Lake Canal and Stabilization of Clear Lake

The Clear Lake component of the project is meant to compensate for the loss of waterfowl habitat due to the Little Bow project components. APWSS suggested that stabilizing Clear Lake and augmenting the supply of water to 12 adjacent wetlands would enhance wildlife habitat. The estimated annual production of about 1500 ducks would offset losses elsewhere in the project area. At the same time, Clear Lake would be a source of water for irrigation and a site for water-based recreation, including angling for pike. During the hearing the Panel heard concerns from some parties that some of the benefits attributed to this component of the project would have unaccounted costs. For example, the proposal to stabilize Clear Lake would improve habitat for waterfowl but destroy shorebird staging and feeding habitat. Similarly, the proposed flooding of 12 wetlands would create habitat for waterfowl but would eliminate 106 ha (262 acres) of foraging habitat for the rare ferruginous hawks. The Panel believes that some care must be taken to understand the tradeoffs that may be involved in any proposal to alter habitat.

Construction of the Clear Lake project component would include realigning a 470 m (1540 ft) section of Mosquito Creek to facilitate the diversion of water into the canal. The canal itself would be roughly 10 km (6 mi) long. Construction traffic would have access to the project area from the municipal roads it intersects. Impervious fill would be available on site and from a borrow pit nearby. Gravel and riprap would be trucked to the canal construction site from a remote location. Seven gravity turnouts, four from the canal and three from the lake, would flood twelve adjacent wetlands, covering 106 ha (262 acres). At the hearing, APWSS described alternatives to this plan. The final design has not been chosen. Clear Lake, at its full supply level of 966.3 m would cover 380 ha (939 acres).

Impacts of the Clear Lake project would include the sensory disturbance of COSEWIC-listed burrowing owls and ferruginous hawks that nest there. These effects can be partially mitigated by identifying the nesting sites and restricting construction activity within 500 m (1640 ft) or, if this is not feasible and as a last resort, moving the nests. The burrowing owl population of Alberta, which is roughly half of the Canadian population, is believed to be between 432 and 864 pairs and declining. Any loss of breeding pairs at these low numbers would be considered a major impact for this endangered species. The ferruginous hawk cannot tolerate human disturbance. It is listed as vulnerable in Canada, having lost 40 per cent of its Alberta range and 50 per cent of its population. Sensory disturbance and displacement during construction would affect numerous other species. Of particular concern is the long-billed curlew, listed as vulnerable by COSEWIC. Some 15 pairs were observed in the Mosquito Creek – Clear Lake area. The Panel concludes the environmental effects associated with the project, if unmitigated, would constitute significant adverse environmental effects. Both APWSS and Environment Canada have proposed measures to partially mitigate the effects of sensory disturbance during construction. The Panel believes they are reasonable precautions and should be followed, should the project be approved. It would be necessary to re-survey the area because the most recent bird surveys are out of date.

The greatest impacts of the Clear Lake project component would be the direct effects of habitat loss and the conversion of one kind of habitat to another. Approximately 75 ha (185 acres) of mixed grassland would be eliminated by the canal construction. A further 106 ha (262 acres) would be flooded in the wetlands. The loss of mixed grass habitat would adversely affect songbirds, upland sandpipers, long-billed curlews and ferruginous hawks among other grassland species. Grassland would also be lost to these species in the northern part of the 380 ha (939 acre) Clear Lake basin. The southern portion of the basin is the breeding site for half a dozen species of shorebirds and a staging site for arctic-breeding migrant shorebirds. These species feed on invertebrates on mudflats and shallow wetlands. Stabilizing the level of Clear Lake would reduce the amount and potentially the quality of this feeding habitat, adversely affecting shorebirds. The major beneficiary of flooding Clear Lake and its wetlands would be ducks and other waterfowl such as coots.

The Panel concludes that the Clear Lake component of the project could substantially compensate for the loss of waterfowl habitat on the Little Bow River, but would do so by converting a substantial contiguous area of mixed grass prairie and shorebird habitat. Among the species that would be adversely affected, some are rare and endangered.

The 1988 Ducks Unlimited proposal to enhance the Clear Lake wetlands included a goal of achieving changes in land use to favour ground-nesting birds within 1 km (0.6 mi) of the wetland development. In the context of the current application, APWSS has undertaken to compensate for the loss of mixed grassland by protecting and enhancing grassland, preferably in the Clear Lake area. Participants in the hearing noted that a contiguous block of grassland next to the enhanced wetlands would be beneficial to species that use both habitats. Environment Canada specifically requested that the compensation area mimic as closely as possible both the topographic and biological composition of the lost habitat. The amount of habitat purchased or otherwise managed, they said, should equal that lost to the project.

The Panel recognizes that it is not feasible to compensate for the loss of habitat in the sense of replacing lost habitat with new habitat (i.e. habitat created from cultivated land) on the scale required in this instance. The proposal to protect and enhance existing habitat would therefore entail a net loss of habitat area, unless the habitat to be protected would otherwise be lost. This is not the case with Clear Lake; much of the area to be protected is known to be unsuitable for irrigated agriculture. APWSS points out that gains in the value of habitat may be obtained by managing the land for this purpose. Net gains in habitat, as measured by suitably calibrated Habitat Evaluation Procedure (HEP) models, are

therefore possible. The Panel agrees with the direction of APWSS's mitigation and would direct them to balance the project-related losses of habitat in the Little Bow and Clear Lake components with gains in habitat value in the compensation areas, if the project was approved. Environment Canada has offered to assist the proponent with the HEP process.

During the hearing, APWSS said it had had limited success with a similar habitat compensation program to mitigate habitat loss associated with the Pine Coulee project. The Panel's conditional acceptance of the proposed habitat trade-off relies on the Applicant's ability to translate its intentions into plans and tangible results. The Panel would therefore like to be reassured that the anticipated benefits of the compensation plan would occur, if the project was approved.

The Panel agrees with a recommendation by Environment Canada that the enhanced wetlands be managed primarily for shorebird habitat to compensate for the loss of feeding and staging habitat due to the stabilization of Clear Lake. The Panel has insufficient evidence at present to assess whether this mitigation would compensate for the loss. A matter that cannot be finished at this time is the potential need to compensate for fescue grasslands that would be inundated by any expanded Squaw Coulee reservoir or another reservoir site. At this time the Panel would only remark that habitat compensation would be required for that component as well and that the compensation lands would have to be in the fescue ecoregion.

The Panel is also aware that the value of a habitat compensation area would only be realized if it is managed to preserve and enhance the biodiversity of the site. Environment Canada recommended restricting motorized watercraft from the northern portion of Clear Lake to resolve potential conflicts between wildlife conservation and recreational activities. The Panel concurs with this recommendation. Both the Applicant and Environment Canada recognized that cattle would have to be excluded from any grassland compensation area, at least until the condition of the grassland could be enhanced. Cattle would also be excluded to prevent nest trampling and disturbance of ferruginous hawks and other wildlife.

5.4 Soils and Land Capability

Three main areas of environmental concern were identified with land use in the project areas: recovery and reuse of valuable topsoil that may be lost from agricultural production due to construction and impoundment; possible flooding and water-logging of adjacent private lands due to changing water levels in various project areas; and possible salinization of agricultural lands due to localized seepage from project components and due to regionally increased irrigation.

In the Applicant's view, these adverse effects could be monitored and mitigated, and were assessed as having minor but long-term impacts that were offset by the project-related gains in agricultural productivity. The following discussion provides the basis for the Panel's evaluation of project impacts on *developed* lands; impacts on natural-state lands were considered in Section 5.3.

5.4.1 Soil Conservation

The project area is located in one of the most productive agricultural regions of Alberta, characterized by a mix of irrigated and dry land agriculture. The dominant soils are loamy, moderately well drained, Dark Brown Chernozemic soils, with a topsoil depth of about 15 cm. The Applicant has proposed a number of soils related conservation and reclamation opportunities.

In all areas of project construction the Applicant intends to use as much local material as possible to minimize land disturbance and to save on materials costs. Canal embankments for the Little Bow and Mosquito Creek Diversion Canals are to be constructed from canal excavations and adjacent borrow areas. Most of the material required for construction of the compacted earth-fill dam would be clay and other earth fill materials. Sand, gravel and rock would also be required, and if not found nearby may be imported from commercial gravel pits in Carseland, Okotoks, or High River. Excavating as much construction material as possible from within the dam site would minimize disturbance of adjacent lands. The Applicant intends to recover topsoil during construction and re-use it where possible. For example, buffer zones along the Little Bow Canal and Reservoir, and Clear Lake would be graded and seeded to prevent erosion. Regional soil ratings for topsoil reclamation vary from good to poor, with limitations primarily being texture and salinity.

Vegetation and some organic-rich topsoil soil would also be cleared from the Little Bow River valley area to be flooded to reduce the presence of biodegradable materials in the newly created reservoir. The main purpose of removing the organic matter is to retard the bacterial release of methyl mercury by removing plant and soils substrates that would stimulate microbial activity in the sediments.

The loss of 967 ha (2390 acres) of productive lands associated with filling the Little Bow River Reservoir was considered by APWSS to be a minor impact offset by the increase of 8,090 ha (20,000 acres) of new irrigation.

5.4.2 Land Classification and Irrigation

In Alberta land is rated for its suitability for irrigation by analyzing a combination of physical and chemical properties, including soil composition and regional topographic features. The purpose of this classification scheme is to ensure that land should be permanently productive under the changes anticipated with irrigation. Land irrigability classification in Alberta is required by the *Irrigation Act* and is determined according to the *Standards for the Classification of Land for Irrigation in the Province of Alberta* and *Procedures Manual for Land Classification for Irrigation in Alberta 1992*.

The soils that are best suited for irrigation are low in salts, well-drained, and have adequate water intake rates and moisture storage capacity. The range of possible Irrigable Land Classes is 1 to 6, with Class 1 being the most suitable for irrigation with fewest restrictions. Class 5 is a provisional non-irrigable class and Class 6 is non-irrigable.

Irrigation does not change gross landscape features such as hills and valleys. It can affect soil structure by introducing additional dissolved salts and minerals via direct sprinkling, by indirect seepage from canals and from distribution works, and by localized surface runoff. Sulphates of sodium, calcium, and magnesium are the primary salts affecting dry-land salinity on the prairies, with less extensive effects from chloride salts. As the relative and absolute amounts of sodium, calcium, and magnesium salts increase, the risk of soil salinization increases. Effects include visible white crusting on the soil surface, changes in soil structure, reduced soil permeability to water infiltration and root penetration, and reduced plant growth and crop yields. Increased sodicity (sodium content) may also be toxic and adversely affect the nutritional balance of plants. Excessive irrigation can also cause changes in local groundwater levels and flow direction, leading to emergence of new saline seeps.

In semiarid southern Alberta soil salinity is primarily induced by natural circumstances such as upwelling of groundwater discharge near soil surfaces. The common feature of both natural mechanisms and irrigation-induced disturbance is that evaporating water loss exceeds precipitation/infiltration and salt residues are deposited on or near the surface of moist soils.

5.4.3 Land Suitability for Irrigation

According to the Applicant, the potential for salinization of land suitable for irrigation is minimal under proper irrigation management. Farmers tend to irrigate at levels lower than the optimum consumptive requirement level of their crop, so excessive surface runoff and/or deep soil percolation are minimized. Studies have shown that there is enough leaching to control the salt balance within the root zone.

Water sources for proposed new irrigation include the Little Bow River Reservoir and River downstream of the reservoir, and Clear Lake. The area identified for incremental agricultural irrigation within the Little Bow basin includes 36,260 ha (89,600 acres) of irrigable Class 1-3 lands within 3.2 km (2 mi) of the water sources. This exceeds the 8,090 ha (20,000 acre) allocation for the Little Bow River/Clear Lake project defined in the South Saskatchewan Basin Water Allocation Regulation, confirming that sufficient lands are available for full use of the planned storage. According to the Applicant, land within the proposed project areas that would be excessively saline would be excluded through the land classification process. Most of the land is suitable for sprinkler irrigation that is more efficient with respect to water conservation than former practices of field flooding.

5.4.4 Project Effects on Soils and Land Capability

5.4.4.1 Little Bow River and Reservoir

Public concerns were raised regarding possible flooding and waterlogging on lands adjacent to the upper Little Bow River caused by increased diversion flows. Flooding might occur if spring flows of 8.50 cms (300 cfs) crested the riverbanks and waterlogging might occur if water tables rose sufficiently to make productive land unworkable.

The Applicant proposed to address these issues by a combination of prevention and compensation. Prevention would consist of protecting large low-lying areas from flooding at peak diversion flows by dyking or channelization. If this were not economically feasible, then some form of easement or land purchase from the affected landowners would be undertaken. This would be the same for eroding lands and waterlogged lands no longer suitable for agricultural productivity. The Applicant anticipates that all such matters would arise and be dealt with within five years after project implementation.

The proposed reservoir is located in a geologically stable area. The main land- related issues with respect to reservoir operation are erosion and slumping of the reservoir shoreline. These effects would be significant and long-term, and would be contained within lands purchased by the Applicant.

Some public concern was expressed regarding possible salinization effects adjacent to the proposed Little Bow River Reservoir. Areas around Vulcan are already known to be significantly affected by saline seeps. Related technical considerations involve seepage from the reservoir, groundwater flow regimes, salinity potential of local soils, and drainage options available to mitigate the potential effects. Soils immediately adjacent to the proposed Little Bow River Reservoir in general have a low potential for soil salinization.

The Applicant indicated that seepage from the Little Bow River Reservoir causing flooding of adjacent lands is not expected because the reservoir FSL is below the level of surrounding lands. However, transient and permanent changes in regional and local groundwater flow systems are expected to result from the impoundment of water in the reservoir. Adjacent surficial aquifers are the most sensitive to change, with possible shifts in groundwater-induced saline seeps if local water tables rise. These changes would likely be limited to low-lying areas along the margin of the reservoir.

5.4.4.2 Clear Lake

Seepage from the diversion canal connecting Mosquito Creek with Clear Lake has been identified as a risk due to the presence of sandy soils along the diversion route. The amount of land that would be susceptible to salinization or waterlogging is estimated to be 61 ha (150 acres), comprising 18 ha (44 acres) of cultivated land and 43 ha (106 acres) of native and improved pasture. Most of this potentially affected land is to the west of the canal route within the proposed wetland restoration areas; all of it is confined within the lands purchased by the Applicant to contain possible seepage effects. The Applicant has purchased all adjacent lands that would be submerged in a 1 in 25-year flood, and obtained easements for flood levels up to 1 in 100 years.

During canal construction the Applicant proposes to inspect the soils excavated, and if sands and gravels with high hydraulic conductivity are encountered, then various degrees of seepage mitigation are available for implementation. Progressive measures include backfilling the canal with less permeable soils, and lining with impermeable clays or synthetic liners where appropriate. Such measures would help conserve diverted water for its intended uses.

Seepage from Clear Lake is not expected to occur if lake levels are managed within the prescribed levels, as previously described. Seepage effects would primarily be saline seeps in adjacent sloughs and are rated minor. Seepage would be confined within the nearest topographic contour matching full supply level, again within lands purchased by the Applicant.

5.4.4.3 Squaw Coulee

Seepage-induce soil salinization was an issue raised by landowners living near the proposed Squaw Coulee diversion canal and expanded reservoir. The Panel's consideration of these issues is deferred until submission of the revised diversion and storage plans.

5.4.5 Overall Assessment of Project Impacts on Soils and Land Capability

The Panel notes the evidence regarding the suitability of lands identified within the Little Bow basin for irrigation purposes. Should the project proceed, there are sufficient lands capable of supporting irrigation in a sustained manner such that the irrigation benefits would not be limited by the availability of irrigable lands.

The Panel understands that land use classification for irrigated lands is extensively addressed in the current regulatory framework. The Panel is also very conscious of the limited water resource in this basin. The Panel has confidence that the relevant authorities responsible for water and land resources would carefully review future resource allocations and development to optimize the benefits from this project, if it were to be approved.

The Applicant has identified the potential sources of seepage from the project and the mitigation options available to avoid salinization problems. The Panel believes that the project can incorporate appropriate mitigation measures in the design and operation of the diversion canals, reservoir, and Clear Lake to prevent project-related salinization of agricultural land in the vicinity of the project.

The Panel confirms its requirement for sustainable use of land resources. The Applicant has proposed groundwater monitoring in the vicinity of the upper Little Bow River and Reservoir, and Clear Lake. In the Panel's view this would be sufficient to detect at an early stage changes in groundwater levels that might increase the risk of salinization and/or water-logging on adjacent lands. The Panel accepts the Applicant's proposals regarding mitigation and if necessary, compensation for lands that may be affected by project-related seepage.

The Panel does not believe that the Applicant should be responsible in any way to implement measures that might be taken to resolve any pre-existing salinization or land-use problems that are independent of the project.

With respect to soils and land capability, the Panel concludes that should the project proceed, the proposed project would not result in significant adverse impacts to soils and land capability provided that the mitigation programs, and the conditions of the Panel, are implemented.

5.5 Concluding Comments Regarding Environmental Effects

The proposed three-component Project is intended to improve water supply through the diversion and storage of freshet water in the proposed Little Bow River Reservoir and at Clear Lake for subsequent release. The diversion and storage of water is to support beneficial uses of the water for a variety of purposes. The proposed three-component project would also result in a variety of environmental effects, some of which are positive and some that are adverse.

The Panel has considered the environmental effects of the proposed three-component Project. Consideration of the environmental effects of the further development of storage for the Highwood River basin through the expansion of storage at Squaw Coulee or at some other storage site is deferred, as discussed in Section 4 of this report. The environmental effects of the proposed three-component project most relevant to the Panel's deliberations are those that pertain to water quantity and quality, fisheries, vegetation and wildlife, and soils and lands. Having identified the environmental effects of the three-component project, the Panel will go on in the next two sections of the decision report to identify the social and economic effects of the three-component project. Once all effects have been identified, the Panel will summarize those effects and draw its conclusions regarding them before determining the public interest in the proposed three-component project.

6. SOCIAL EFFECTS

The Panel must have regard for the social effects of the proposed three-component project. The communities in the Highwood and Little Bow basins have a vital interest in the proposed project and its long-term implications for the sustainability of their communities. Residents of this drought-prone area have learned through hard experience the fundamental importance of having a secure and reliable source of clean water. The availability of water has never been taken for granted by basin residents. The residents of this area expect that the proposed three-component project will meet their expectations for a secure, reliable and clean water supply.

The Panel recognizes that the proposed three-component project affects many basin residents in a variety of different ways. One potential effect is the flooding of the lands on which the Little Bow Hutterian Brethren have developed their colony. A second potential social effect pertains to disruptions in local transportation systems associated with the proposed Little Bow River Reservoir.

In considering the social effects of the proposed three-component project, the Panel has relied upon evidence, gained from the public hearing, which emphasized a strong sense of community and a commitment to accommodate the interests of neighbors. The strength of this community commitment was demonstrated throughout the lengthy public process associated with the development of the many parts of this project. The Panel expects that this commitment will continue into the future. Sustainable development requires a strong community supported by a strong economy and a healthy environment. The economic implications will be examined in Section 7.

The Panel respects the community spirit shown by the interveners and their respective stakeholder groups. They have demonstrated cooperation, commitment, trust and hope as shown by community efforts to define a win-win project where no one will be disadvantaged. The Panel believes the project will continue to benefit from public participation as an integral part of the planning, implementation and operation of the project.

6.1 Little Bow Hutterian Brethren

The Little Bow Hutterite Colony is located close to the confluence of the Little Bow River and Mosquito Creek. It is a self-contained religious and farming community. Almost all of the Colony buildings actually sit in the river valley on lands that will be inundated by the proposed Little Bow River Reservoir. The Colony is located just north of Secondary Highway 529 that runs between Parkland and Champion. The Colony has lands on both sides of the river and is therefore situated in both the County of Vulcan and the M. D. of Willow Creek.

According to testimony presented to the Panel, the Colony consisted of 101 residents in 1997. These included 21 married couples, 10 single people over the age of 18, and 49 individuals under 18. Colony facilities that will have to be relocated or compensated for as a result of this project are as follows:

- living accommodations, including three row house units, six mobile homes, a group kitchen and church complex, a school, and a nursery;

- agricultural facilities, including a 250-sow hog barn, a 50-cow dairy barn, a large poultry enterprise (involving chicken layers, broilers, ducks, geese and turkeys), a feed mill, and field crops, and,

- utilities, including sewer, power, water, gas, and phone, and other infrastructure

Should the project proceed, the Colony would lose approximately 259 ha (640 acres) of land along the Little Bow River. Their land holdings total approximately 2,960 ha (7,311 acres). Of this, 2,733 ha (6,750 acres) are cultivated and about 264 ha (652 acres) of this land is irrigated. The Colony has 189 ha (467 acres) of improved pasture and 40 ha (100 acres) of native grass.

The Hutterite lands are essential for the project and relocation is inevitable should the project proceed. A number of possible social and economic impacts were identified. The Colony submitted that the NRCB/CEAA hearing may constitute the Hutterite's opportunity to clarify the particulars about APWSS's intent to acquire their lands so that it can be later determined if these land acquisitions are "fair, sound, and reasonable". The Expropriation Act establishes that the test for whether an expropriation should be approved is "whether the intended expropriation is fair, sound, and reasonably necessary in the achievement of the objectives of the expropriating authority". Legal counsel for the Hutterian Brethren directed the Panel to have regard for the decision of the Alberta Court of Appeal in Calgary Power v. Henkel. This case was presented as a precedent to suggest that the Panel's examination of the project and its effects may constitute the Hutterian Brethren's opportunity to object to an expropriation.

The Panel was asked to condition any approvals for the project to safeguard the needs and interests of the Colony. The position of the Colony was that, if it was found that this project was in the public interest and the Colony had not yet been successfully relocated, APWSS would move ahead with the Project, expropriate lands, and send the remaining issues to the Land Compensation Board or court review. The Panel is aware that a determination of appropriate compensation under the Expropriation Act is conducted separately from the determination of whether the expropriation is "fair, sound, and reasonably necessary".

The Hutterites indicated that they would like to retain some control over future developments that might occur on their lost lands. They would like to have these lands revert back to their ownership if the reservoir were no longer operating. They would like to lose the least amount of land possible. They would like to have continued access to and use of the water to be impounded. They indicated that they were not opposed to the use of the lands for a water management project, but they might be opposed to other uses of those lands or to losing any access or say in the future of those lands.

The Little Bow Hutterian Brethren asked that the Panel specify that any land purchased or expropriated by APWSS for the project be conveyed to APWSS in the form of an easement rather than an estate in fee simple. Legal counsel for the Hutterites argued that an easement would in no way reduce the Crown's ability to control the land. One of the stated reasons for this request was the desire to retain ownership rights to lands adjoining the reservoir. This would give the Hutterites, and others in a similar circumstance, continued riparian rights.

APWSS indicated that most of these matters were issues that could properly be brought up in the ongoing negotiations with the Colony. For the most part, APWSS indicated that they would not welcome the Panel imposing conditions pertaining to land ownership in an approval, as recommended by the counsel to the Hutterites. APWSS remains firm that they need these lands in fee simple and they do not believe that it is appropriate to bind future governments in the ways suggested.

APWSS agreed that the Colony currently occupies a site in the Bow River valley that has many amenities. The Colony is located in a river valley that provides a reliable source of natural running water. The river provides water for their domestic needs and the Colony is well positioned to irrigate. The Colony has good road access; the river valley fits well with their other land holdings; they have all necessary utilities for their operations at hand; and it includes valuable sheltered pastureland. APWSS did agree that it was an excellent place and that it would require all these things to be considered in finding a suitable relocation site. APWSS also agreed that the Colony would have to acquire all the necessary approvals, licenses and permits from local and provincial governments to establish the same basic operations at a new site. Relocating the Colony was of vital importance in considering this project.

Counsel for the Hutterites sought assurances from APWSS that they would help them acquire all the necessary approvals and that APWSS would accept a condition of no development until the Colony is successfully reestablished. APWSS indicated that such a condition was inappropriate, but they felt that it might be more appropriate for the Panel to issue such a condition for applications to municipal governments. They also believed that the local authorities and the provincial agencies would grant the various necessary approvals if the Hutterites met the requirements, standards and conditions.

The general position of the Colony was well stated by one of its witnesses:

> "The Little Bow Hutterian Brethren take no position on whether this project is in the public interest having regard to the social and economic effects of the project and the effect of the Project on the environment. And the reason for the Colony's equivocation is that if the Project proceeds the Colony will have to relocate. The Colony is happy in its present location in the Little Bow River valley. The Colony could quite happily live there forever. However, the Colony understands the benefits the Little Bow Dam and the Reservoir could bring to the area. The position throughout has been that if area residents wish the Project to proceed, then the Colony is prepared to support its neighbours. However, if the Colony's neighbours are of the view that this project is not worthy of support because it does not bring with it the benefits which it is touted to bring, or if it directly and adversely affects others in ways that are nonpayable, then the Colony does not support the project."

For many years the project was deemed to be coming shortly, but that has not been the case. The Colony has had to live with a high level of inconvenience, uncertainty and stress for over 13 years. This Colony was established in 1979, took four years to construct, and by 1983 had completed most of the buildings. In 1984, a development permit was sought from the M.D. of Willow Creek to build additional housing. This permit was denied because it involved building on a site that was intended to be flooded. Since that time some of the Colony's families have had to live in mobile homes, and this is inconsistent with their communal religious perspective. The M.D. gave the same reasons to deny the Colony's application for permits to renovate and expand a sow barn that they had acquired when they purchased the property. Thus their agricultural options have been circumscribed for many years. In the words of one of their witnesses:

> "Unfortunately, the Project has not been as imminent as everyone was led to believe and, as a result, for the best part of the last decade we've been in a state of uncertain limbo and certainly the costs have been immense."

Counsel for the Hutterites and their financial advisor provided a picture of the history of continuing land negotiations with APWSS so that the Panel might appreciate both the nature of the impacts on the Colony and the issues that remain unresolved. By the fall of 1995, the Hutterites had withdrawn from a joint negotiating committee because they saw no prospect of any successful conclusion to the negotiations.

The Hutterites' dilemma is that, while the Government of Alberta has continued to support the project and has indicated that it would negotiate in good faith, the Project Application was incomplete and an NRCB hearing date had not yet been established. The government declined to assist the Colony in locating an alternative site to expedite their relocation. While the condition of infrastructure on the Colony continued to require attention, repairs and new construction could not be undertaken because the necessary permits could not be acquired from the approving authorities.

The Negotiating Committee got back on track after the Minister of Public Works, Supply and Services visited the community in 1997. This meeting led to an APWSS agreement to purchase replacement lands. This purchase and its location were announced at the hearings. The Hutterites had previously identified the replacement site as being acceptable for relocation. Discussions on other relocation matters continue.

In their presentation to the Panel, a number of recommended conditions were requested by the Hutterites and indicated through their advisor and legal counsel.

1. APWSS must acquire the Hutterite lands by negotiation and not expropriation. This condition would allow the land to be acquired by expropriation only after a specified time limit during which a bona fide attempt would be made to negotiate an agreement.

2. The Colony should be relocated on replacement lands with accommodation and facilities that are at least equivalent to their current lands and facilities.

3. The necessary municipal, environment, and health approvals required to locate the Colony should be forthcoming. Some of the operations involved might require approvals for a different size of operation. A large number and variety of regulatory approvals are necessary and must be acquired before the Colony can be relocated.

4. Appropriate compensation should be provided to cover all costs that are the natural and reasonable consequence of the relocation.

5. The Colony should be allowed to retain the riparian rights, privileges, and responsibilities that are associated with owning lands adjacent to a river or other water body. The submission asked that the Panel provide that Colony lands required for the project be taken by an easement interest, rather than by an estate in fee simple.

6. The Colony should share in the benefits of the project by receiving permanent water rights on irrigable lands owned by them. The amount of these benefits should be commensurate with the number of new acres of water rights being created by the project and should reflect the Brethren's contribution to and sacrifice for the project.

7. No other recreational or cottage development, other than day-use facilities, be allowed to take place without a thorough canvassing of the merits of such development.

The Panel was also asked to maintain an ongoing jurisdiction over the relocation process:

> "We don't see this Board approval process as being a one-shot affair. If you impose conditions, you're going to have… some ongoing jurisdiction with respect – not to determining what constitutes at least equivalent compensation—or equivalent accommodation, but to making sure that it does happen. Whether by the Land Compensation Board or the Courts in the sense that once they—once they receive that guidance and they make a determination, it presumably will have happened. Similarly with respect to municipal approvals. We're not expecting—this Board can't give us that approval, the municipality has to give us that approval, but this Board certainly has to take an ongoing interest that the municipality does—that the condition is somehow met or otherwise addressed."

Counsel for the Colony asked that the Panel seek a mechanism to bind AEP, the ultimate operator of the facilities, to any of the promises APWSS made or to any conditions that the Panel may seek to attach to any approval. This concern was raised because APWSS took the position there is only one proponent and they are that proponent. The intervener's concern was that, since the project would be turned over to AEP once construction was complete, the Panel's decision should ensure that any conditions attached to the project would follow with any transfer of ownership and control.

6.1.1 Panel Views

The Panel believes that the relocation of the Little Bow Hutterite Colony is perhaps the major single adverse social impact of the proposed Little Bow River Reservoir. The Colony is home to more than 100 residents who will have to be up-rooted and relocated if the project were to proceed. In Alberta's extensive history of resource development there are very few examples where an entire community has been relocated to facilitate the development of a natural resource. In this case, the community being disrupted is relatively unique due to its religious beliefs and cultural practices. Due to these extraordinary circumstances, the Panel has given special consideration to the effects of this proposed project on the residents of this Colony.

The fact that this Project has been in a planning phase for in excess of 10 years has placed the Colony in a peculiar situation. The effect of the uncertainty surrounding the relocation of the Colony has, in itself, had a significant social impact on its residents. In the normal course of events, new Hutterite colonies are created when internal circumstances in the founding colony so require. In this case, the delay in reaching a decision on the Little Bow/Highwood project and the resulting uncertainty has had a material effect on the division of the Colony and the development of new housing and agricultural facilities at its current location. To meet the proposed construction schedule it would likely be necessary for APWSS and the Colony to engage a variety of contracted services to construct the new buildings required and to relocate those buildings that can be moved. Hutterite colonies tend to develop their facilities through direct labor provided by Colony members, and the involvement of contracted services is not the normal way that Colony buildings and facilities are developed.

The Panel recognizes that the various effects on the Hutterite Colony cannot be avoided if the project is to proceed. The Panel is aware of the evolving plans to successfully relocate the Colony at an identified site along the Little Bow River relatively close to the existing Colony. While the successful relocation of the Hutterite Colony would be intended to make the Colony whole again, the Panel recognizes that the forced relocation would inevitably involve residual impacts for which there can be no compensation. These unmitigated effects are the direct consequence of the proposed project, and are over and above the unquantified effects associated with the uncertainty regarding the need to relocate that occurred during project planning.

The Hutterites questioned whether APWSS had the authority to build this project. They also questioned whether AEP, as the future owner and operator of the works, would be bound by the conditions accepted by APWSS. A similar situation also arose during the review of the Pine Coulee Project. The Panel believes that the viewpoint and decision taken during that review are also applicable to this project and would meet the concerns raised by the interveners.

> "The Panel notes as well that the two departments are involved in the design, construction and operation of the proposed project and act on behalf of Her Majesty the Queen in right of Alberta. For the Panel's purposes, it will adopt the view that the Government of Alberta will be the entity responsible for the design, construction and operation of the proposed project. Where convenient, the Panel will refer to the specific department involved in various phases of the project. But such references are not intended to imply that the obligations of the Government of Alberta for the project are divisible nor does the Panel adopt the view that the commitments of APWSS are binding only on that specific agency; rather, as indicated in the hearing, commitments made by APWSS are made on behalf of the Government of Alberta." (Pine Coulee Decision Report, 3-3)

The panel that drafted the approval for the Pine Coulee Project used the word "operator," rather than proponent, applicant or APWSS, to indicate that AEP was included in the conditions stipulated.

The credibility of the review process depends on implementation of the conditions determined by the Panel. The Hutterites and other interveners raised this issue. The NRCB legislation does provide for the Board's ongoing involvement, on a limited basis, but the Board has not exercised this aspect of its jurisdiction for previous approvals. The Panel encourages the NRCB to take an active role where appropriate.

The Panel accepts this advice from interveners and would require that APWSS file a report on the progress of negotiation with the Hutterites. The Panel requests that APWSS indicate how and when the various matters raised by the Hutterites in their final argument have been dealt with. In particular, the Panel wishes the NRCB to be informed about the relocation process and whether or not the appropriate permits and licenses have been acquired. This progress report would form part of a general mitigation progress report that APWSS would be asked to file within one year of the release of this decision report.

Counsel for the Hutterites asked for a number of conditions. In response to this request, the Panel points out that, as a general principle, many of these conditions are normally dealt with by other decision-making agencies. In the case of compensation it could either be the Applicant, the Land Compensation Board or the Courts. In the case of acquiring permits and licenses for development, various decision-makers are responsible for issuing these approvals. With respect to water rights and diversion, the Controller of Water Resources is responsible. The Panel respects the jurisdictions of these decision-makers. Indeed, the Panel heard evidence that these decision-makers were prepared to deal with

the Colony and were fully aware of the Colony's contribution to the project and the unique needs involved in their relocation.

The Hutterites asked the NRCB to maintain an interest in the negotiations that are now under way with APWSS. The Panel asks both parties to stay in intensive, good faith negotiations and recommends that APWSS report the general results to the NRCB within one year. The Panel further recommends that no expropriation proceedings be undertaken during this time and that every effort be made to relocate the Colony and its agricultural operations.

The Panel appreciates that the Crown operates in many areas of its jurisdiction using easements rather that fee simple. It also appreciates the Hutterite argument that they are willing to provide reasonable easements for the life of the dam and reservoir. The Panel appreciates the documentation provided which shows that other approaches to land acquisition exist and are used in Alberta. The Panel believes that these matters are part of the negotiation now on-going between APWSS and the Hutterites and should continue to be dealt with there. The Panel encourages the parties to find an acceptable way of meeting each of their legitimate needs.

The Panel urges all the regulatory bodies involved to expedite permits, licenses and approvals after the Hutterites have made the appropriate applications. The Panel requires that APWSS keep the NRCB informed as to both the success and difficulties involved in the various applications. The Panel recommends that APWSS assist the Colony wherever possible to obtain these necessary approvals.

The Panel believes that it is reasonable that landowners adjacent to the Little Bow River Reservoir retain riparian rights or be granted water licences to replace these rights. However, it leaves the manner and way that this can be done to the negotiation process. The Panel accepts the APWSS and AEP information that there are remaining, unallocated irrigation rights that can be applied for around the reservoir. The Panel believes that the costs of acquiring new rights and any possible losses of existing rights are properly included in the negotiations. The Panel does not agree that people who lose lands to the project should be given special water rights, but it does agree that they should be properly compensated and given opportunities to apply for project-related benefits.

The Panel believes that the successful relocation of the Hutterite Colony will take special care and attention on the part of the various parties involved, including APWSS, local jurisdictions, area residents and the Colony itself.

6.2 Transportation

The Panel was presented with extensive evidence regarding the transportation impacts of the Little Bow River Reservoir and Clear Lake components of the project. The transportation issues are complex for this project due to geographical considerations, related inter-municipal planning considerations, and changing community needs.

6.2.1 Current Conditions

The proposed Little Bow River Reservoir would be situated at the confluence of Mosquito Creek, the Little Bow River and east-west Secondary Highway #529 (SH 529) and would remove the most direct east-west transportation route in the project area. SH 529 connects major agri-

service centers, recreational centers, and industrial hubs. It connects to major north-south transportation corridors, such as Highway #2 on the west and Highway #23 on the east. The transportation network in the area has evolved to address the physical constraints imposed by the location of the Little Bow River and Mosquito Creek. East-west and north-south roads in the project area cross the river valley and coulees at only a few points. Consequently, the normal grid pattern for roads in a rural area has not been developed in the vicinity of the proposed Little Bow River Reservoir. These geographic limitations emphasize the importance of the existing roads in meeting regional transportation needs.

The Little Bow River Reservoir is situated on the boundary between the County of Vulcan and the M. D. of Willow Creek. The challenges of making decisions within municipalities on transportation issues related to paving, secondary designation and route selection are compounded when two municipalities are involved. Regional towns such as Stavely, Vulcan, Champion, Carmangay, and others have an interest in decisions regarding secondary roads affected by the proposed Little Bow River Reservoir. Inter-municipal co-ordination and cooperation between rural and urban communities is required to designate an east-west secondary highway to meet their transportation needs around the proposed Little Bow River Reservoir.

The project area is primarily agricultural. The recent closure of rail lines in the Nanton and Claresholm areas, and the proposed building of large grain terminals between Vulcan and Barons on the CP railway line, has made the mitigation of the transportation effects caused by the Little Bow River Reservoir project more complex. The difficulty of making transportation decisions is further compounded by other regional transportation concerns, such as the development of secondary and value-added agricultural products, the resurgence in oil and gas activity, anticipated recreational opportunities and service needs, and regional health service needs. School busing within the region is an important consideration, and involves towns such as Vulcan, Stavely, High River, Nanton, Claresholm, Champion, Carmangay, and Barons.

Efforts to develop a transportation mitigation plan for the project have been underway for some time. The Public Advisory Committee (PAC) and the Applicant worked for several years to identify replacement roads for those that would be disrupted or inundated by the project. The PAC and the Alston Community spent extensive time on assessing routes in the vicinity of the Little Bow River Reservoir. They examined current and evolving transportation needs for people living in the immediate project area and others living within the region.

Evidence provided by various parties clearly demonstrated that there had been, and continues to be, disagreement concerning the most effective means of mitigating the transportation effects associated with the proposed Little Bow River Reservoir. At the pre-hearing meeting, the Panel identified the need to resolve local transportation concerns by the responsible local authorities prior to the hearing. Those most directly involved included the Applicant, Alberta Department of Transportation and Utilities, the M.D. of Willow Creek, the County of Vulcan, the PAC, residents along Fireguard Road, and the Alston Community Group. Although meetings were held to address this issue, no single agreed upon solution was presented during the hearings.

In reviewing transportation considerations in the vicinity of the Little Bow River Reservoir and Clear Lake, the Panel recognizes the importance of the east-west road system for the communities. The Panel's key concern is to review alternative transportation mitigation measures for east-west connections near the Little Bow River Reservoir and the Little Bow River and to identify the alternative with the least negative community and social impact, yet with an affordable cost.

6.2.2 Project Effects on Transportation

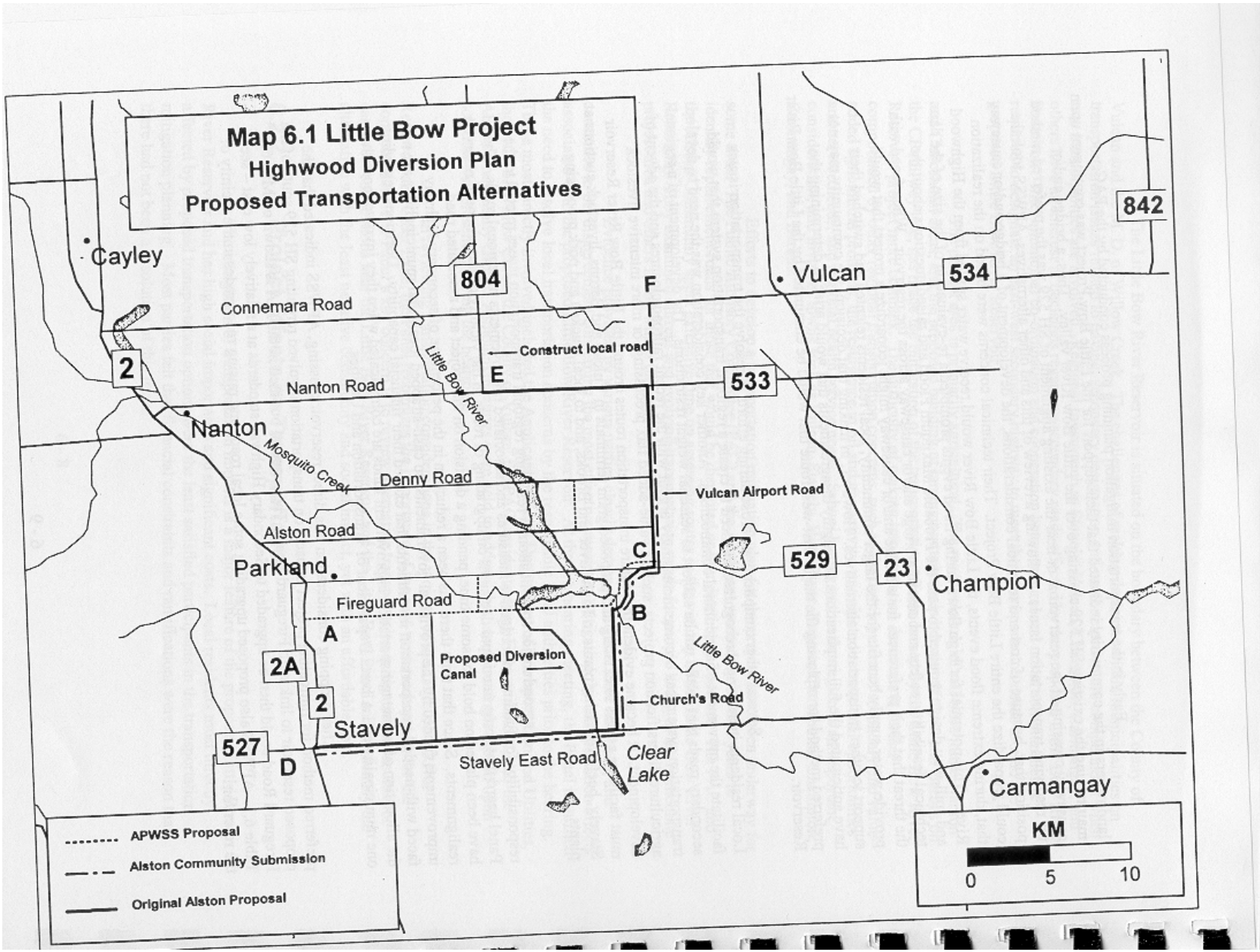
The mitigation of transportation impacts is a major feature of the proposed Little Bow River Reservoir and has high social importance and significant costs. Local residents most directly affected by proposed transportation options were the least satisfied participants in the transportation mitigation planning. Most parties felt that financial constraints and ramifications were the reason that there had not been a resolution of this issue.

Early in the transportation mitigation planning process conducted by the PAC, landowners in the community indicated that their support for the Little Bow Project was contingent upon maintaining the existing SH 529 crossing over the Little Bow River valley. Thus, a bridge and/or causeway crossing of the reservoir at or near the existing alignment of SH 529 was the preferred method for resolving transportation issues. Following a review of this and other alternatives, APWSS took the position that, because of cost and technical considerations, the development of a bridge and/or causeway could jeopardize the entire Little Bow Project. Their technical concerns were based on the realization that, during extreme flood events, the Little Bow River would receive water spilled from the Highwood River. This potential for high flows during flood events prompted a re-evaluation of the size of the dam and spill-way design required to pass the Probable Maximum Flood and raised questions about the technical feasibility, safety and cost of a bridge and/or causeway across the reservoir. When faced with the threat that their preferences for a bridge and/or causeway might jeopardize a project that would provide water supply benefits for the larger community, local residents relented and switched their support to other transportation alternatives. However, in making that decision, the community may not have anticipated the full implications or lengthy disagreements that would arise in determining the preferred method for replacing the major east-west route that would be eliminated by the Little Bow River Reservoir.

Several other complications arose during efforts to resolve the transportation issues. Local residents increasingly recognized the need to create a regional transportation system that would facilitate the movement of agricultural commodities. Another key consideration was the need to develop secondary roads that would not be subject to seasonal weight restrictions. The development of a regional transportation system has become increasingly urgent with the recent railroad closures and the advent of agriculture diversification projects, such as value-added flax processing, or more intensive livestock development. It became evident that future transportation routes around the Little Bow River Reservoir must facilitate access to existing and proposed grain terminals in Vulcan and Barons, livestock auctions at Stavely, beef processing plants in High River and Brooks, and to local chicken and pork processing plants.

A second major complication in resolving regional transportation issues related to the responsibility for funding of mitigative measures and associated improvements in regional roads. The Panel heard that some municipal decisions on upgrading of roads in the vicinity of the proposed reservoir have been placed on hold for some time, pending a decision on the project and associated road realignments. Since that time there has been a reduction in the percentage of secondary highway improvements funded by the provincial governments, so cash-strapped local rural municipalities are now faced with needed transportation investments that exceed their financial capability. Decisions regarding the allocation of scarce transportation improvement funds are complicated when they involve more than one municipality and Alberta Department of Transportation and Utilities.

After dropping consideration of a direct reservoir crossing, APWSS indicated that the preferred method for mitigating project impacts on transportation involved rerouting SH 529 south of the proposed reservoir to link with Fireguard Road. The proposal outlined in the EIA is shown on Map 6.1. Fireguard Road could then be upgraded to Secondary Highway standards at a relatively low cost – see Table 6.1. APWSS also proposed upgrading some local roads and raising road grades in the vicinity of the reservoir.


Map 6.1 Little Bow Project
Highwood Diversion Plan
Proposed Transportation Alternatives
Cayley
804
F
Vulcan
534
842
Connemara Road
Construct local road
Little Bow River
2
E
Nanton Road
533
Nanton
Mosquito Creek
Denny Road
Vulcan Airport Road
Alston Road
C
Parkland
529
23
Champion
Fireguard Road
B
A
2A
Proposed Diversion Canal
Little Bow River
2
Church's Road
Stavely
527
D
Stavely East Road
Clear Lake
Carmangay
APWSS Proposal
Alston Community Submission
Original Alston Proposal
KM
0
5
10

At the hearing, representatives of the Alston Community presented another alternative that would see SH 529 re-routed south of the reservoir onto Church's Road and then onto Stavely East Road. They also proposed upgrading the north-south Vulcan Airport Road. They concluded that Fireguard Road represents a safety hazard for high-speed traffic and slow-moving farm equipment because it is located on a correction line with north-south discontinuities. The Alston Community indicated that their proposal would better address regional transportation requirements because of better direct links to Stavely and Vulcan. They also concluded that the Stavely East Road would better connect the proposed recreational developments at Pine Coulee, Clear Lake and the Little Bow River Reservoir, with existing recreational facilities at Chain Lakes and Travers Reservoir.

At the hearing, various interveners expressed support for one or the other of these options, using arguments related to safety, travel time and distance and concerns about road dust. The M.D. of Willow Creek indicated that it supports the Alston Community's proposal to re-route traffic along the Stavely East Road. The Fireguard Road alternative is supported by adjacent landowners.

TABLE 6.1

COST SUMMARY OF TRANSPORTATION ALTERNATIVES

Alternative	Segment on Map 6.1	Length (kilometres)	Cost (millions)
APWSS Proposal	A-B	17.3	$3.7
(Fireguard Road)	B-C	5.0	$4.4
	Total	22.3	$8.1
Original Alston Proposal	D-B	24.0	$5.1
(Link Z)	B-C	5.0	$4.4
	C-E	21.7	$4.5
	Total	51.1	$14.0
Alston Community Submission	D-B	24.0	$4.1
(including 10 km of oiled surface extension of SH 533 to the Vulcan Airport Road)	B-C	5.0	$4.4
	C-F	16.7	$3.5
	Total	45.7	$12.0

Source: APWSS, November 29, 1997.

Notes:

- All roads are assumed to be constructed to the RCU-209-110 Secondary Highway standard.
- General road costs are based on unit costs of $210,000 per kilometre for first stage paving.
- River crossing costs are based on preliminary engineering estimates.

6.2.3 Panel Views

The Public Advisory Committee, with input from the Applicant, dealt extensively over several years with the need to provide for replacement roads and roads to accommodate new land uses in the immediate vicinity of the proposed Little Bow River Reservoir.

The Panel notes that should the project as proposed, with a new road around the south end of the reservoir, be approved, the existing rural road system in the immediate vicinity of the project

would need to be revised to provide replacement roads for those inundated by the proposed reservoir and also to accommodate existing uses and potential future needs of water-based recreationalists and non-agricultural users.

The Panel has considered the requests of the Applicant, the M.D. of Willow Creek, the County of Vulcan and other participants to provide guidance on the transportation implications of the proposed project. The Panel believes that such matters are normally dealt with in a satisfactory manner through consultation between the Applicant and various local parties and authorities. However, in this case such a resolution has not been reached.

The Panel concludes that transportation issues are an important component of the overall project and these issues need to be resolved to ensure that the long-term public interest in the social, economic and environmental aspects of the project are met.

The Panel has been asked by some affected parties to recommend the best transportation development plan for the region from several alternatives offered by APWSS and various local interest groups. However, some local municipal governments clearly indicated to the Panel that they felt they were both responsible for and in the best position to make local decisions regarding local transportation issues. They gave no indication that they were prepared to abdicate their responsibility to the Panel with respect to transportation route selection. Other local governments wanted the Panel to recommend a preferred alternative so that development of the eventual regional transportation system would not strictly be governed by the availability of funds from Alberta Transportation and Utilities.

With respect to the east-west regional transportation route directly impacted by the Little Bow River Reservoir, the Panel believes it has the jurisdiction to decide on transportation mitigation measures that are directly related to the proposed reservoir. However, the Panel believes that decisions related to the routing, upgrading and construction of secondary highways, are more appropriate for local community residents, the Applicant, the M.D. of Willow Creek, the County of Vulcan, and Alberta Transportation and Utilities. The Panel is not, therefore, prepared to impose specific transportation mitigation conditions on the Applicant that would prejudice or preclude the decisions that will be made by the appropriate authorities. However, given the extensive evidence presented on this matter, the Panel is prepared to offer specific recommendations that may assist in the resolution of the required transportation mitigation decisions.

Taking all factors into account, the Panel believes that a direct crossing of the proposed Little Bow River Reservoir best meets the needs of the community affected the most. Crossing the reservoir requires the construction of a bridge that is capable of passing a major flood that would primarily originate in the Highwood River basin. A combination of a bridge and a causeway, similar to the solution at Pine Coulee but with a larger bridge, might provide a more efficient but more expensive transportation solution. The Applicant has not pursued this option due to cost and safety considerations. Instead, the Applicant has proposed a new route around the southern end of the dam. This new route places the burden of cost and inconvenience on the local municipalities and area residents. The Panel recommends the transportation route directly across the proposed Little Bow River Reservoir. This transportation routing has and would have the full support of the community and would place the financial obligation for mitigation squarely on the shoulders of the Applicant. The municipal authorities would then be responsible for those costs required to ensure appropriate roads lead up to the reservoir crossing. This would allow the long-postponed upgrading of the existing SH 529 in the M.D. of Willow Creek to proceed.

In the Panel's opinion a direct crossing of the proposed Little Bow River Reservoir at or near the location of the existing SH 529 would provide the most effective mitigation of the transportation effects of the proposed reservoir. The Panel has no evidence before it that it is not technically feasible to build a causeway/bridge across the proposed reservoir that is safe and capable of passing the predicted Maximum Probable Flood of the Little Bow River. Based on the evidence, it appears that the

causeway/bridge crossing of the proposed reservoir would cost at least $12 million. The cost of the various alternatives to route traffic around the reservoir is in the range of $4 million to $8 million. All of these alternatives are inferior to the direct crossing of the proposed reservoir and impose a direct social and financial burden on the community residents directly affected by these alternatives. The Panel concludes that the issue could come down to the price of successfully mitigating this major project effect.

In almost all other aspects of the proposed project the Applicant has identified the best mitigation measures available and, where equivalent measures were evaluated, lower-cost alternatives have been selected. For example, to mitigate diversion plan impacts on the fishery resource in the Highwood River, the Applicant has proposed the expansion of the Squaw Coulee Reservoir at a cost of over $7 million. In selecting this proposed mitigation measure, the Applicant has placed priority on the effectiveness of the mitigation measure, not its cost. The Panel believes that similar reasoning should be applied to be consideration of mitigation alternatives for transportation impacts. The Panel is also aware that a bridge/causeway has been selected for the Pine Coulee Reservoir at considerable extra expense to minimize the negative social effects in that case. The circumstances in the current Application are more compelling in the Panel's opinion.

The Panel believes that mitigation of transportation impacts is the sole responsibility of the Alberta government. The Panel believes that the Applicant attempted to control the Little Bow River Reservoir construction costs at the direct social and economic expense of the communities affected by not providing a direct crossing of the proposed reservoir. Review of alternative routes to provide an east-west connection appeared to show many new routes that placed the burden of cost and inconvenience on local municipalities and area residents and did not meet the transportation needs of the area.

The Panel believes that, should the project be approved, it would be appropriate for APWSS to compile comparative further information on transportation alternatives including a potential bridge and causeway crossing of the Little Bow River Reservoir. Furthermore, the Panel recommends that a more comprehensive regional transportation plan be created with all municipal, provincial authorities and area resident stakeholders to meet the needs of all communities impacted by the Little Bow River Reservoir project. Attention should be focused on current community needs and resolving the transportation conflict created by the Little Bow Project. The past APWSS position regarding the bridge/causeway restricted successful resolution of the transportation conflict.

Mitigation of transportation impacts during project construction is also required, if the project is approved. For example, during construction of the Little Bow River Reservoir, APWSS should identify and implement dust control mechanisms, such as oiling, to reduce dust adjacent to gravel roads used by heavy construction traffic. In addition, APWSS should identify and use construction traffic routes that do not conflict with school bus routes or playground areas in local towns.

6.3 Water Supply and Use Impacts

As described in Section 4, seasonal and annual variations in the availability of water represents an important factor limiting development in the Little Bow and Highwood river basins. Spring freshets can bring too much water, leading to various problems associated with flooding. More importantly, seasonal and extended droughts pose considerable difficulties for farmers, who need water for themselves, their crops and their livestock, and for municipalities and water cooperatives, which provide drinking water for many regional residents. Development of the three-component project is being proposed as one more step in the historical process of trying to overcome the natural limitations to water shortages in the basin. The Little Bow River Reservoir and the Clear Lake component are being proposed as a means of creating more water storage, which would increase the security of water supplies for

existing water users. Increased water storage would also provide opportunities for the expansion of irrigation in the region and regional residents would be able to use the new reservoir for recreation. However, the sustainability of these water supply benefits is contingent upon maintaining water quality, and this is related to water supply and wastewater and agricultural management practices in the basin. This section of the report will summarize existing water supply and demand in the region, for all types of water use, and will describe how project implementation would affect these conditions.

6.3.1 Municipal and Domestic Water Use

According to APWSS, part of the rationale for implementing the three-component project is to secure more water of better quality for various municipal and domestic water users in the region. Communities that are expected to benefit from the proposed three-component project include Vulcan, Carmangay and Champion. Some of the six rural water co-operatives in the region may also benefit, as would licensed and unlicensed domestic water users. Future population growth in High River, Okotoks, and the surrounding areas would create additional demands for water and may benefit from development of the proposed project.

6.3.1.1 Current Conditions

According to information presented in the EIA, towns and villages that rely on surface water sources have two general types of problems. First, they pump water from surface water sources when available and must store water for use during low flow periods, such as the late summer, fall and winter seasons. This means that water shortages can occur during dry periods, especially in the winter. Second, when surface water is abundant such as during the spring run-off or after major storms, it is also very turbid (i.e. contains large amounts of suspended solids). Turbid water increases water treatment costs and is reported to be of concern to most communities.

The current status of municipal water use in the basin is described in Table 6.2, along with a summary of municipal water supply concerns. Communities are attempting to resolve these concerns. Some communities rely on ground water more than surface water. For example, Nanton only draws from Mosquito Creek when the flow from their wells and springs declines. Carmangay supplements their water supplies by using groundwater but is currently assessing whether increased water storage will address their concerns.

For most towns and villages, the principal water management concern is that of raw water turbidity and the rising costs of treating this problem. Turbid water causes increased wear on pumps, more frequent cleaning of cisterns, occasional plugging of filters, and poor quality drinking water. High turbidity in the Little Bow River, Mosquito Creek and Squaw Coulee is normal during spring and summer months. However, this is the time when most communities will try to fill their raw water storage reservoirs because water from these sources may not be available at other times of the year.

The Town of Vulcan indicated that in 1991 it cost $12,600 per year to treat water from the Little Bow River but that the corresponding cost in 1997 will be close to $100,000. They noted that turbidity levels in the raw water have risen from 0.8 NTU in 1986 to 12.0 NTU in 1997, and identified outflows from Frank Lake as one of the reasons for the deterioration in water quality. AEP provided evidence that, prior to 1995, treated water from Vulcan exceeded the current standard of 1.0 NTU on at least one occasion per year and that this prompted efforts to better operate the water treatment plant.

AEP also noted that Vulcan's recent efforts at improving their chemical treatment process has resulted in the production of better quality water that routinely meets a standard of 0.5 NTU. AEP expects that, in order to maintain these quality standards, future operating costs will continue to be high even if the water quality impacts associated with Frank Lake are resolved.

The Village of Champion faced a similar concern about water quality several years ago but was able to solve the problem by switching their source of supply to the Travers Reservoir. This source poses some other problems. Pumps must lift water about 213 m (700 ft) above the reservoir, resulting in high operating costs. In addition, the line cannot be used in the winter due to freezing and the Village must rely on raw water storage during this period.

The other water supply problem faced by municipalities results from low flows in the Little Bow River and Mosquito Creek during the late summer and winter. Low flows during the summer months sometimes make it impossible for Vulcan and Carmangay to draw water from the Little Bow River. In addition, they cannot pump during the winter months when the lines can freeze. As a consequence, most communities have developed large raw water storage facilities.

There are also two licensed domestic water users that might be affected by the project. Both the Carmangay Hutterian Brethren and the Little Bow Hutterian Brethren are licensed to withdraw and use water from the Little Bow River for domestic purposes. These licences are for a total of 58 dam3 (47 ac-ft) of water, and have a maximum combined rate of withdrawal of 0.06 cms (2.0 cfs). Landowners with property adjacent to the Little Bow River and Mosquito Creek are also allowed to withdraw water for household uses without requiring a licence. The extent of this unlicensed domestic water use was not reported.

Rural residents who do not have direct access to surface water face the alternative of having to use groundwater. In many parts of the region the groundwater was described as having a high soda and iron content which give it a bad odour and taste and stains clothes. Many interveners described the difficulties of finding adequate amounts of useable groundwater, and how they often resorted to hauling water from rivers or dug-outs to meet their needs.

The search for better water appears to be a continuing problem for many rural residents in the Little Bow basin. One recent solution has been the evolution of water co-operatives. There are currently six rural water co-operatives in the region. One of these co-operatives is located northeast of the Town of Vulcan and distributes treated water from the Town to about 35 farm families. The other five co-operatives supply raw water to another 125 farms. Two of these co-operatives draw water from Travers Reservoir while three draw their water from the Little Bow River. Members of each of these co-operatives are responsible for treating the raw water before they use it.

The three co-operatives that use water directly from the Little Bow include the Champion - Little Bow Co-op, the Champion West Water Co-op and the Champion East Water Co-op. Each has its own water licence and in total they are allowed to withdraw 212 dam3 (172 ac-ft) of water per year at a combined maximum rate of 0.01 cms (0.42 cfs) to supply 48 farms. The Panel heard that the establishment of these water co-operatives has provided many benefits for rural households. Access to more and better quality water has encouraged them to build new houses, start new businesses, diversify their farming operations (including elk ranching, gardens and growing herbs) and to generally achieve a better quality of life.

TABLE 6.2

SUMMARY OF MUNICIPAL WATER USE

	Population	Source	Licensed Quantity dam^3 (acre-feet)	Maximum Rate cms (cfs)	Raw Water Storage dam^3 (million gallons)	Treated Water Storage dam^3 (thousand gallons)	Treatment Plant Capacity m^3/day (gallons/day)	Concerns
Carmangay	261	Little Bow River & Wells	93 (75)	0.01 (0.25)	none	0.25 (55.0)	518 (114,100)	Turbidity No raw water storage
Cayley	243	Squaw Coulee	86 (70)	0.01 (0.31)	21.8 (4.8)	0.39 (85.8)	455 (100,100)	No winter supply Turbidity
Champion	401	Travers Reservoir	n.a.	n.a.	84.5 (18.6)	0.23 (50.6)	980 (215,715)	High pumping costs
Nanton	1612	Mosquito Creek	617 (500)	0.10 (3.50)	189.0 (41.6)	27.26 (6000)	1,963 (432,000)	Low flows Turbidity wears out pump
		Well	79 (64)	0.01 (0.23)				
		Spring	123 (100)	0.01 (0.50)				Spring stops in dry years
Vulcan	1466	Little Bow River	296 (240)	0.04 (1.30)	458.9 (101)	2.27 (500)	2,813 (619,200)	Turbidity Need additional water

Note: Water licence information for Champion was not included in the EIA or hearing exhibits.

6 - 16

6.3.1.2 Project Effects on Municipal and Domestic Water Use

APWSS believes that implementation of the three-component project will benefit municipal and domestic water users in a variety of ways. The EIA lists these benefits as:

- securing water supplies for Vulcan, Carmangay and three rural water co-operatives;
- giving Champion an alternative or second water source which would provide a year-round supply and lower pumping costs;
- reducing turbidity in the raw water supply for Vulcan, Carmangay, and three water co-operatives and subsequently reducing water treatment costs; and
- improving domestic and stock water supply for users along Mosquito Creek, the Little Bow River and around Clear Lake.

APWSS also indicated that the pumphouse and water intake structure for the Town of Vulcan might be directly affected by the Project. The pumphouse is located in an area that would be inundated by the Little Bow River Reservoir and APWSS has committed to pay for relocating the intake. The water intake might also have to be relocated to maintain raw water quality when the reservoir is drawn down. APWSS has agreed to fund the relocation of the water intake to a deeper portion of the reservoir should this be required.

For the Town of Vulcan, project implementation would provide access to water stored in the reservoir. This would allow the town to withdraw water when required, rather than when river flows are available, and would give treatment plant operators more flexibility. Representatives of the town believe that the reservoir water would be less turbid, which would mean lower treatment costs. However, they recognize that future water quality in the reservoir is contingent on better management of discharges from Frank Lake and pollutants from other upstream sources.

Since the water intakes for Carmangay and the three water co-operatives are all currently located downstream of the proposed reservoir, the quality of their raw water supplies should improve as a result of the project. According to the EIA, the Little Bow River reservoir would act as a sediment trap. Substantial amounts of sediment will settle out during the time the water is held in the reservoir, so that sediment loads in the Little Bow River downstream from the proposed reservoir would be much lower than at present. Lower sediment loads mean less turbidity and lower water treatment costs. The project would provide a more secure water supply for Carmangay and the three water co-operatives based on the operating plan for the Little Bow River Reservoir. During the irrigation season flows in the lower reaches of the Little Bow River would be higher as water would be released to meet irrigation demands. These higher flows might give Carmangay and the three co-operatives some flexibility in determining when to fill their storage reservoirs and cisterns during the irrigation season.

Since the water intake for Champion is located on Travers Reservoir, the project is not likely to directly affect the quantity of water available for pumping. APWSS does note that Champion and the three water co-operatives would attain a more secure water supply if they chose to relocate their diversion to the proposed reservoir. Champion would like to have a viable all-season water source and the new Little Bow River Reservoir would be suitable. The pumping distance would be about the same as from Travers Reservoir but pumping costs would be lower because the change in elevation is lower by about 100 m (330 ft). However, evidence presented at the hearing was that none of these users was considering such a change at this time and there was no assessment of the cost of obtaining access to the proposed Little Bow River Reservoir. Another option presented at the hearing was the development of a regional water supply system where water from the Little Bow River Reservoir would be treated at the facilities in Vulcan and then piped to other users. Again, there are no plans or commitments to develop a

regional supply system, but Vulcan did indicate that its water treatment plant had sufficient capacity to meet regional demands and could be expanded at a relatively low cost.

The Town of Nanton currently relies on flows in Mosquito Creek downstream of Squaw Coulee for part of its water needs, especially in the summer months. In their hearing evidence, Nanton indicated their support for additional security of water supply to supplement their spring water sources. Nanton suggested that a more reliable water supply from an expanded Squaw Coulee Reservoir would facilitate the growth of their town.

Development of the three-component project will not have any immediate impact on the municipal water supply for Nanton or Cayley. During open water periods, Cayley draws its water from Squaw Coulee downstream of the Squaw Coulee Reservoir. During the winter months, Cayley residents must rely on stored water. The Panel has chosen to defer consideration of the expansion of Squaw Coulee Reservoir and the diversion plan. At the hearing, there was considerable discussion of the adequacy of proposed conveyance flows in Mosquito Creek and Squaw Coulee. Benefits to Nanton and Cayley could occur, depending on the final resolution of expanded storage proposed at Squaw Coulee or elsewhere.

In terms of the three-component project impacts on water quality, reductions in turbidity on Mosquito Creek and Squaw Coulee are not predicted. The communities of Nanton and Cayley are not likely to see any improvements in the quality of their raw water supplies as a result of the three-component project. However, a Super Expanded Squaw Coulee or similar storage reservoir may provide improvements in water quality.

6.3.1.3 Panel Views

The Panel believes that implementation of the project will benefit Vulcan in terms of creating a dependable municipal water supply. Having year-round access to water should allow plant operators to pump and treat water as demanded, and should lead to some reduction in operating costs. However, reduction in water treatment costs will depend on the steps taken to resolve the problem of discharges from Frank Lake and steps taken to control and minimize other potential upstream sources of pollution.

The Panel concludes project implementation will lead to more secure water supplies for current municipal or domestic water users located at or below the proposed Little Bow River Reservoir. Water managers will have more flexibility in how they meet municipal and domestic water demands. The Panel is concerned that any future development in the area be scrutinized for any negative impact on water use. The Panel believes that the reservoir would cause reduced turbidity in the lower reaches of the Little Bow River if the eutrophic status of the reservoir, as described in the EIA, were to be achieved. Municipal and domestic users could then experience some benefits in the form of improved water quality and reduced treatment costs. Since turbidity currently appears to be of greater concern to these communities, the Panel concludes that project implementation might have some beneficial impacts on water users in Carmangay and the three water co-operatives.

The Panel believes that project implementation could also benefit existing licensed domestic water users. The Carmangay Hutterian Brethren withdraw their water at a point downstream from the proposed reservoir so they may see reductions in turbidity and lower treatment costs. This Colony will have more security of their water supply as a result of the operating regime for the reservoir. The Little Bow Hutterian Brethren currently withdraw water from the Little Bow River at a location that would be flooded by the reservoir. However, since this Colony would have to be relocated, project impacts on their domestic water supply will depend on the new location of the Colony. The replacement

site identified by APWSS is located on the Little Bow River downstream from the reservoir. Relocation of the Colony to this site may then give them the same domestic water quality benefits that would be experienced by the Carmangay Hutterian Brethren.

6.3.2 Impacts on Domestic Groundwater

Some regional residents rely on groundwater for their domestic use. At the hearing, members of the Upper Little Bow River Basin Water Users Association expressed concern about whether implementation of the project would affect the quality and quantity of water drawn from wells adjacent to the Little Bow River.

6.3.2.1 Current Conditions

According to the Upper Little Bow River Basin Water Users Association, there are about 200 domestic water users in the region and about half of them use groundwater. Some groundwater users have deep, cased wells located at some distance from the Little Bow River. Others have shallow wells located in the floodplain adjacent to the River. The Panel heard that a few people with these shallow wells believe that groundwater in the Little Bow River valley and rates of flow in the river are related. During dry years, both river flows and groundwater levels drop. The Panel heard that, during the droughts of the mid-1970s, some shallow wells adjacent to the river went dry and people were forced to haul water needed for their homes and their livestock. During wet years, river flows and groundwater levels increased. And, at times of high turbidity in the Little Bow River, some groundwater users have also noted an increase in the turbidity of their well water.

Domestic groundwater users along the Little Bow River have recently become concerned about levels of nitrates detected in their well water. They are concerned about farming and livestock practices that may affect water quality. Some users are also concerned about the potential of Frank Lake discharges to affect shallow well water quality. Groundwater users are responsible for monitoring the quality of water from their wells and several interveners testified that they submit water samples for testing on an annual basis. AEP indicated that they do not regulate the quality of groundwater and warned that water from wells connected to surface water should be treated before it is consumed.

6.3.2.2 Project Effects on Domestic Groundwater

The Panel heard conflicting evidence concerning potential project impacts on groundwater wells. Some interveners suggested that, along the upper reaches of the Little Bow River, the surface water noticeably affects their groundwater. They are concerned that any project-induced changes in conveyance flows or reduced water quality would adversely affect domestic groundwater users. They testified that the reduction in conveyance flows during the late summer, as contemplated by the proposed Diversion Plan, might reduce the availability of groundwater. Some users are also concerned about the recent decline in river water quality caused by nutrients released from Frank Lake, and worry that this might adversely affect the quality of their groundwater. They requested that various measures be used to reduce nutrient loads and other contaminants from point and non-point sources in the basin.

APWSS provided experts who offered the opposing view that groundwater flows towards the Little Bow River. They noted that depending on local hydrogeological conditions and the rate and total volume of water being pumped, groundwater users could actually have localized effects on groundwater/surface water interactions. A high pump rate for an extended time in porous gravels could reduce groundwater levels and could lead to some water being drawn in from the river. However, they generally concluded that, since groundwater tends to move very slowly, any project-related effects on flows in the Little Bow River would have an insignificant effect on groundwater wells, in terms of quantity or quality. APWSS indicated that they were prepared to monitor groundwater wells after the project was implemented and to mitigate any adverse effects on groundwater that might occur.

6.3.2.3 Panel Views

The Panel agrees that, whether or not implementation of the project would affect groundwater in specific localized or seasonal situations is uncertain but possible. The Panel concludes that monitoring water levels and quality in groundwater wells is a prudent method for addressing intervener concerns. The Panel also believes that it is appropriate for APWSS to mitigate any project-related groundwater problems experienced by domestic water users, should any such problems occur, and supports APWSS's commitment to do so.

The Panel notes AEP testimony that shallow groundwater wells in an agricultural setting are intrinsically at greater risk of contamination from run-off from intensive livestock operations and agri-chemicals. To ensure water from these sources is suitable for human consumption, treatment is generally required. Alternatively, water users may seek out deeper groundwater sources that have not yet been impacted.

6.3.3 Irrigation Water Use

An overview of the history of water use and development in the Highwood and Little Bow River basins was provided in Section 4. This overview shows that there has been a substantial increase in irrigation water demand in the Little Bow basin since the mid-1970s but that no new irrigation licences have been issued since 1984 because water supplies were insufficient. According to the EIA, implementation of the three-component project will allow irrigation expansion on 8,100 hectares (20,000 acres) and will secure water supplies for 4,660 ha (11,500 acres) of existing irrigated farming adjacent to and downstream of the Little Bow River Reservoir.

6.3.3.1 Current Conditions

Currently, irrigation occurs on about 6,110 ha (15,100 acres) of land in the Little Bow River basin above Travers Reservoir and on 2,025 ha (5,000 acres) in the Highwood River basin. The majority of these licences allow irrigators to withdraw water at any time during the irrigation season. However, licences issued between 1981 and 1984 prohibit irrigation withdrawals after July 31 (or July 25 in some cases) because of insufficient flows to meet licensed demands and instream flow requirements on the Highwood River.

At the hearing, various residents of the Little Bow River basin and the lower Highwood River described the benefits of irrigation and how they had adapted their farming operations to reflect water supplies in the basin. Many people were farming lands that had been in their family for several generations and they described how the introduction of irrigation during the last 10 to 20 years had allowed them to diversify and expand their farming operations. Irrigation allows farmers to grow three to four times more hay and alfalfa per acre of land by ensuring a second cut, and this then enables mixed farmers to expand their livestock herds or sell hay as a commodity. For these farmers the biggest benefit results from irrigation during July and August. Farmers with July cut-off dates in their licences reported irrigating barley for silage that they use to feed cattle. For these farmers, one of the main benefits of irrigation was stabilization of farm incomes by ensuring successful crops even during drought years. Farmers in the region are now growing mint, canary seed and mustard under irrigation, and are also considering ginseng.

The Panel also heard that the seniority system associated with water licences is an effective way of ensuring agricultural production during dry years. Farmers testified that in dry years, they were sometimes asked to shut down their irrigation for periods of time but such incidents seldom led to crop losses. However, during very dry years, and 1985 was cited as an example, junior licencees are unable to get sufficient water for their crops and experienced reduced incomes and/or higher costs as a result.

The potential benefits of improving the security of water supply in the Little Bow River basin have been discussed and recognized for some time. The concept of developing "adequate storage, flow control and the essential diversions to … support optimum irrigation in the Highwood-Little Bow and the Willow Creek sub-basins" was originally recommended as part of the Alberta Water Resources Commission Report of Water Management in the South Saskatchewan River Basin (1984). Further support for irrigation expansion in the Highwood and Little Bow sub-basins was provided in the South Saskatchewan Basin Water Allocation Regulation in 1991. In setting the upper limits for irrigation expansion in Alberta, this regulation set an upper limit of 38,460 ha (95,000 acres) for the Bow River basin, including 8,090 ha (20,000 acres) for the Little Bow/Clear Lake project.

6.3.3.2 Project Effects on Irrigation Water Use

A primary benefit of the three-component project would be the development of 6,680 ha (16,500 acres) of new irrigation in the Little Bow River basin adjacent to or downstream of the Reservoir. An additional 1,410 ha (3,500 acres) of new irrigation would be developed in the vicinity of Clear Lake. According to APWSS, the 8,090 ha (20,000 acres) of new irrigation would be developed over 10 years. About two-thirds of this would occur in the five years after project completion, especially in the area around Clear Lake. Two soils classification studies were offered as evidence to show that there are 8,090 ha (20,000 acres) of potentially irrigable lands within the study area. These reports show that there are some 36,260 ha (89,600 acres) of potentially irrigable land within 3.2 km (2.0 mi) of irrigation water sources and, of this, 9,450 ha (23,360 acres) are considered to have high capability for irrigation (Class 1). At the time of the hearing, the Controller of Water Rights was holding water licence applications for water rights on 5,127 ha (12,669 acres) on land that could be supported by the proposed Little Bow River Reservoir.

Evidence presented in the EIA indicates that with the switch from dryland to irrigation farming, farmers would change the types and composition of crops being grown. They would cease to grow rye and spring wheat in favour of alfalfa and soft wheat. Summer fallowing would no longer occur on the affected areas. A slight decrease would occur in the amount of land used to grow canola and wheat

but there would be a large increase in the land area used to raise barley (an increase from five per cent to 35 per cent) and alfalfa (30 per cent). With irrigation, the yields of canola and barley are expected to more than double while wheat yields would increase by a factor of four. Use of irrigation would also improve the quality of the barley crops, as measured in terms of selling price, by about six per cent. As a result, the gross value of crops produced on newly irrigated lands would be about 650 per cent higher than dryland farming.

To capture these benefits, farmers would have to make an initial investment in irrigation equipment and other capital items, like more equipment, buildings and grain storage. The investment in a center-pivot, pumps and pipes would amount to $100,000 per 55 ha (135 acres) of irrigation. Farmers would also incur pumping costs as well as higher costs for fertilizer, seed, machinery, and labour. A more complete description of the economics of converting to irrigation farming is provided in Section 7.1.3. The net result is that farmers who invest in irrigation stand to increase their incomes by an average of about $81 to $101 per hectare ($200 to $250 per acre) per year. They would also enjoy more stable incomes since irrigation would help ensure crop yields even during periods of drought.

The water requirements for new irrigation are estimated to be 405 mm per hectare (1.33 ft per acre). This requirement is based on a review of likely crop mix, crop moisture requirements and available natural moisture. Water requirements are also based on the assumption that irrigators would use medium-pressure center-pivots with an application efficiency of 75 per cent. The analysis provided by APWSS also assumes that, at first, new irrigators would apply less water than is required to optimize agricultural production but that they would gradually learn how to irrigate effectively and would increase their water use and crop yields. Switching to irrigation would not entirely protect farmers from the effects of drought. The analysis provided by APWSS recognizes that some water shortages would still occur during dry years. Deficits of up to 75 mm (3 in) per year might occur two years in 10 but this should not affect crop yields. Deficits of 75 to 150 mm (3 to 6 in) might occur during one year in 10 and could reduce crop yields by up to 15 per cent. This variability in yields was factored into the assessment of potential irrigation revenues.

Development of 8,090 ha (20,000 acres) of new irrigation along the Little Bow River and around Clear Lake would result in a two per cent increase in total irrigation in Alberta and would have a more significant regional effect. The affected land areas straddle the M.D of Willow Creek and the County of Vulcan, and this region currently has about 34,800 ha (86,000 acres) of irrigated land. Completion of the Project would create the potential for a 23 per cent increase in irrigated agriculture in the region. The incremental irrigation production would generate a three per cent increase in gross agricultural revenue within the region.

APWSS also lists the securing of water supplies for 6,475 ha (16,000 acres) of existing irrigation in the region as one of the benefits of the project. Depending on their location some of these existing irrigation operations may be affected by the proposed project and associated operating plan. Project impacts on existing irrigators located above the proposed Little Bow River Reservoir (unsupported irrigators) would depend on how diversions from the Highwood River are operated. As noted in Section 4, the Panel has deferred any decision on the diversion plan and additional storage but in the interim, continuation of the existing operating procedures should not adversely affect unsupported irrigators along Mosquito Creek, the upper Little Bow River and lower Highwood River.

Clear Lake

In terms of irrigation development at Clear Lake, APWSS indicated that this component of the project could proceed only if farmers made a prior commitment to irrigate the full 1,410 ha (3,500

acres). Irrigation withdrawals in this amount are required to ensure that the quality of water in Clear Lake is adequate to support irrigation and recreation in the long term. There was some concern at the hearing about how farmers at Clear Lake could make such a commitment, in that they would be reluctant to apply for a water licence unless the water was actually available from Clear Lake. Near the conclusion of the hearings it was reported that Clear Lake farmers had decided to hire specialists to conduct a Level 2 land classification evaluation on about 2,025 ha (5,000 acres) of land to further confirm that these lands are capable of supporting irrigation. Such an evaluation is a precondition to acquiring an irrigation licence and involves a cost to the farmer of about $4 per hectare ($10 per acre). Local farmers felt that this investment demonstrated their commitment to irrigate from Clear Lake and they invited AEP to negotiate whatever additional guarantees are required to ensure that this part of the project can proceed. Supporters of the Clear Lake project indicated strong support for the expansion of irrigation and confidence that the area residents would quickly convert to irrigated agriculture.

Little Bow Basin

Most interveners recognized the advantages of irrigation expansion in the Little Bow basin and around Clear Lake. A concern raised by interveners was that the EIA may not have adequately captured all the potential benefits of irrigation expansion. Some interveners indicated that the production of irrigation forage crops would allow farmers to diversify or expand their livestock herds. Others indicated that irrigation would allow farmers to diversify their operations to include other types of high-value specialty crops. Overall, there appeared to be a consensus that irrigation expansion would increase farm incomes, reduce the risks associated with drought and provide farm operators with more flexibility in managing their crop and livestock operations.

In terms of potential impacts on existing irrigators, many interveners expressed serious concern about implementation of an operating plan that might increase deficits, especially in dry years. Irrigators belonging to the Upper Little Bow River Basin Water Users Association clearly described how their farming operations could be adversely affected by any reduction in the availability of water upon which they have come to depend. Representatives of other water user groups also testified that they could not support the implementation of an operating plan that would impose increased deficits on existing irrigators in other parts of the basin. As noted in Section 4, these concerns are some of the reasons why the Panel has chosen to defer any decision on the proposed operating plan.

The EIA indicates that about 4,660 ha (11,512 acres) of existing irrigation located adjacent to or downstream from the proposed Little Bow River Reservoir could be supported by the project. Under average conditions, APWSS predicts that these irrigators would experience no significant impacts in terms of their ability to withdraw water from the Little Bow River. During dry periods, however, water storage in the reservoir would reduce deficits for existing irrigators since they would have senior licences.

6.3.3.3 Panel Views

The Panel believes that at a minimum, implementing the three-component project would allow irrigation expansion on 8,090 ha (20,000 acres) and that this would help stabilize and expand farm incomes. The project may also provide a more reliable irrigation water supply to existing irrigators at or below the reservoir. Impacts on unsupported irrigators would ultimately depend on a revised diversion plan that the Panel expects will ensure that none of the existing irrigators face higher deficits, especially

during drought conditions. The Panel recognizes and agrees with the common belief among regional residents that increased water storage will support expansion and diversification of the regional agricultural economy.

Panel believes that Clear Lake area farmers are committed to conversion from dryland to irrigation farming and appear aware of the risks regarding the need for timely irrigation withdrawals to stabilize water quality in Clear Lake. The farmers have waited a long time and appear ready to assume responsibility to make this component work successfully.

The Panel believes that the costs incurred by farmers around Clear Lake to assess soil irrigability demonstrates sufficient commitment to proceed with development of this component of the project and AEP needs to identify more clearly the role of Clear Lake water users in any irrigation "sign up" plan. The Panel recommends that a Clear Lake Irrigation Development Plan be put in place involving local farmers, Alberta Agriculture Food and Rural Development (AAFRD), AEP and APWSS, if the project is approved.

6.3.4 Recreation Water Use

According to APWSS and AEP, one of the principles governing the use and management of water in Alberta is multi-purpose water use. Part of the rationale for developing the project and diversion plan was to increase or enhance recreational water use in the basin. In the EIA, APWSS concluded that recreational benefits would result from increased flows in the Highwood River, the restoration of Clear Lake, and the creation of the Little Bow River Reservoir. During the hearing, interveners raised various questions about the suitability or adequacy of water quality and quantity to support recreation, and about the extent of recreational development that could or should result from the project.

6.3.4.1 Current Conditions

This region of Alberta features few natural lakes and high seasonal and annual variability in water levels in rivers. The Panel heard that, prior to 1985, Clear Lake was the only water body of considerable size within the M.D. of Willow Creek to support recreation. Several local residents talked about using Clear Lake for fishing, boating and swimming and described how the community established recreational facilities, including a community hall, playground, boat launch and floating dock. The EIA reported that Clear Lake supported a northern pike/perch fishery as recently as the late 1970s, but that fish kills were reported as the lake level started to decline. Local residents testified that this decline in the lake level was attributed to a combination of increasing water use in the drainage basin and drought conditions. Clear Lake was totally dry by 1985, and has had low water levels since then. Local residents still heavily use the recreational facilities and have been working since the mid-1980s to find a way of restoring Clear Lake to its former state.

Recreational use was reported for both the Little Bow River and Mosquito Creek. Regional residents described using both for swimming, fishing and even boating on an opportunistic basis. Several people described family outings and events during high flows. In addition, the Panel heard that local residents have become increasingly concerned about water quality and no longer swim in the rivers.

Various interveners also talked about the recreational opportunities that have evolved through the development of water storage at Travers, MacGregor and other reservoirs. Both Travers and

MacGregor reservoirs support pike, perch and walleye fisheries, offer camping or day-use facilities, and feature boating and swimming. Data provided in the EIA suggests that in combination, these two reservoirs account for about 5 per cent of all water-based recreational activity by residents of Calgary, and the Highwood and Little Bow river basins. This amounts to about 15,300 trips per year. The Panel heard that water-based recreation at these reservoirs is a key element in the tourism strategy for the region and that the amount of tourist traffic through the region has been steadily increasing.

The Panel also heard considerable testimony related to the recreational importance of the Highwood River. Although the upper reaches of the Highwood are used for boating during high water conditions, the lower reaches are heavily fished, primarily by local residents. Estimates provided by APWSS indicate that recreationists make about 7,750 trips to the lower Highwood River each year. The Fisheries Coalition noted that the Highwood River serves as the rearing grounds for many of the rainbow trout caught in the lower Bow River. The Fisheries Coalitions also provided evidence that shows the reach of the Bow River between Calgary and the Carseland weir is known as a world-class trout fishery and supports a significant guiding and service industry. Data provided by APWSS suggest that regional residents make an estimated 36,565 trips to the lower Bow River for fishing or boating. At the hearing, APWSS acknowledged that their estimates of recreational activities do not include usage by visitors to the region and the extent of this usage could be substantial.

6.3.4.2 Project Effects on Recreational Water Use

According to the EIA, implementation of the project and proposed diversion plan would impact regional recreation in three different ways. First, APWSS believes that implementation of the Diversion Plan would improve water-based recreation on the Highwood River. Second, restoring Clear Lake would re-establish fishing and other opportunities for water-based recreation. Third, development of the Little Bow River Reservoir could offer additional water-based recreational opportunities within the region. APWSS expects that the Project would not significantly affect recreational activities on Mosquito Creek and the upper Little Bow River, since they are rarely used.

In terms of the Highwood River, the majority of recreational benefits are associated with the proposed Diversion Plan. As described in Section 4, the Panel has serious concerns about the effectiveness of the proposed Diversion Plan and is deferring its decision on this aspect of the APWSS proposal. However, APWSS also proposed to construct fish screening devices at the diversion point for the Little Bow canal. The Fisheries Coalition provided striking evidence about the importance of fish screens on canals and argued that an effective fish screen will lead to higher rainbow trout populations in the Highwood River because of reduced entrainment in the canal. Increased trout populations may lead to higher fishing success rates and increased recreational use and enjoyment of the Highwood River.

There was strong support among interveners for re-filling Clear Lake. While the resulting lake would support new irrigation, it would also provide opportunities for swimming, boating and various beach activities. APWSS predicts that the level of the lake would remain fairly constant, leading to the development of aquatic vegetation and the possible establishment of a pike/perch fishery. APWSS predicts that based on its future recreational attributes, Clear Lake would be visited by about 6400 parties per year. This is equivalent to about 75 per cent of current visitation levels at Travers Reservoir.

In terms of future recreational development, APWSS is not proposing to construct any new facilities at Clear Lake. However, the M.D. of Willow Creek testified that a recreational plan for Clear Lake was developed some years ago. This plan considered expansion of camping facilities adjacent to the existing site as well as the potential development of a cottage subdivision. The M.D. of Willow

Creek indicated that any future development would be subject to the development and approval of an area structure plan for Clear Lake.

During the hearing, several questions were raised about water quality in Clear Lake and its suitability for irrigation and recreation. There was concern that high levels of salts in the existing lake bed would be absorbed into the lake, leading to high levels of dissolved solids. As reported earlier (Section 5.1.6), irrigation pumping would serve to keep salt levels in the lake within the normal range for prairie lakes and better than observed historically. In addition, Environment Canada requested that motor boat use of Clear Lake be restricted when migratory waterfowl are breeding and that the northern part of Clear Lake should be out of bounds for motor boats. Environment Canada also suggested developing educational displays in the vicinity of a proposed Clear Lake Grasslands Conservation area.

APWSS testified that creation of the Little Bow River Reservoir would be a positive, major, long-term impact of the project, especially given the relative scarcity of other lakes or reservoirs in this region. Their fisheries studies suggest that the reservoir would create abundant but poor quality habitat that could support a walleye and pike sport fishery. And while much of the land area adjacent to the reservoir would not be suitable for development due to steep slopes and potential for erosion, the water quality in the reservoir could be capable of supporting water-based recreation.

To realize the recreational potential of the reservoir and to mitigate risks to public safety as a result of uncontrolled recreational access, APWSS has proposed constructing public day-use facilities at the reservoir. Four possible sites were identified in the EIA, but APWSS is now considering development at only two sites on the reservoir. The proposed facilities would provide opportunities for picnicking, boating, swimming and fishing, and would cost up to $1.2 million. Based on this development and the characteristics of other regional sites used for water-based recreation, APWSS predicts that about 5,530 parties would visit the reservoir each year. In terms of public safety, APWSS is proposing to install safety booms above the dam and use appropriate signage to effectively mitigate this potential problem.

APWSS also believes that there is the potential for some cottage development by the private sector at sites adjacent to the reservoir. This is based on the observed demand for cottaging at other reservoirs in southern Alberta. In the EIA, APWSS identified the potential for cottage development on up to 32 ha (80 acres) of land adjacent to the reservoir as a positive, minor, long-term impact of the project. However, such development is contingent on approvals from local governments and requires public consultation with affected landowners such as the Hutterian Brethren.

At the hearing there was considerable discussion about the nature and extent of recreational facilities that could be developed at the reservoir. The Recreational Interest Group believes that the reservoir has the potential to support “high-end” recreational activities, like cottage subdivisions, resorts, golfing and tennis, and that there is a very high regional demand for such facilities. They believe that the potential for high-end recreation could be better achieved by restricting drawdown on the reservoir, creating lagoons, and stabilizing the shoreline in selected areas. They believe that managing the reservoir to enhance recreation will lead to a broader range of economic, social and environmental benefits for the region and for people with land adjacent to the reservoir. In response, APWSS noted that the potential for cottaging was addressed in the EIA and they concluded that the creation of lagoons or stabilization of shorelines is “prohibitively expensive and out of scale with the benefits”.

Questions about reservoir drawdown and recreational capability generated considerable discussion. The Recreational Interest Group reported that average drawdown would be 5 m (16 ft) with a maximum drawdown of 14 m (46 ft), and this could translate into average variations in shoreline of between 33 m and 100 m (110 ft and 330 ft), depending on the slope. APWSS replied that the results of more recent modelling suggests that reservoir drawdown would not be as great. Their evidence is that in half of the years drawdown would be less than 3 m (10 ft) and would be less than 5 m (16 ft) in over 80 per cent of years. The maximum drawdown of 14 m (46 ft) would only occur after a succession of very

dry years. AEP confirmed this assessment and noted that during times of extreme drawdown the reservoir would likely be unsuitable for recreation. AEP also noted that they have issued guidelines for development adjacent to reservoirs. These guidelines help ensure that any such development does not endanger the public, does not impact water quality, and does not impinge on the reservoir's primary purpose of water supply.

One intervener who owns property near the upstream end of Travers Reservoir provided additional evidence concerning the effects of drawdown. Pictures showing the effects of drawdown on Travers Reservoir during July of 1997 were provided and the intervener commented that their boat could not be used because of low water, even though they had recently put in a costly docking system. In addition, they were quite worried about the levels of contaminants in the sediments exposed during drawdown. This landowner also reported that visitors to Little Bow Provincial Park were unable to swim or boat during that period. They suggested that a reservoir operations plan that gives equal weighting to all water uses be developed. In response, AEP indicated that the primary purpose of the water reservoir is water storage and subsequent use, so that any recreation facilities to be developed will have to accommodate variable water levels.

The Little Bow Hutterian Brethren provided their views on the possible development of intensive recreational facilities or cottaging on the Little Bow River Reservoir. The Colony believes that the Panel should not approve the use of the reservoir for intensive recreation purposes. The Colony believes that the decision to allow intensive recreational development should the responsibility of local government based on input from adjacent landowners. The Colony is not opposed to the construction of public day-use facilities being proposed by APWSS.

Both the County of Vulcan and the M.D. of Willow Creek support the proposal of regulating land use around the reservoir by way of a joint area structure plan. A joint plan is required to ensure that consistent zoning occurs on both sides of the reservoir. At present, the M.D. is more restrictive in terms of subdivisions because it does not have rural country subdivisions within its boundaries, unlike the County of Vulcan, which has existing rural subdivisions on Travers and MacGregor reservoirs. Development of a joint area structure plan would involve public consultation and would establish the rules by which intensive recreational development would be managed in the future.

In general, most interveners believe that project implementation will provide a substantial increase in opportunities for water-based recreation within the region. Re-filling Clear Lake would allow local residents to resume activities that have been suspended since the mid-1980s and the creation of the Little Bow River Reservoir would create new recreation opportunities. In addition, some interveners see Clear Lake and the Little Bow River Reservoirs as major components in future strategies to promote tourism in the region and diversify the regional economy. The County of Vulcan Economic Development envisages fishing derbies, cottaging and other recreational activities. The discussion of transportation routes through the region included an option that would directly link Pine Coulee, Clear Lake and the Little Bow River Reservoir with Travers and MacGregor Reservoirs.

6.3.4.3 Panel Views

The Panel believes that development of the three-component project would have a positive, long-term impact on recreation in the region, resulting in improvements in the quality of life and providing opportunities for economic diversification. The Panel also believes that it would be in the public interest for APWSS to construct day-use facilities on the new reservoir. This would allow safe access to the reservoir and would minimize potential impacts on adjacent landowners by concentrating activities at one or two locations on the reservoir.

The Panel recognizes that, at some time in the future, more intensive recreational facilities may be developed on the reservoir and at Clear Lake. However, APWSS has not proposed the development of any such facilities, and the Panel has neither the mandate nor intent of approving any intensive recreational development at this time. The Panel believes that the County of Vulcan and the M.D. of Willow Creek should adopt area structure plans for both the reservoir and Clear Lake, and should use this process to determine the types of recreational development that are appropriate to local residents.

The Panel has reviewed the suggestions made by the Recreational Interests Group to modify the construction and operations of the reservoir to maximize the potential for future recreational interests. While these proposals may be technically feasible, the Panel believes that it would be more appropriate for the private sector to seek approval and pay for any shoreline modifications needed to support future recreational development. Such modifications would of course require all the necessary approvals from regulatory authorities prior to implementation. In terms of modifying the reservoir operating regime to reduce drawdown, the Panel believes that the primary goal of the reservoir is to store water for consumptive use. Consequently, recreational usage would be affected by the inevitable fluctuations in water levels that would occur from withdrawing water to meet these needs. The Panel concludes that placing constraints on reservoir operations that might limit water supply from the reservoir during water shortages is not in the broader public interest.

The Panel also recognizes the importance of the north end of Clear Lake for water fowl and shorebird habitat and believes that intensive recreational activities in this area should be limited during times when these species are most prone to disturbance.

6.4 Impacts on Municipal Sewage and Waste Water Disposal

One of the issues raised at the Pre-Hearing Conference concerned potential project impacts on municipal wastewater treatment and storm drainage systems. Discharges of municipal sewage and storm water run-off adversely affect water quality in the Highwood River, Little Bow River and Mosquito Creek. There is concern among some municipalities that new limitations will be placed on their wastewater and storm drainage systems to ensure that water quality in the reservoir and canals is adequate for irrigation, municipal water supplies and contact recreation.

6.4.1 Current Conditions

Treated sewage from High River is pumped into Frank Lake along with treated effluent from the Cargill meat packing plant. Sewage discharges from Blackie also enter Frank Lake intermittently via a dry creek channel. Okotoks is currently discharging their treated sewage into the Sheep River. Both Vulcan and Champion discharge wastewater into lagoons that do not drain into the Little Bow River. Effluent from their lagoons is sometimes used for irrigation. Nanton currently discharges wastewater into Mosquito Creek.

Evidence before the Panel indicated that the Frank Lake wetlands can discharge phosphorous loads to the Little Bow River. Although the wetlands provided a means of nutrient removal, high nutrient levels are now found in Frank Lake outflow. This proved to be a problem in 1996 and 1997 when high run-off resulted in substantial discharges from Frank Lake into the Little Bow River. The increased nutrient loads in the river resulted in substantial weed and algae growth that has affected downstream water users. The Town of Vulcan provided evidence concerning the extent to which their water treatment costs had increased as a result of poorer water quality which they attributed to Frank Lake outflows.

The Town of Nanton currently operates their wastewater treatment facility to provincial standards. The treatment facility was upgraded most recently in 1981 and has the capacity to treat sewage for a population of about 2500. The current population of Nanton is 1665. Nanton is currently not required to treat wastewater to remove phosphorus or nitrogen. Discharges from the treatment facility enter an oxidation ditch and eventually enter Mosquito Creek. At the hearing, it was noted that during winter, flows in Mosquito Creek below Nanton consisted almost entirely of treated sewage effluent. The current approval for Nanton's sewage treatment plant expires August 1, 1998.

Nanton and AEP also provided some evidence concerning the effects of sewage discharges on water quality in Mosquito Creek. This evidence showed that, although concentrations of total phosphorous in the effluent were fairly high (averaging 3.5 mg/l), the water quality in Mosquito Creek above and below the sewage treatment plant was nearly identical. AEP concluded that "when the creek flow assimilates the plant flow, there is no measurable change in Mosquito Creek water quality other than an improvement in the creek suspended solids level." The Panel understands that dilution is used to manage waste discharges into flowing water such as Mosquito Creek. However, expert testimony also showed that the cumulative adverse impact of effluent loads to a confined water body, such as the Little Bow River Reservoir or Clear Lake, could be significant.

Storm sewers and storm water lakes in the Town of High River drain into both the Highwood River and the Little Bow River. Two of five storm water ponds are intensively managed by pumping water in from the diversion canal to maintain water levels and water quality during dry periods and pumping out after storm events to ensure capacity to accommodate subsequent storm events. The other three storm water lakes are periodically pumped out into the canal to maintain storage capacity. Operation of the storm water system requires provincial government approval and the most recent approval requires High River to monitor storm water quality. High River was also asked to develop a by-law that will regulate releases to storm sewers. Storm water from Nanton is not of concern because it drains to a salt lake south of the town and evaporates.

6.4.2 Project Effects on Municipal Wastewater Disposal

The nutrient problems associated with Frank Lake outflows are a recent phenomenon that was addressed in the hearing. There was considerable discussion of the extent to which the higher nutrient loads from Frank Lake that originated with Cargill and High River might compromise water quality in the proposed Reservoir. There was agreement that the problems associated with discharges from Frank Lake must be resolved even without the project. AEP provided an analysis of several different methods that could be used to manage nutrient levels found in Frank Lake outflows.

In analyzing the potential impacts of the proposed project, APWSS accounted for Nanton effluent loads in the water quality modeling done for Clear Lake and the Little Bow River Reservoir. Based on their analysis, APWSS concluded that with Nanton effluent discharges, the quality of water in Clear Lake and in the Little Bow River Reservoir would be suitable for all purposes. Consequently APWSS concluded that project implementation would not impact Nanton's sewage treatment practices.

Nanton expressed concern that once the project is in place, concerns raised by downstream water users about nutrient levels, bacteria or water quality would force them to upgrade their sewage treatment facilities to include tertiary treatment and/or disinfection. Provincial grants pay for up to 65 per cent of the costs of treatment plant upgrades. Nanton presented evidence to show that it does not have the financial resources to undertake such upgrades. It has above average debt for a community of its size and has very little allowable debt remaining ($960,000). Upgrading of the sewage treatment plant might cost up to $3.2 million and would have a significant effect on town residents, considering that the existing plant would otherwise be sufficient to the year 2011. Nanton's position was that its existing licence for the sewage treatment plant should be honoured if the project proceeds. Nanton requested that the cost of any required sewage treatment upgrades be included as a cost of the Project and paid for by APWSS. AEP noted that future upgrades of the sewage treatment system might be required if sewage treatment discharges are shown to be having an adverse effect on aquatic or human life.

In terms of stormwater, APWSS testified that stormwater from High River does represent another source of nutrient loads for the Little Bow River, but that these should not have a significant effect on water quality in the proposed reservoir. They suggested that the provincial approvals process represents the best method for monitoring this problem.

Despite assurances that discharges of municipal effluents and storm water were adequately addressed or would be resolved independently of the proposed project, some interveners are concerned about the potential impacts of these pollutant sources on reservoir water quality. The Upper Little Bow Basin Water Users Association provided considerable evidence concerning how nutrient loads from municipal and other sources might compromise water quality in the reservoir. Various interveners asked the Panel to make recommendations regarding nutrient loading from Nanton sewage, storm water from High River and discharges from Frank Lake as part of a project approval.

6.4.3 Panel Views

Project impacts on municipal sewage treatment and stormwater management practices are directly related to the broader issue of project impacts on water quality, which were discussed in more detail in Section 5. Evidence presented at the hearing suggests that the Little Bow River Reservoir would be hypereutrophic, and the resulting water quality would adversely affect the reservoir's ability to sustain a viable fishery, support recreation, or provide improved municipal drinking water. The Panel is hopeful that various efforts will be taken to reduce nutrient loads in the Little Bow River and Mosquito Creek,

including the development of a basin water quality management strategy to reduce nutrient loads by 60 to 80 per cent. As one expert stated, "the Little Bow River, unfortunately, has become the waste water disposal site of choice in recent years". The Panel believes that it is time for this practice to end. The Panel believes that the costs of controlling pollutants should be borne by those who are responsible for generating them and not passed on to downstream residents or the public at large.

The Panel notes the concerns of residents of the Little Bow and Highwood river basins related to adjacent land use, agricultural cropping and livestock practices, and municipal stormwater and wastewater management impacts on downstream water quality. The Panel believes it is in the public interest to address and mitigate point and non-point source pollution impacting water quality. The Panel recommends that a basin wide initiative on water quality should be established. This will be referred to as the Little Bow Water Quality Protection Plan.

The Panel is concerned about the water quality in Frank Lake negatively impacting the potential Little Bow River Reservoir and current water quality for Upper Little Bow water users. The Panel recommends that AEP create a Frank Lake Water Quality Mitigation Plan, which would control nutrients from Frank Lake to background levels that existed prior to the receipt of wastewater directed to the Lake. It is further suggested that monitoring results from the Frank Lake Water Quality Mitigation Plan be released to the public annually once the mitigation plan has been initiated.

In regard to Nanton, the Panel believes that although existing sewage releases may not appear to significantly add to the elevated nutrient concentrations in Mosquito Creek, they are adding a nutrient load to the lower reaches of the basin. The cumulative impact of all nutrient releases, including those from various non-point sources, may seriously constrain the ability of the project to achieve its stated objectives. Like all other sources within the basin, Nanton may also have to improve the quality of its surface water discharges.

6.5 Navigation

In order for the project to proceed, APWSS requires an authorization from the Department of Fisheries and Oceans under the provisions of Section 5(1) of the Navigable Waters Protection Act. During the hearing, issues arose concerning what constitutes a navigable river and whether specific flow requirements for navigation should be incorporated into the operating plans for the canal and reservoir.

6.5.1 Current Conditions

Evidence provided by APWSS and various interveners indicates that navigation on water bodies to be affected by the project consists entirely of recreational activities. APWSS reported that boating on the Highwood River amounts to about 560 trips per year and occurs from May through August. Records show that canoeists consider flows below 10 cms (353 cfs) to be too low for navigation while the preferred range of flow is between 12 and 33 cms (425 and 1165 cfs). Such flows only occur during the run-off period so that the majority of canoeing occurs during the month of June.

Various residents provided anecdotal evidence about boating on the Little Bow River and Mosquito Creek. Canoeing activities occur irregularly on the Little Bow River and are tied to high water events. Even with high flows, periodic creek crossings and barbed-wire fences impair navigation. The Boy Scouts were identified as frequent users but navigation appears limited to high water conditions in the spring. Local residents indicated that there are no boating activities on Mosquito Creek because water levels are either too low or too high to be safe. APWSS noted that a book on canoeing in southern Alberta concludes that the Little Bow River, downstream of the confluence with Mosquito Creek, may be navigable for a three-week period during average to good conditions, but is not navigable in dry years.

6.5.2 Project Effects on Navigation

APWSS concluded that implementation of the project and diversion plan would have no significant impacts, either positive or negative, on the navigability of either the Highwood or Little Bow rivers, or Mosquito Creek. In terms of the Highwood River, APWSS has stated that, under the diversion plan, there would be no change in the amount of time the flows in the Highwood River are too low for canoeing (less than 10 cms or 350 cfs).

In the case of the Little Bow River, APWSS noted that implementation of the project would result in higher flows on the reach above the reservoir during the spring and early summer, particularly May and June. Below the reservoir, summer flows would be significantly increased and would improve opportunities for boating. However, they also stated that higher flows would not likely affect navigability since various land use characteristics are more significant limiting factors. No changes in navigability are expected for Mosquito Creek since the three-component project is not anticipated to affect flow conditions. APWSS further concluded that neither the Little Bow River nor Mosquito Creek are navigable "in any meaningful sense" so that requirements for sufficient flows to support navigation need not be addressed in the operating plan for the diversion canals.

The Canadian Coast Guard sector of the Department of Fisheries and Oceans is responsible for safeguarding navigable waters and testified that based on current policy, a determination of navigability is based on the potential for use of a waterway, not just actual use. Consequently, they believe that Mosquito Creek and the Little Bow River are navigable waters even though they are used infrequently. The Coast Guard concluded that development of the project would increase opportunities for recreational boating, despite shortening the period of navigability on the upper Little Bow River. They further concluded that the project could be approved under the NWPA, subject to the following conditions related to navigational safety:

1. The owner shall ensure that all construction material and debris does not enter the waterway.

2. The owner shall ensure that all obstacles and potential obstructions to navigation within the reservoir and Clear Lake are removed prior to flooding.

3. The owner shall implement an annual maintenance program for the removal of debris from the waterways that may accumulate with increased flows.

4. Navigation safety booms shall be installed and maintained at diversion structures as required by the Coast Guard.

5. Boat launching ramps for small non-powered craft shall be provided as portages around the dam on the Little Bow River and around the diversion structure on Mosquito Creek.

6. Operating plans for the diversion structure and dam shall be approved by the Coast Guard as required under the *Navigable Waters Works Regulations*. The plans should include a safe operating level below which notification to the Coast Guard would be required to jointly determine appropriate action in the interest of navigation safety.

7. All ancillary marine works such as docking facilities, bridges that require reconstruction, et cetera, constructed as a result of this project, will be subject, or would be subject to separate applications under the *Navigable Waters Protection Act*.

8. Monitoring and reporting on the effects of reservoir drawdown on navigation safety shall be undertaken by the owners.

9. Public notification, including the posting of signs on those canals and other offstream bodies of water that will not be permitted access for the purposes of navigation.

In response, APWSS indicated that for most of these items, they are willing to comply and would welcome the advice of the Coast Guard. The EIA includes the installation of safety booms and appropriate signage to ensure public safety at the Little Bow River Reservoir. However, APWSS is opposed to incorporating conditions related to navigability into the operating plans for the diversion structure and dams. They believe that such conditions are unnecessary for Clear Lake because recreational activities have already been factored into their proposed operating plan. They also believe that water requirements for recreation should not be included in the operating conditions for the Little Bow River Reservoir because, at times of low water, municipal, domestic and agricultural needs should take precedence over recreational navigation requirements. To ensure public safety, APWSS intends to close recreational facilities on the reservoir if water levels drop below a specified minimum.

APWSS is also opposed to having requirements for navigation included in the operating plan for the diversion canals. They believe that DFO does not have the authority to impose flows for navigation, other than downstream of a dam, and that there is no precedent for imposing such conditions. In addition, specific flows required to support navigation on the Little Bow River or Mosquito Creek are not warranted because of the low incidence of recreational use. Consequently, APWSS asks that the Panel recommend that the Federal Government authorize approval of the project under the NWPA, but without the requirement that operating plans include provisions for minimum reservoir levels or flow criteria for navigation.

6.5.3 Panel Views

The Panel expects that the proposed Little Bow project would have a minor impact on navigation on the Little Bow River, Mosquito Creek or the Highwood River. The Panel recommends that the Coast Guard, in considering APWSS's application for approval of the proposed dam and diversion canals, include various conditions related to navigation and public safety. Such conditions would include requirements for constructing portage routes around the dam and diversion structures and for designing,

building and operating the works in a manner that minimizes the risk to boaters who might use the rivers, creeks and canals in the vicinity of the project.

In regard to including conditions related to navigation in the operating plans for the dam and diversion works, the Panel believes that it is not in the public interest to place constraints on the project's ability to store and convey water for consumptive uses. The Panel believes that in times of drought, water requirements for municipal, domestic and agricultural use should take precedence over navigational and recreational uses, especially since such activities occur so infrequently. The Panel expects that water shortages would tend to occur in late July and August, when normal flows on Mosquito Creek and the upper Little Bow River would preclude boating. Furthermore, including provisions for navigational flows could lead to greater recreational usage and increased risks to public safety unless landowners remove fencing, canal/river crossings and other obstacles. To ensure boating safety on the reservoir, the Panel supports APWSS's proposal to close recreational facilities if water levels drop below a specified elevation.

6.6 Land Use and Planning Impacts

Development of the Little Bow project would affect land use adjacent to the reservoir and diversion canals, and would have implications for municipal planning.

6.6.1 Reservoir Land Management

At the hearing, some of the interveners expressed concern about project impacts on adjacent land owners. Landowners currently have access to the streams on their lands but realize this access will change when these lands are purchased and the reservoir is established. Some landowners also have licences to irrigate on lands that will be purchased for the project, and they are concerned about the future status of these licences.

6.6.1.1 Current Conditions

Under the Water Resources Act, people owning or occupying land that adjoins a river, stream, lake or other body of water are entitled to use water from that water body for domestic purposes. This is termed a riparian right. Domestic purposes include the withdrawal of water for households, sanitation and fire prevention, the watering of domestic animals and poultry, and the irrigation of a garden not exceeding one acre. Riparian landowners are also allowed to pump water from a stream to fill a dug-out, if the water is to be used for domestic uses. Riparian landowners using water for domestic purposes can do so without having to acquire a water licence. It is also common practice for riparian landowners to allow their cattle to consume water directly from rivers, streams and lakes. Water required by riparian owners is considered to be part of conveyance flows.

In order to use water for other purposes, landowners must acquire a water licence. These licences are issued for a specific purpose and amount of water and they are tied to a specific piece of land or point of diversion. Licences have priority among themselves according to the date they were filed. Since licences are attached to the land, they would normally be transferred to the new landowner if the lands were sold. It is possible for a licencee to change the point of diversion from one location to another.

6.6.1.2 Project Effects on Reservoir Land Management

According to the EIA, construction of the dam and subsequent filling of the reservoir will flood one farmstead, one country residence and the Little Bow Hutterite Colony, and will directly affect three additional farmsteads near the dam site. A total of 23 landowners would lose lands due to flooding. APWSS has already purchased all the land necessary for the Clear Lake component of the project. To mitigate impacts on landowners, APWSS is proposing to relocate the Hutterite Colony (see Section 6.1) and negotiate settlements to compensate for damages to all landowners. Compensation would be paid for any land lost as a result of the project, plus relocation or replacement of buildings, corrals or fences.

At the hearing, APWSS indicated that their normal practice is to purchase all lands around a proposed reservoir site, up to the top-of-dam elevation, plus any additional lands that might be subject to sloughing. APWSS prefers to acquire land rights through negotiation. However, should negotiations with landowners fail to secure an agreement for compensation, APWSS would still retain the ability to acquire the necessary lands through expropriation. The acquisition of these lands ensures that APWSS has full control over access to the reservoir. Consequently, APWSS would become the riparian landowner and adjacent landowners would lose the riparian right to use water from the water body for domestic purposes.

This change in riparian rights is of considerable concern to adjacent landowners. The Public Advisory Committee recognized the potential difficulties associated with the loss of riparian rights and proposed that easements for access to the reservoir for domestic water use be negotiated with APWSS as part of land purchase agreements. At the hearing, the Little Bow Hutterian Brethren requested that they be allowed to retain riparian rights, privileges and responsibilities and suggested that APWSS acquire the necessary lands by way of an easement rather than by fee simple purchase.

APWSS indicated that they were aware of concerns raised by landowners about the loss of riparian rights. They noted that it is common practice for a reservoir operator (AEP in this case) to generally allow, within reason, access to the reservoir across its right-of-way after a formal authorization has been issued. General conditions are usually attached to these authorizations. These conditions could include that any works to be built adjacent to a reservoir be designed using acceptable engineering standards and that the works would not interfere with the Department's ability to operate or maintain the reservoir. Other conditions are that the slope stability at the site be assessed, that the works be available for public use, and that the people applying for access to the reservoir are responsible for maintaining the works and for the cost of constructing these works. Such arrangements could be used to gain access to the reservoir to obtain water for domestic purposes.

Filling of the Little Bow River Reservoir would also inundate 23 existing irrigation intakes, of which 15 would be modified or replaced by APWSS. Eight intakes would be no longer be required because the lands they irrigate would be flooded. Several interveners, as well as APWSS, provided evidence that existing water licences may be transferred from one parcel of land to another with the approval of the Lieutenant-Governor-in-Council.

In terms of impacts on individual landowners adjacent to the reservoir, APWSS is prepared to negotiate site-specific mitigation or compensation. APWSS would like the Panel to confirm that the best method for resolving problems with landowners involves monitoring project effects after project approval and negotiating with individual landowners.

6.6.1.3 Panel Views

The Panel believes it is generally appropriate for APWSS to acquire the lands to be flooded or impacted by the new reservoir through purchase in fee simple, with certain exceptions. In this way, APWSS can control and minimize the impacts of any future water fluctuations or bank erosion or slumping and maintain the maximum flexibility in operating the reservoir. This means that landowners surrounding the reservoir will no longer have a riparian right to water. The Panel believes that it is in the public interest for these adjacent landowners to be able to continue to withdraw water from the reservoir for domestic purposes. The Panel therefore directs APWSS to ensure that the legal right to domestic water use from the reservoir will be negotiated in the land purchase agreements with landowners around the reservoir.

The Panel believes that it is up to APWSS to negotiate compensation and mitigation agreements directly with affected landowners, and recognizes that procedures for resolving disputes are established elsewhere. The Panel urges APWSS together with AEP to provide assistance to landowners who wish to relocate or transfer existing irrigation licences to other diversion points or lands adjacent to the reservoir.

The Panel also believes that it is not in the public interest to allow livestock direct, unrestricted access to the canals or reservoir. The Panel encourages APWSS and AEP to enter into agreements with landowners to implement measures to prevent cattle from entering these water bodies, thereby protecting water quality and shoreline habitat. In addition, the Panel encourages landowners to build dugouts on adjacent lands so that livestock will have an alternative source of supply.

6.6.2 Planning

The three-component project would lie within three municipal planning regions: the M.D. of Willow Creek, the County of Vulcan and the M.D. of Foothills. The proposed reservoir site straddles the boundary between the County of Vulcan and the M.D. of Willow Creek, and these two municipal governments would have jurisdiction over land use activities on the shoreline of the reservoir. The Clear Lake diversion and canal lies within the M.D. of Willow Creek, while the Little Bow canal is situated in the M.D. of Foothills and the Town of High River.

6.6.2.1 Current Conditions

Within the M.D. of Willow Creek, lands potentially affected by the project are currently zoned as “Rural General”. This classification was created to protect “better agricultural land in the region by limiting or regulating development other than cultivation or grazing”. Under this zoning, most agricultural activities (other than intensive livestock operations) are permitted, some activities like public

and private recreation and public utilities are discretionary, while grouped country residential developments are prohibited. The M.D. has other zoning classifications that would allow the development of grouped country residences.

Potentially affected lands in the County of Vulcan are also zoned as "Rural General" and this designation was established as a means of protecting "the agricultural land base of the municipality while allowing non-agricultural developments that complement the area's economy." Farm residences and additions are permitted uses while various agricultural support activities and public utilities are considered discretionary uses. The County has created two types of zoning to deal with recreational development. One of these zones (Reservoir Vicinity) allows various agricultural activities, single lot residences, group camps and various types of public recreational facilities to be developed adjacent to reservoirs. The other classification (Rural Recreation) allows various types of private recreational facilities and grouped country residential development.

Within the Town of High River, lands adjacent to the existing canal and diversion structure have been zoned for a variety of purposes. These include convenience commercial, public service, urban reserve, and residential medium family districts. Sections of the canal located near schools or residential districts have been fenced to ensure public safety.

6.6.2.2 Project Effects on Land Use Planning

APWSS testified that, under the Municipal Government Act, they are not required to obtain development permits for the construction of the dam and canals. However, as with Pine Coulee, they intend to apply for the appropriate permits from M.D. of Willow Creek, the M.D. of Foothills, the County of Vulcan, and the Town of High River.

Both the M.D. of Willow Creek and the County of Vulcan indicated that they support the project. They expect that after the reservoir and Clear Lake have filled, there will be pressure to allow new types of development on adjacent lands. Although not concerned about the public recreational facilities being proposed by APWSS, both municipal governments expect that there could be demand for cottage subdivisions and that this would require rezoning lands around the Little Bow River Reservoir. Clear Lake is already zoned for recreation.

Both the M.D. of Willow Creek and the County of Vulcan believe that a joint land-use plan for the area around the Little Bow River Reservoir should be developed. The development of such a plan would provide an opportunity for the two municipal governments to resolve some differences between them in terms of zoning related to country residential and non-agricultural subdivisions. The M.D. of Willow Creek is currently more restrictive in terms of subdivisions around reservoirs and is developing new zoning designations that would allow industrial development adjacent to reservoirs where appropriate. Both municipal governments believe that the requirement for a joint land-use plan is consistent with recent Provincial Land Use Policies, especially in terms of planning co-operation and water resources. Representatives of the M.D. of Willow Creek and the County of Vulcan asked for the Panel's endorsement of their proposal to have a joint Area Structure Plan prepared.

At the hearing, some interveners were concerned about the future potential for intensive livestock operations in the Little Bow River basin and how this type of development could adversely affect water quality. Currently, the municipal governments refer applications for intensive livestock operations to Alberta Agricultural Food and Rural Development and the Chinook Health Region for their comment and input. Municipal governments also base their decisions on the current Code of Practice for the Safe and Economic Handling of Manure as it applies to intensive livestock operations. It is then up to

the Municipal Planning Commission to approve applications for intensive livestock operations, subject to a public review process.

6.6.2.3 Panel Views

The Panel believes that to accommodate development of the proposed dam, canals and public recreation sites, it is not necessary to revise the current land-use plans of the County of Vulcan and the M.D. of Willow Creek. These plans provide for public utilities as discretionary land uses and the proposed project components are for public utility-like purposes. For more certainty, if the Panel's view of the current land use by-law is not accurate, then the Panel would direct that the lands affected by the project be zoned to accommodate the construction and operation of water management facilities as described in the Application.

The Panel supports the development of a joint area structure plan for the proposed Little Bow River Reservoir because this would provide a process whereby adjacent land owners could provide input into decisions about what types of development could occur on lands around the reservoir. The Panel requires that, if the project is approved, APWSS prepare an area structure plan and request amendments to the local land use by-laws from the M.D. of Willow Creek and the County of Vulcan prior to commencement of reservoir operations and diversions.

The Panel notes that more complete participation by the Town of High River and the M.D. of Foothills at the hearing would have been appreciated, given that they would be affected by the project were it to be approved and developed. All future development in the Little Bow and Highwood basins could potentially affect the quality and availability of water for downstream users, and these potential impacts should be considered in current and future land use decisions.

6.6.3 Land Management

At the pre-hearing conference and in submissions to the Panel, various interveners expressed concerns about how project operations would affect their activities on lands adjacent to the reservoir and canals, including impacts on fences, creek crossings and livestock watering. These issues had arisen at meetings of the Public Advisory Committee and were the subject of meetings between APWSS and local landowners.

6.6.3.1 Current Conditions

Landowners adjacent to the Little Bow River and Mosquito Creek have adopted various strategies for minimizing the effects of flow variability on their agricultural practices. Some have built various structures to allow machinery and livestock to move from one side of the river to another. These range from bridges or roads with culverts, to informal, grade-level, gravel crossings. Many farmers also run fences across creeks and canals in order to keep their livestock from straying off their property. Because of the lack of steep banks along the Little Bow River and Mosquito Creek, land can be cultivated right to the water’s edge and livestock can drink directly out of creeks and canals.

6.6.3.2 Project Effects

Increasing the rate of diversion from the Highwood River to 8.50 cms (300 cfs) would triple flow rates in the Little Bow River for at least part of the year. Adjacent landowners may experience various problems as a result of these higher flows. The EIA predicts that informal crossings of the Little Bow River would no longer be useable at times of high flow and that fences would be washed away. However, they suggest that increasing flow rates from 2.83 cms to 8.50 cms (100 cfs to 300 cfs) would only cause a 0.5 m (20 in) rise in water levels in reaches of the upper Little Bow River. APWSS concluded that increased erosion would not be a widespread problem in the basin.

As part of project mitigation APWSS is proposing to replace any culvert crossings that are legally licenced by AEP and have a licence of occupation. Existing culvert crossings that are not legally approved will not be replaced. For grade crossings of the river, APWSS would undertake repairs designed to withstand flows of 8.50 cms (300 cfs). However, landowners would be responsible for any damages that occur should flows exceed 8.50 cms (300 cfs) under natural flood conditions. In terms of fences, APWSS indicated that ice and high flows would always be a problem but they committed to placing steel fence posts at strategic locations adjacent to the river. They note that any fences across the river must conform to standards set by the Canadian Coast Guard under the Navigable Water Protection Act.

APWSS is also proposing to build dykes or channels to protect any land areas that would be subject to flooding at flows of 8.50 cms (300 cfs), particularly if infrastructure or buildings are at risk. They estimate that about 53 ha (130 acres) might be susceptible to increased flooding. Where it is more cost-effective, APWSS would purchase flood-prone lands or any lands that are water logged or heavily eroded. The land purchase option would end five years after project implementation.

Because these types of impacts on lands are difficult to predict and mitigate, APWSS also proposed developing a process that effectively protects landowner interests. They suggested using Subcommittee III of the PAC to bring landowner concerns forward to APWSS and proposed using photographs to document pre-project and post-project conditions. In cases of disagreement, APWSS has offered to pay the costs of hiring a mutually agreed third party to resolve disputes during a five-year period after project implementation and for maintaining the photographic record during this period.

Some interveners questioned the effectiveness of the proposed mitigation measures. They presented evidence suggesting that previous efforts to install and maintain culvert types crossings, notably on Squaw Coulee, have not worked. They argued that the culverts are too small and are regularly overtopped or silted in, and require regular maintenance. There was also testimony that the increased variability in flows in the canal would lead to mudflats during low water. In the case of Squaw Coulee, there was evidence that APWSS did not act on landowner concerns about mudflats until cattle became trapped and died, after which APWSS paid compensation and subsequently rebuilt the watering area with a solid base. Some people questioned the adequacy of placing steel fence posts adjacent to the canal or river, because this would not stop cattle from wandering if the fence across the creek gets washed away during high flows. There was also concern about the high costs of building a licensed dry ford to accommodate the higher flows. The only alternative is to move cattle from one side of the canal or river to the other using one of the few available bridge crossings.

There was also evidence that cattle are being allowed to water in the canals and creeks and that this practice has been occurring for some time. Landowners are concerned about whether livestock would continue to have safe access to the water because higher flows could lead to erosion and steep banks while, during a period of low flow, the resulting mud flats might be a hazard. The possibility of fencing the canal and establishing pump stations and livestock watering tanks was considered to be a viable solution to this problem. At the same time, the Fisheries Coalition expressed concern about livestock damage to the riparian zones of rivers and creeks and suggested that the Cows and Fish Program

be considered as a means of protecting aquatic and riparian habitat. This program, as described in Caring for the Green Zone, includes changing grazing patterns and using corridor fencing to control livestock access to riparian areas. However, there is concern that fencing of canals and the reservoir would restrict livestock access to water and create a barrier to wildlife.

6.6.3.3 Panel Views

The Panel believes that the best approach for dealing with these land management issues is for APWSS to deal with individual landowners on a case-by-case basis as these issues arise. They believe that it is in the public interest to have APWSS mitigate or compensate landowners for any project-related damages to structures, fences or stream crossings that are in compliance with existing laws and regulations. The Panel also believes that it is appropriate to establish a window of time during which APWSS would be required to address landowner concerns. However, the Panel believes that this window should be for five years after implementation of an acceptable diversion plan rather than five years after project implementation.

The Alberta Riparian Habitat Management Project also known as the "Cows and Fish" project is one successful example of how people can effectively work together to improve and preserve range lands and riparian areas. The Highwood and Little Bow basins provide excellent opportunities for ranchers, livestock operators, rural and town residents, and government and private organizations to address some of the concerns that were raised in the hearing with respect to water pollution, stream damage and the health of the riverine ecosystem.

The Panel notes that simply providing more water for irrigation, domestic consumption, fisheries, wildlife, recreation and other uses, without everyone doing their utmost to protect the quality of the water and the riverine environment, would be a losing proposition. Certainly government needs to act directly in their areas of responsibility for water management but the voluntary efforts of local area ranchers and residents must play a role. The control of cattle in the riparian areas is absolutely crucial and the "Cows and Fish" project provides practical advice and tools for accomplishing this. The Panel urges local residents to review Caring for the Green Zone: Riparian Areas and Grazing Management (Exhibit #216) and begin such programs in the Little Bow/Highwood area.

In terms of landowners concerns about continued livestock watering in water bodies and the resulting disturbances to riparian habitats and water quality, the Panel requires that APWSS develop a detailed plan for resolving these issues along the affected water bodies. Such a plan should be developed in consultation with local landowners and stakeholders and should be reviewed and approved by AEP and Alberta Agriculture Food and Rural Development. The Panel recommends that the funds to cover the intermediate and long-term costs of implementing such a plan be included in the capital and operating budget for the project. In addition, responsibility for implementation of the plan should be passed on to AEP when project ownership is transferred over from APWSS.

6.7 Public Safety and Risk

Interveners were concerned regarding public safety related to flood management, risks during construction of the new Little Bow River Reservoir dam and diversion canal structures, and impacts on cattle crossings of rivers and creek.

6.7.1 Little Bow Dam and Diversion Canal Safety

Public concerns regarding emergency flooding below the Little Bow River Reservoir dam were identified as the major safety issue at the Pre-Hearing Conference. There are 10 homes near the Little Bow River downstream of the proposed dam, and the Panel instructed the Applicant to meet with downstream residents to address their concerns about dam safety. The Panel notes that the interveners who raised dam safety concerns at the Pre-Hearing Conference did not repeat these concerns during the hearing. There appeared to be public acceptance of the design safety measures, emergency preparedness and response plans that would be developed with additional public input. Evidence indicated that significant risks of downstream flooding would more likely arise from an extreme weather event rather than structural failure of the earth-fill dam, and that the capability of the dam to hold and delay passing floodwaters could help mitigate peak flood effects.

The Panel observes that a number of regulatory, design, construction, and operation features of the Little Bow project address public safety. First, the 1991 Alberta Dam Safety Regulation Guidelines require that the Probable Maximum Flood (PMF) be used as a safety design standard where a potential for loss of life exists. The Little Bow River Reservoir dam and spillway system are designed to pass the PMF which has been estimated at 2,746 cms (97,000 cfs). The PMF is a theoretically estimated 1:1000 year flood consisting of combined Highwood and Little Bow basin snowmelt, runoff, and rain. The design height of the dam was increased to augment the freeboard above FSL from 2.7 m to 4.7 m (9 ft to 15 ft) to manage this higher level of inflow. This represents a design upgrade from the early project concept in which only runoff generated in the Little Bow basin was considered, and reflects that 70 per cent of flood volume at the dam would come from Highwood River overflow. The largest spring flood ever recorded at the Little Bow dam site would be rated less than a 1:50 year flood. The Panel believes that using the 1:1000 year flood as a design standard provides a significant safety margin.

Second, the reservoir will be raised and filled in stages. The dam would be a 25 m (82 ft) high compacted earth-fill structure with a low level conduit to supply water downstream. The dam would be a zoned embankment with an impervious (clay) core and pervious and semi-pervious outer shells. An impermeable cut-off with inclined and horizontal filters would be provided for seepage control. A concrete service spillway and an emergency earthen spillway could safely pass floods up to the 1:1000 year event.

Construction of the Highwood diversion canal expansion would be scheduled later in the project to coincide with completion of the reservoir dam. The intermediate containment capacity of the reservoir would thus not be challenged by the full capacity to divert 8.50 cms (300 cfs) into the Little Bow River.

Hearing testimony indicated that failures of earth-fill dams, although highly improbable, are most likely to occur during reservoir filling or in the first few years of operation while the consolidated structure is still compacting and settling in. After that earth-fill dams “maintain a stable situation”. Once built, the dam would be thoroughly instrumented and monitored to provide the earliest possible indication of any problem. Following construction there will be on-site daily inspections by dam operators who are there to operate gates, assess structural integrity and provide maintenance if needed.

Third, in the remote event of imminent flood in which high flows must be passed through the spillway, the emergency response system would be in place to immediately call, find, or physically visit individual residents who might be at risk. In all likelihood meteorological forecasting would have already provided a few days advance notice before emergency notification was required. In the event of actual flood spillage from the Highwood River into the Little Bow River, early warning time would allow up to 10 hours for notice during the travel time that it would take for peak flows to reach the reservoir. The Panel observes that the emergency response plan is a legal requirement. The plan would be developed with community participation, and must be in place and tested prior to reservoir filling. The Applicant would be responsible for ensuring that a construction emergency response plan and adequate flood warning procedures are also in place during the construction period. The Panel is confident that the potentially affected interveners will give this effort their utmost co-operation.

During natural flood conditions on the Little Bow River the gates at the Highwood diversion structure would be closed. Consequently flows above 8.50 cms (300 cfs) in the canal and/or river would be the result of natural flooding. Periodic flooding would still occur in the Little Bow basin; however, the dam could reduce downstream flood levels and lessen impacts.

Controlled flows downstream of the reservoir are expected to be less in spring (than historic freshet flows) and slightly higher and more stable in summer when water is released for irrigation withdrawals. There would be a phase-in period both upstream and downstream of the reservoir during which new operating flow patterns would be established and some cattle crossings might be relocated. The Applicant has proposed to manage these changes as they arise.

General public access to the expanded diversion works canal, reservoir spillway and control structures will be restricted by temporary and permanent fencing. This relates to the public concern that children and animals might otherwise be endangered by their curiosity in these structures, especially near the diversion canal in High River.

Other public safety risks include shoreline instability in the new reservoir, which could have major adverse impacts if residential or cottage properties are developed close to the reservoir shoreline. The shoreline is expected to regress over the long term due to combined wave-action and wind erosion. The Panel believes that the Applicant has carefully established their property takeline to contain such instabilities and not endanger the public.

6.7.2 Clear Lake

Hearing evidence suggested that the final design of the restored Clear Lake and wetlands might require from four to ten small dikes to maintain lake levels and contain a 1:125 year flood. The number of dikes depends on the final design details. The dikes would be low structures, probably 1 m to 2 m (3 ft to 6 ft) high, constructed of local earth fill materials. In the event of overtopping, flow would pass onto adjacent hayfields and no residences would be impacted. The flood risk and possible impacts were considered minor.

6.7.3 Panel Views

The Panel believes that planning for and protecting public safety is of high priority in enabling the three-component project to successfully meet its objectives. APWSS provided evidence that the dam and spillway were designed to accommodate the Probable Maximum Flood and that this provides

a safety margin such that the probability of a dam failure is extremely small. The Panel believes that, although the environmental and social impacts of a dam failure would be significant, the potential risk of such a failure would be insignificant. The Panel also believes that APWSS has considered geotechnical and hydrological factors in the design of the dam and other structures so that the potential impacts of the environment on the dam and other structures would also be insignificant. The Panel requires the Applicant, their contractors, and future project operators to abide by all safety codes, regulations, engineering design standards, and established best management practices relevant to the construction, operation, and maintenance of the project.

The Panel is confident that the public's participation in developing the Emergency Response Plan will produce a practical and reliable plan. The Panel supports the Applicant's position that they will provide compensation for project-caused property damages but not for damages caused by natural events.

6.8 Aboriginal Interests and Concerns

The Panel is directed by the Terms of Reference issued by the federal Minister of the Environment to review the environmental impacts of the project relating to the concerns and interests of aboriginal people. The CEAA defines environmental effects to include any change in the environment, including any effects of such change on physical and cultural heritage and on current use of land and resources for traditional purposes by aboriginal persons. The Panel believes it should provide a summary of the concerns and interests expressed to the Panel by aboriginal people. The Panel understands the following to be the major concerns and interests of aboriginal peoples about the effects of the project:

- aboriginal sites and artifacts located in and around the proposed Little Bow River Reservoir, Clear Lake and Squaw Coulee will be or may be destroyed or affected by the proposed project;

- the proposed Project would affect flows in the Highwood, Bow, Little Bow, and Oldman Rivers and could affect the water rights and interests of the Treaty 7 First Nations;

- aboriginal interests and concerns have been inadequately reflected in the archaeological assessments of the proposed Project due to inappropriate consultation with aboriginal people and inappropriate assessments of impacts on their culture; and

- the proposed Project could affect plants and wildlife that could affect the interests of the Treaty 7 First Nations.

Water plays a critical role in southern Alberta, and the Indian reserves in the South Saskatchewan basin are associated with water in many ways. Water management considerations in southern Alberta affect, and are influenced by, the Indian reserves that are an integral part of the South Saskatchewan basin. The Panel notes that it received presentations from the Peigan Nation (representing some interests of the other Treaty 7 members) and the Blood Tribe. The Panel appreciates that, had it received presentations from the other aboriginal people within the basin, it would have more complete information about the potential effects of the project on aboriginal interests and concerns. It also appreciates that the Blood and Peigan do not represent all aboriginal interests within the Blackfoot Confederacy and Treaty 7. However, the Panel does believe that the submissions are indicative of aboriginal interests and concerns associated with the proposed project, particularly as they relate to the potential effects of the proposed project on water and archaeological sites. The Panel believes that the

degree of interest and concern of aboriginal people about the effects of the proposed project would be less for those further away from the project. The Panel believes that the concerns of the Blood and Peigan people regarding the cultural and religious significance of the identified archaeological sites at the confluence of the Little Bow River and Mosquito Creek, and the Old Woman's Buffalo Jump and campsite, would be indicative and fairly representative of all aboriginal concerns.

6.8.1 Indian Reserves in the South Saskatchewan River Basin

Treaty 7 and the South Saskatchewan River basin (SSRB) have different boundaries, but most of the area is common to both. This common land area covers over 100,000 km2 (38,610 mi2) of the most southerly part of the province of Alberta with more than one million residents. Indian reserves are located in two of the major sub-basins within the SSRB: the Bow and the Oldman. Each reserve has significant existing water management projects within its boundaries or located nearby. The South Saskatchewan Basin Water Allocation Regulation has allocated water for irrigation purposes to three Blackfoot Indian reserves: the Siksika, Blood and Peigan. The proposed Little Bow/Highwood project's four components would be located near the towns of High River and Vulcan, and have facilities on the Highwood River, the Little Bow River, Mosquito Creek and Clear Lake. Except for the uppermost reaches of the Highwood River, the Highwood and Little Bow basins are settled agricultural lands that contain only one smaller Indian reserve (Eden Valley in the upper reaches of the Highwood River). As shown in Map 6.2, the major Indian reserves that lie within the SSRB and the lands covered by Treaty 7 are between 50 and 150 km (30 and 90 mi) south or north of the project. The existing water management structures within or near these Indian reserves, as well as other structures throughout the system, including the project, all have their own operational regimes. These regimes interact in varying degrees to directly or indirectly affect the flow of water to accomplish the overall management strategies of the South Saskatchewan River basin.

The Siksika Indian Reserve (146) straddles the Bow River in the lower part of the Bow basin. The reserve is located in settled prairie farmland about 40 km (25 mi) northeast of the proposed Little Bow River Reservoir and adjacent to the Bow River Irrigation District. The South Saskatchewan Basin Water Allocation Regulation allocated the Blackfoot Indian Reserve sufficient water to irrigate 6,070 ha (15,000 acres) of additional land. One on-stream control structure, the Bassano Dam, is located on the Bow River at the eastern extremity of the reserve. The resulting reservoir is a source of irrigation water for the Eastern Irrigation District, which is located east of the reserve. A second on-stream control structure, the Carseland weir, is located just upstream from the reserve and diverts water through the Carseland-Bow River Headworks system to the Bow River Irrigation District. The Western Irrigation District adjoins the reserve to the north. Residents of the reserve did not directly participate in the hearing.

The Blood Indian Reserve (148, 148A) is located 60 km (35 mi) southeast of the proposed Little Bow River Reservoir, in an area of settled prairie farmland. The reserve lies within the Oldman River basin. It is bounded on the northeast by the Oldman River, on the southeast by the St. Mary River, on the northwest by the Belly River and on the south by an east-west line running just north of Cardston, Alberta. The St. Mary and Belly rivers are tributaries of the Oldman River. The South Saskatchewan Basin Water Allocation Regulation allocated the Blood Reserve sufficient water to irrigate an additional 10,120 ha (25,000 acres). Diversions can be made to the reserve from the Belly River, the St. Mary River and the Waterton-St. Mary Headworks system. The St. Mary Reservoir is located on the southeastern boundary of the reserve. The Waterton Reservoir, located on the Waterton River (a tributary of the Belly River), lies a few kilometres to the west. Several other water management projects and irrigation projects are located on the reserve. The Mountain View, Leavitt, Aetna, United, Magrath, Raymond, Lethbridge and part of the Lethbridge Northern irrigation districts are either adjacent to or near

the reserve. Representatives from the Blood Indian Reserve made presentations at the SSRB Planning Program review, the hearing on Pine Coulee and the hearing for the current Application. Their focus in the current hearing was on cultural and religious concerns regarding archaeological sites.

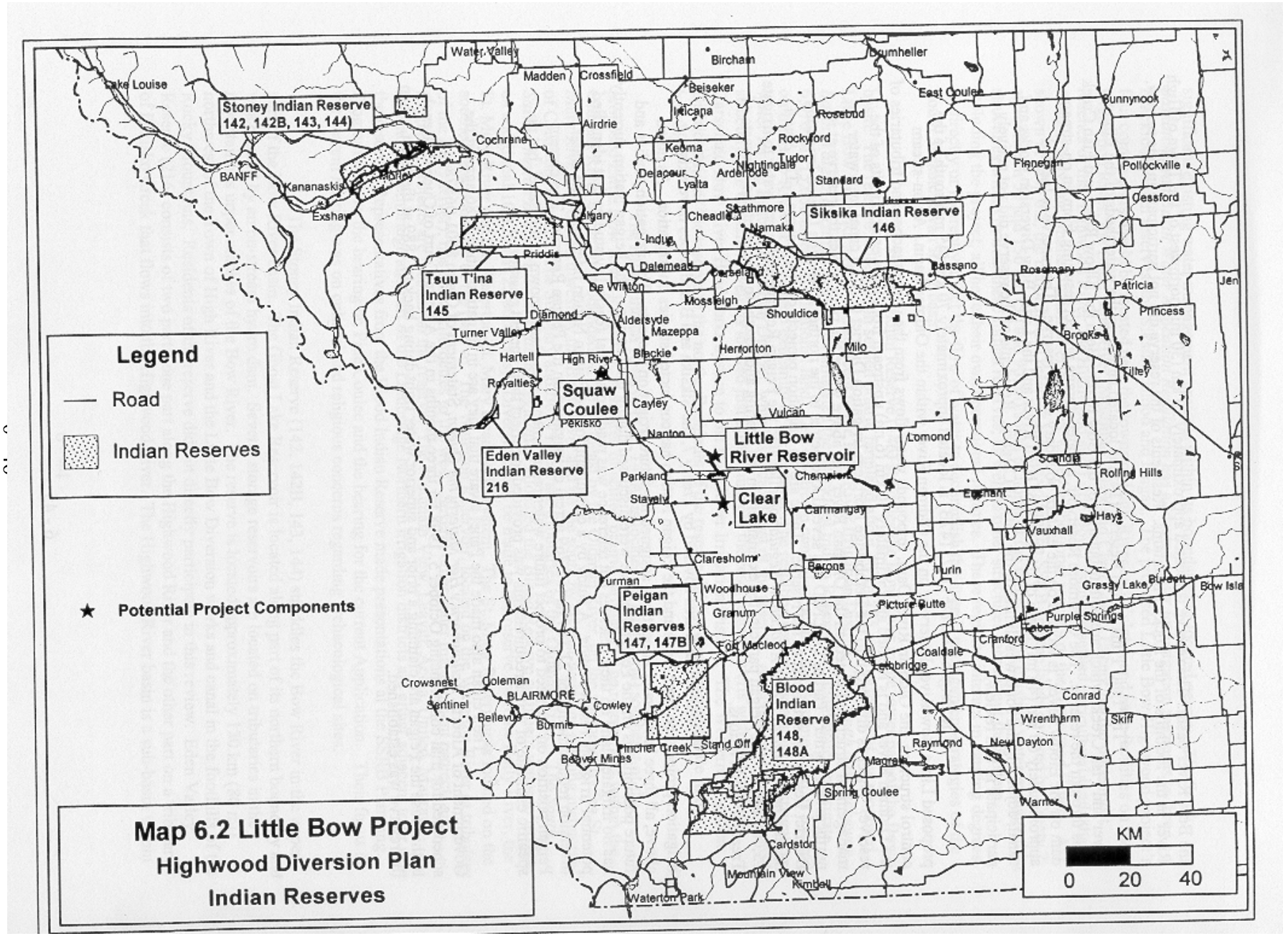
The Stoney Indian Reserve (142, 142B, 143, 144) straddles the Bow River in the upper part of the Bow River basin. The Ghost Lake Reservoir is located along part of its northern boundary and was created by an on-stream hydro dam. Several storage reservoirs are located on tributaries in the mountainous upper reaches of the Bow River. The reserve is located approximately 130 km (80 mi) northwest of the Town of High River and the Little Bow Diversion works and canal in the foothills of the Rocky Mountains. Residents of the reserve did not directly participate in this review. Eden Valley Reserve (216) consists of two parts, one part along the Highwood River and the other part on a tributary of Pekisko Creek that flows into the Highwood River. The Highwood River basin is a sub-basin within the Bow River basin. The reserve is located approximately 50 km (30 mi) northwest of the Town of High River in the foothills of the Rocky Mountains. Residents of the reserve did not participate in this review.

The Tsuu T'ina Indian Reserve (145) is located largely in the watersheds of the Elbow River and Fish Creek, which are both tributaries of the Bow River. Both the Elbow River and Fish Creek pass through the reserve. The Glenmore Reservoir, a water storage project resulting from an on-stream dam on the Elbow River, is located on the eastern boundary of the reserve. The reserve is located approximately 60 km (40 mi) north of the Town of High River and the Little Bow Diversion works and canal, adjoining the southwest limits of the City of Calgary. Residents of the reserve did not actively participate in this review.

The Peigan Reserve (147, 147B) is located approximately 70 km (45 mi) south of the proposed Little Bow River Reservoir on the Oldman River within the Oldman basin. An on-stream control structure, the Oldman River Dam, impounds water flows from the upper reaches and tributaries of the Oldman River and is located approximately 10 km (6 mi) upstream from the western limits of the reserve. Water is diverted into the Lethbridge Northern Irrigation District (LNID) canal by a water management structure located on the Oldman River just above where the river leaves the reserve at its northeastern corner. Part of the LNID lies several kilometres to the northeast, and the United Irrigation District lies to the southeast of the reserve. There are no irrigation projects on the reserve. The South Saskatchewan Basin Water Allocation Regulation allocated the Peigan Reserve sufficient water to irrigate 15,000 acres. The Peigan participated extensively in the hearing and sought to represent the interests of Treaty 7 First Nations.

Within the land area covered by Treaty 7, the Siksika and Blood tribes have existing irrigation projects on their lands and the Peigan Nation has conducted studies on irrigation. As noted above, all three have water allocations assigned for future irrigation projects. The irrigation studies and future possibilities on the Peigan Reserve were discussed during the hearing. The Peigan Nation currently has no irrigated land on their reserves but reference was made to several feasibility studies that identified potential irrigable reserve lands. A study by a consultant for the Peigan Nation referred to the water diversion requirements for 21,164 ha (52,269 acres) of irrigation on the Peigan Reserve. The current Peigan position on the need to protect future water requirements was made known to the Panel, but no specific estimate of water requirements was provided to reflect their current position.

The Peigan also made the Panel aware that they are in litigation since 1986 against the Government of Alberta. Yellowhorn v Her Majesty the Queen, Statement of Claim 8601-06578 is scheduled for trial commencing October 5, 1998 for three months in the Alberta Court of Queen's Bench. In this case the Peigan are claiming a prior and superior water right dating back to 1889 at the latest, when the reserve was established.


Stoney Indian Reserve 142, 142B, 143, 144)
Tsuu T'ina Indian Reserve 145
Siksika Indian Reserve 146
Eden Valley Indian Reserve 216
Peigan Indian Reserves 147, 147B
Blood Indian Reserve 148, 148A
Squaw Coulee
Little Bow River Reservoir
Clear Lake
Legend
Road
Indian Reserves
Potential Project Components
Map 6.2 Little Bow Project
Highwood Diversion Plan
Indian Reserves
KM
0 20 40
Water Valley
Lake Louise
Madden
Crossfield
Bircham
Drumheller
Beiseker
East Coulee
Sunnynook
Irricana
Rosebud
Airdrie
Cochrane
Rockyford
Keoma
Tudor
Nightingale
Ardenode
Standard
Finnegan
Pollockville
BANFF
Kananaskis
Delacour
Lyalta
Gessford
Exshaw
Calgary
Strathmore
Cheadle
Namaka
Indus
Priddis
Dalemead
Carseland
Bassano
Rosemary
Patricia
Jen
Bo Winton
Mossleigh
Princess
Diamond
Aldersyde
Shouldice
Turner Valley
Mazeppa
Brooks
Hartell
High River
Blackie
Herronton
Milo
Tilley
Royalties
Cayley
Vulcan
Pekisko
Nanton
Lomond
Scandia
Rolling Hills
Parkland
Champion
Stavely
Enchant
Carmangay
Hays
Vauxhall
Claresholm
Barons
Turin
Turman
Woodhouse
Grassy Lake
Bow Isle
Granum
Picture Butte
Purple Springs
Fort Macleod
Taber
Cranford
Coaldale
Lethbridge
Crowsnest
Coleman
Sentinel
BLAIRMORE
Cowley
Conrad
Bellevue
Wrentharm
Skiff
Burmis
Raymond
New Dayton
Pincher Creek
Stand Off
Beaver Mines
Magrath
Spring Coulee
Warner
Cardston
Mountain View
Kimball
Waterton Park

6.8.2 Alberta Community Development Historic Resource Responsibilities

The Cultural Facilities and Historical Resources Division of Alberta Community Development manages the *Historical Resources Act* (HRA*)*. Under the authority of the HRA, Alberta Community Development (ACD) is the provincial agency responsible for the co-ordination of the orderly development, preservation, study, interpretation and promotion of appreciation of Alberta's historical resources. When the Minister is of the view that an operation or activity will, or is likely to, result in an alteration, damage, or destruction of historical resources, Section 33(2) of the act allows the Minister to require a project proponent to undertake an assessment and prepare a report, known as a Historical Resources Impact Assessment, which contains an assessment of the effect of the proposed operation on historical resources. The authority to require an Historical Resource Impact Assessment (HRIA) has been delegated to the Assistant Deputy Minister, Cultural Facilities, and Historical Resources Division of ACD, who also the authority to issue *Historical Resource Act* clearance. According to the HRA, the Crown owns archaeological resources that are located off the reserves on non-federal lands.

ACD set the terms for the HRIA that was required of the proponent APWSS. ACD reviewed the project application and the research work done by the consultants, and they set the mitigation requirements and stipulated any further work. ACD would also oversee any monitoring that is done during any construction activities. ACD indicated that APWSS advised them about this and other possible water storage projects in southern Alberta in the late 1980's. At that time, ACD advised APWSS that the Little Bow/Highwood Project would require an HRIA. During the period from 1989 to the fall of 1997, the required HRIA was conducted by the consultant firms of Fedirchuk, McCullough & Associates (FM&A), Bison Historical Services Limited (BHSL), and Carbecks Geological Services Limited (CGSL).

BHSL did their work in the Little Bow River Reservoir area in 1989 and reported their findings and recommendations in February 1990. FM&A did their work in the Clear Lake/Mosquito Creek area in 1989 and they reported their findings and recommendations in March 1990. BHSL also examined the Squaw Coulee area in 1997 and reported their findings and recommendations in October 1997.

The archaeological work done resulted in the discovery of:

- 128 historical sites in the proposed Little Bow River Reservoir area (124 were pre-contact sites);
- 13 historical sites in the Squaw Coulee area Expanded Project (11 were pre-contact sites);
- 11 historical sites in Super Expanded Project of Squaw Coulee (9 were pre-contact sites); and
- 3 pre-contact historical sites in the Clear Lake/Mosquito Creek diversion works.

In total there were 155 sites discovered of which 147 sites were pre-contact ones and 8 were from the historic period. The Division as a result of these assessments recommended some initial, additional mitigation work.

Staff from ACD appeared at the hearing, according to their Counsel "… not as an adversary, not as an advocate, but really as a resource, a resource of assistance to this Panel and is not here … to be seen as – as urging in that sort of contentious fashion, anything." According to ACD and from the perspective of the legislation, APWSS had done the required research on historical resources.

Some additional work was required in a few areas but the proponent was generally deemed to have completed the work to the satisfaction of ACD.

The Little Bow River Reservoir Project was also the subject of a paleontological HRIA. As no fossils were noted in any of the outcrop exposures during the conducting of the HRIA, ACD provided APWSS with clearance for those projects from a paleontological perspective in November of 1995. The HRIA state all components of this project have been completed and a staged Phase 1 mitigation program was identified and agreed to by APWSS. Depending on the results of the Phase 1 investigations, additional excavations may be required.

The general position of ACD is that it is satisfied with the mitigation measures that have been developed as a result of the impact assessments completed by the consultants for APWSS. The mitigation measures proposed by the Proponent are considered reasonable and adequate in the circumstances. As the project evolves, additional assessments of impacts on historical resources can develop and more investigations may be commissioned.

ACD stressed a number of points about their mandate, practices and views in the context of this project. ACD is constrained by the legislation and there are situations that can not be made a requirement for a proponent. Studies outside the area of direct project impacts can not be required. The primary focus of the HRIA is to gather and store information. Developers can not be held accountable for tangential or indirect effects. The developer is only responsible for the immediate impact area. The developer should study features that directly link to project sites.

ACD made some comments regarding communication and noted that, in 1989, it was not common practice to involve aboriginal groups. It is becoming more common now to consult with aboriginal groups. ACD values the perspective of contemporary aboriginal people. However, communication with aboriginal groups is very difficult to achieve, requires great perseverance, but eventually proves productive. Communication with aboriginal people should begin with Chief and Council.

According to ACD, the historical resources that would be lost should the project proceed are not unique. Assemblages of these types of sites do exist and are preserved elsewhere. There is nothing of historical importance in the project area that is equal to the Old Woman's Buffalo Jump in terms of significance, size or scope. The confluence of Mosquito Creek and the Little Bow River is an area rich in archaeological sites, and is richer than Pine Coulee. It is significant but not unique.

Enhancement opportunities can not be required of the developer. However, ACD is interested in assisting in any enhancement programs. Any activities regarding pre-contact sites require ACD approval.

On a number of points ACD disagreed with the recommendations provided by the Treaty 7 Coalition archaeological consultant. Their general logic was that sufficient examination had been done of almost all the sites identified, many sites were not unique in and of themselves and other similar sites existed in southern Alberta. ACD concluded that the costs of the additional work were prohibitive when compared to the additional knowledge that might be gained. They especially pointed out that the legislation did not allow them to require that the proponent carry out a number of the recommendations that were made.

During the discussions of aboriginal concerns about archaeological sites and resources, several references were made to the Buffalo Stone identified in the Pine Coulee area. In 1995, a joint panel had recommended a number of actions with respect to that particular feature and ACD was asked to clarify the current status of these actions. They reported that one meeting had been held in accordance with panel recommendations but that there has been no resolution of the issues involved and the Buffalo Stone still remains in it original site. The Panel was not sure what measures have been taken to assure its

protection nor of the rock art that was identified. ACD did comment that, from their perspective and current knowledge, "there's nothing like that in this reservoir project."

6.8.3 Blood Tribe

The Blood Tribe, part of the Blackfoot First Nations in southern Alberta, chose to represent itself separately from the Treaty 7 Coalition. The Blood Tribe presented an initial group of three elders, a chairperson (two of the four had administrative roles within the Tribal administration) and a professional archaeologist. In their final argument, they presented a different group of two Band members (one an elder and one from Band Council), a chairperson who was also on Council, and their archaeological consultant. The testimony of the two groups was basically the same. They noted that their traditional territory included the project areas and especially noted the confluence of the Little Bow and Mosquito Creek.

> "The Blackfoot First Nations including the Blood Tribe/Kainaiwa, Piikani, and Siksika Nations, traditional territory centered on the western plains and adjacent foothills of today's southern Alberta and northern Montana. It is here that Napi, the Creator, created the world. Our oral traditions point to a long and intimate association with these lands, extending back, as verified by the archeological, linguistic, and genetic evidence, well over 1500 years.
>
> … It is important to remember that the Little Bow River was a traditional resource, harvesting and settlement area of the Blackfoot First Nations, particularly the confluence of the Little Bow and Mosquito Creek, which is traditionally known as the White Willow Place or Foul Water Creek Place. Large numbers and dense concentration of campsites and bison kill sites were found within the proposed reservoir at this locale during the Historical Resources Impact Assessments of the proposed Little Bow River Reservoir. The area is clearly of regional/provincial significance. The loss of this traditional archaeological area is of great concern to the Blood Tribe. The impacts of the proposed project on the traditional/archaeological resources far outweigh the economic benefits this project may have to the people of Alberta. This project will be of no benefit to the First Nations. They will lose more of their traditional/archaeological sites. The impacts of the project on these resources can not be mitigated."

Their main concerns were "the environmental effects of the project upon historical resources, aboriginal land use, and related interests, including water rights." The Blood Tribe did indicate support for the Treaty 7 First Nations and particularly the Peigan lawsuit with respect to water and water rights. The Blood Tribe believes "in concurrence with the other Treaty 7 First Nations, that we possess Aboriginal and Treaty Rights—Treaty Water Rights within the Province of Alberta." A small portion of their presentation alluded to water, noting "the dangers of over-allocation of this resource," and that… "we possess aboriginal and Treaty water rights" and that anything that alters the waters or lands in the South Saskatchewan basin could affect their right to use the waters and the lands affected.

The main thrust of their intervention and final argument focussed on the loss of ancestral lands and the consequent losses to their history, cultural and religion. The two presentation groups noted that there were a great number and variety of prehistoric sites, and the entire area had a rich significance for the Blackfoot people. Much could and should be learned by protecting and studying these and any other sites that might be nearby.

The presentations included a number of suggestions for mitigative actions, should the project be approved. However, the Blood Tribe made it abundantly clear that "Our recommendation with respect to the mitigation and interpretation of the historical resources should not be construed as support for the Project." Basically the economic benefits of the project could not, in their view, outweigh the impacts and the impacts can not be mitigated.

6.8.3.1 Cultural Impacts

The elders provided the following types of arguments, examples or observations to seek to clarify their views. In this context it important to note the standing of the two female representatives and one male elder that came before the Panel. "We come from a society that is traditionally matriarchal in process… Before any major decisions are made in our communities, clan mothers have to be consulted first and lastly…" Both women were members of and held leadership positions in the Sacred Buffalo Women's Society. They noted the following points in their presentations:

- the long occupation of these lands by the Blackfoot people,
- the spiritual significance of these lands,
- the kinship between the Blackfoot people and the land,
- the connection between these lands and their tribe's stories and legends,
- their sacred responsibility is to never forget the lands,
- the land has Blackfoot names,
- the land provides useful and sacred plants,
- the markings of the ancestors are in the land,
- the land and our culture is alive to us today,
- the land is our teacher and our classroom, and
- the land and its markings are needed as part of our ceremonies.

The following direct quotes indicate how the Elders felt.

> "To us everything is sacred. These lands that will be affected by this proposed reservoir carry the spirit of our ancestors. We have a lot of sentiment, we have a lot of feeling for those who have walked before us, those who have showed us the way."

> "This is the part of the plains where the creator meant us to be. We are the first people of this part of the plain. On the land are the markings that we have left for many generations. We documented well the presence of our people on these lands."

"This land is special to our people. We have names for virtually every part of this area. These names are in our stories; these names are in our legends. We know exactly where things most precious to our people can be found: water, the plants, the medicine that we use, other sacred articles. We know this land well."

"Now if all those places are gone, I was just wondering, how are my grandchildren ever—and my children ever going to experience what I experienced? How will they know our history?"

"… as your roots are back in your – overseas countries… Those are our roots, and this is why we feel, especially speaking for the people back home, the elders that—they were crying, in visiting those sites."

6.8.3.2 Cumulative Effects

From the archaeologist's perspective there were many residual or secondary impacts of this project that could not be mitigated because the sites and the knowledge that they contain would be essentially destroyed. This is the case even if the sites were extensively studied. The archaeological consultant to the Blood Tribe reported that, if the Little Bow River Reservoir were built without additional studies being done, the knowledge to be gained from that work would be lost and that for all intents and purposes these features would be destroyed. Having these features under water does not provide the Blackfoot people what they need from their culture. He noted "… a sense of place is absolutely critical in the work I've done with the Blackfoot elders for some years now. And it's the same with us. You take people to a place. And even if they've never been there, once they get to the place they remember the stories that their grannies and grandparents, grandfathers told them when they were little kids. Over here something happened. This was important. They get to the place and they start to remember this."

What makes the loss even more serious is the fact that it could come on top of significant losses that have already occurred in the region. The archaeologist noted that the Blackfoot have lost very important places because of the Oldman River Dam, Pine Coulee Dam, and the Travers Reservoir. He states: "The Three Rivers area was the – one of the two most important wintering areas for the Piikani Nation of the Blackfoot - speaking people. The other is under the City of Calgary and adjacent areas. Those are the two major wintering valleys, the Bow and the Oldman. Willow Creek is part of the Old North Trail settlement area along the Porcupine Hills, as is Squaw Coulee…. Pine Coulee area was part of the Willow Creek complex. This area out here, the Little Bow and Mosquito Creek, which has a traditional Blackfoot name, is a traditional area known to the people as well. It will remove one of two areas on the Little Bow. The other is under the Travers Reservoir." He concluded that, even if the recommended additional studies were done and studies were done to assess the impacts on the Blackfoot culture determined from the additional and original archaeological work done, he would still have to recommend against the project. "Because if it does irreparable harm, you cannot mitigate the impacts, therefore my recommendation – my opinion would be that it should not proceed."

Some additional information and comment was provided by the Blood Tribe in answer to questions raised by the counsel for the Treaty 7 Coalition. A number of points were emphasized including: "I would evaluate it as one of the—certainly a regionally and probably significant, provincially significant, archaeological area within the plains part of this province." It was indicated that further study

of all these sites (especially arrow points and pottery) would provide valuable and a large amount of information and insight into the Blackfoot people.

Members of the presentation group from the Blood Tribe indicated that they felt badly about a number of matters and asked the Panel, the government and the proponent to respond. First**,** they raised the issue of the improper and derogatory naming of several of the project sites, in particular, Old Woman's Buffalo Jump and Squaw Coulee. Secondly, they raised the issue of consultation and the HRIA by questioning why they were not notified earlier; notified before decisions were made; and why they were not more a part of assessing and protecting these valuable resources. Thirdly, through their comments and through their archaeological consultant the Blood Tribe made it clear that they did not believe that sufficient work, nor work incorporating their perspective or world view, had been done to fully examine and understand all the sites that would be disturbed, destroyed and submerged if the project went ahead.

6.8.3.3 Proposed Mitigation and Other Recommendations

Within the context and understanding that the Blood Tribe was opposed to this project, a number of suggestions were made. Some were project related and some were not. First, they asked that the names of Old Woman's Buffalo Jump must be changed to "Woman's Buffalo Jump" and Squaw Coulee be changed to "Woman's Coulee". Secondly, they requested the teepee ring markings, including the two fire pits, be relocated to high ground and be properly signed to indicate their importance. It is important to note here that one of the elders indicated that it was her ancestor's place. Thirdly, the Blood Tribe requested that much more extensive archaeological work must be undertaken in all project areas. They were hopeful that the proponent and the ACD were open to consultation with the Blackfoot people and would consider changes in the mitigation program. Their specific recommendations are identified below.

Little Bow River Reservoir

The Blood Tribe indicated that an ethnobotanical study is required. It should be done with the elders assisting a professional botanist. The entire Little Bow River Reservoir area must be studied, including areas upstream and above full supply level. A quantitative assessment needs to be done to determine the regional and cumulative impacts and their significance in terms of the proposed reservoir. The area around Travers Reservoir also requires study. This assessment should include a comparison with other comparable areas in the Alberta. A cumulative assessment of the impact of removing this area and all its collective resources is required. Some special attention needs to be given to the confluence of the Little Bow and Mosquito Creek and the grasslands surrounding it. It should be examined in its entirety. Opportunities for enhancement through interpretation need to be further identified and explained in order to put any losses into perspective. The interpretation must involve First Nations' people and be available to the public in an understandable form. Residual impacts need to be identified because this project would have aspects that cannot be mitigated. To keep shoreline erosion to a minimum and assist in monitoring, a reservoir management plan needs to be developed. Impacts downstream of the dam also need to be identified, areas studied and mitigation planned. If the reservoir is built, it is recommended that the site called EbPi 51-52 be moved to a nearby hilltop and reset with appropriate signage.

Clear Lake

The Blood Tribe requested that a deep backhoe-testing program be carried out to evaluate any early site in the proposed canal alignment. This location was identified as an old melt channel and may contain some very old sites. An archaeological survey is required for the lands surrounding the current area of Clear Lake. Site EbPi 4 on Mosquito Creek needs to be more intensively surveyed. Further study is required at the inlet of Mosquito Creek to the canal. The mitigation work done to date is seen as insufficient.

Flow Augmentation in the Highwood and Little Bow Rivers

The Blood Tribe requested that all sites subject to erosion and slumping on the Highwood River and on the Little Bow River upstream of the proposed reservoir need to have an HRIA. This study should also record all archaeological sites, assess impacts on them, and develop mitigation where appropriate.

Squaw Coulee

The Blood Tribe asked that no dam be built on the site at SR540 because it would create a very negative visual impact on the Old Woman's Buffalo Jump (Site EcPl 1) which "has a high quality sense of historic place." If the project were approved, a videographic and photographic record should be compiled before any construction begins. Augmented flows, illegal digging and other activities in Squaw Coulee have contributed to erosion, undercutting and slumping of the area below the Jump. This campsite area requires some immediate protection. As noted previously, the Blood Tribe would also like an official change on name for the two places that the Blackfoot people find so offensive. The new names would be Woman's Buffalo Jump and Woman's Coulee. They would also like to have an interpretive place or pullout developed on SR 540 with appropriate interpretive facilities. This area also requires a management plan.

Old North Trail

The Blood Tribe indicated that the HRIA omission of studying the Old North Trail was a serious deficiency. They felt that this should be studied prior to any project approval. Several additional concerns were raised about the lack of examination of trails and their interconnections in the region. Trails are an important part of first people's lives and can teach us a great deal. The archaeologist for the Blood Tribe noted "… as we know now, our First Nations had excellent mental maps and they had preferred areas to travel…" and "…they link preferred areas of settlement together..." His own examination of the Project area indicates that remnants of trails are visible.

Another aspect of looking more closely at trails includes "the sacred dimension" associated with major trails. The archaeologist remarked that "clearly along the Old North Trail and some of the other trails we find marked out in stone are – are sacred figures, medicine wheels as we call them, effigies, Napi figures, animals. And these clearly, as well as writings on rock, these clearly have a very important role to play in the sacred geography."

6.8.3.4 Views of Alberta Community Development

ACD clarified a number of items. First, it agreed to deal with the question of the derogatory names by stating "… remarks that have been made by a number of people here now concerning the names in question have been noted by my client, the chief archaeologist to the province, and the survey—and the process that exists for changing such names will be looked at. And so the names which have—offensive names which have been highlighted here will be examined and that process will—will occur to change those names, is my expectation."

Second, ACD obtained clarification about further archaeological work that was being suggested by the Blood Tribe. This included establishing the size of additional excavations (about 100 to 400 m^2 [1,080 to 4300 ft^2] depending on the significance of the site), the approximate number of sites (some 30-35 sites were suggested in the Little Bow River Reservoir area itself), the potential cost (about $3 to $3.5 million), and the estimated time required (a minimum of two to three years). ACD also obtained clarification of the Blood Tribes' requests for additional HRIA work downstream of particular works (including Mosquito Creek near the Old Woman's Buffalo Jump; the Little Bow proposed reservoir, and even in the Highwood River itself).

Third, ACD sought further clarification about what was meant by the comment "…generally its determined that the--the area directly affected is rich in sites" and therefore there may be a great potential for erosion affecting "quite a number of sites off the development Project site as well." It was not determined what that additional cost might be but it was suggested that it would not be as high as $3.5 to $5 million. It was also pointed out that the province already had experience with a variety of ways to stabilize and armour sites.

Fourth, the suggestion of an ethnobotanical study was further discussed. ACD pointed out that such studies are not common in Alberta and in fact an inventory of plants had been done as part of the EIA. The discussion concerned the differences between what a biologist would do in an inventory of plants and how the aboriginal people would identify and classify them. In particular there would be different uses and perhaps rare plants identified. In reply it was stated "It hasn't been, because under the Alberta *Historical Resources Act*, as it's been interpreted, traditional resources or sites rather than what is - are not defined under the act, which defines paleontological, historic, and archaeological. So since they're neither historic in the sense of how they are defined, they have tended not to be considered in studies in Alberta."

Fifth, the need and responsibility for a popular type book written about the area were discussed. The appropriateness of a book was demonstrated by the fact that such a book concerning the Oldman River Dam had been written.

Sixth, ACD sought clarification of what constituted a "visual alteration" of the Old Woman's Buffalo Jump. The existing road SR540, the ranchstead, and the old fencing were not seen as a "visual impairment."

During final argument ACD responded to the recommendations made by the Blood Tribe in a point by point manner. They stated that an ethnobotanical study is normally not required and they do

not see the need for one in the proposed Little Bow River Reservoir area. Such studies already exist. They concluded that a quantitative reassessment of the proposed Little Bow River Reservoir sites is not necessary and see no value in comparing different significant sites. They believe that studies of sites above the Full Supply Level of the proposed Little Bow River Reservoir and 4.0 km (2.5 mi) up Mosquito Creek can not be required and are unrealistic. There is no support for an assessment of site significance of the proposed Little Bow River Reservoir site, including the confluence of the Little Bow River and Mosquito Creek, in a regional or provincial context or in terms of cumulative impacts. There is no support for a study of possible impacts on lands around or adjacent to the proposed Little Bow River Reservoir.

ACD agreed that a photographic and video documentation should be prepared for the Old Woman's Buffalo Jump. The suggested changes in place names have been referred for review and ACD supports the request for change. ACD will support the moving of site EbPi 51-52 with appropriate signage, if that is the wish of aboriginal people. This action can not officially be required of the Applicant. It was agreed that protective measures should be taken by APWSS to deal with the erosion that is taking place at the Woman's campsite in Squaw Coulee.

ACD has not been provided with any evidence of a trail in the project area and a general study of trails in the project area is not the responsibility of the Proponent. There is no support for such an Old North trail study. ACD did not agree that APWSS should be required to study or deal with the impacts of changes in flows in streams outside the immediate project areas. There was no agreement that any backhoe work should be done in the Clear Lake diversion canal area. The HRIA did not identify any need for deep testing. ACD did agree that there should be monitoring during construction and, if any sites emerged, additional study would be warranted. There was no support to do any work in the area of Clear Lake itself or its changing shorelines. It was agreed that some HRIA work should be done in the areas where any retaining dikes are built. ACD did not agree that additional excavation work should take place at site EpBi-4. In their view it would provide redundant data.

6.8.3.5 Concluding Summary Statements by the Blood Tribe

"…We ask that you be mindful of our overall position and that development not take place and that you view our specific recommendations with respect to mitigation in their proper context, that the additional work that Mr. Reeves has made reference to be done prior to any approval occurring if such approval, you know, has to occur."

"While it is interesting to note that APWSS commits to involve 'the First Nations in the design and implementation of the mitigation program,' in addition to the requirements of Alberta Community Development under the *Historical Resources Act*, it is ironic that a willingness to listen and involve First Nations occurs at the stage of designing and implementing a mitigation program. A commitment to respect and safeguard the historical resources, social rights, land, and water rights of First Nations in the actual decision-making stages would be more appropriate, more beneficial, and greater appreciated.

Our recommendations with respect to the mitigation and interpretation of the historical resources should not be construed as support for the project. They are merely intended as a last recourse, should the project proceed despite our position.

This project will be of no benefit to the First Nations. The impacts of the project on traditional archaeological resources and water rights far outweighs the economic benefits

of this project for the people of Alberta who are, in this case, few in number. The impacts of the resources can not be mitigated, and we recommend that the project not be approved."

6.8.4 Treaty 7 Coalition

The Treaty 7 Coalition counsel provided a group consisting of two Peigan Band members (one an elder and the other a Band Councillor) and a technical water expert. The elder was the holder of two Bundles - the Thunder Medicine Pipe Bundle and The Beaver Medicine Bundle - and he was a former member of the Horn Society on the Blood Reserve. Since the elder was to speak on cultural and spiritual matters, they felt that it was important that the Panel understood his background, authority and limitations. The elder himself indicated:

> "There is general information or public information that's readily available to not only our people but people from all walks of life, but there comes to a certain situation when we come to sacred knowledge where more protocol is understood. That sacred knowledge cannot be passed on unless the people who are going to be learning it and hearing it live it. So this sacred knowledge kind of limits my testimony today."

The Peigan representatives also wanted it understood that this presentation was their own but did reflect concerns of all of Treaty 7. The intent was to represent all of Treaty 7 but the constraints of time and required protocols made it impossible to complete the consultation in a satisfactory way and in time for the Hearing.

6.8.4.1 Peigan First Nation's Cultural Perspectives

The counsel to the Treaty 7 Coalition reaffirmed much of the testimony from the Blood Tribe when she summarized key arguments in their final argument. "I'm going to begin with the cultural heritage issue. And this is the foremost problem which we say the project poses, and that it will have a conclusive destructive impact on an area which is unusually rich in Blackfoot culture, an area which should be preserved and protected for the benefit of this and future generations."

In their presentations regarding cultural matters, the Peigans made a number of important points. The Little Bow area is located in their traditional Blackfoot territory and their religious ways prohibit "disturbances to water" and "water is sacred". Areas such as the Little Bow are still used by the Peigan and are important to Blackfoot people. They continue to use these areas in gathering herbal medicines. They are places of on-going education as they use these areas to teach their children. They use them today. These areas are important to their existing ways of life. In order for their people to continue with their ways of life, these areas have to be available to them. The cultural material that might be put under water would be considered lost to them and their children. "Those things are – in our culture are still viewed as alive and, just like any other place that is being occupied, you don't disturb those areas." The whole Little Bow area is culturally significant. It was a "significant camping area" and … "that whole area was adjacent to other significant areas that are connected to the Little Bow."

The loss of historical Blackfoot sites including those flooded as part of the Oldman River Dam and Pine Coulee is having a very negative effect on the Peigans. Flooding the Little Bow valley only adds to that loss. They stated that … "our environment is our classroom. And once we start limiting those areas we start losing our knowledge. The knowledge not only is sometimes shared with our own people, our youth, but it's shared with the outside world."

The Coalition identified the difficulties that exist when people living in two different cultures seek to try to understand each other or discuss the meaning of sacred sites and historical resources. They also indicated that it was important for them to understand the research methods used by our culture in examining and studying the past. They have spent time learning about these methods. Yet they want the opportunity to critique our processes and to share their perspectives in "good faith and constructively". Their intent in appearing at the hearing was to … "do a good job of conveying important points to promote positive developments, while at the same time maintaining our cultural integrity from a Peigan perspective."

In responding to questions regarding the importance of the Little Bow area to the Peigan and other Blackfoot, the elder stated that the area was generally shared with others, though the different Blackfoot groups all had preferred sites. Then he recounted his personal experiences of camping there and summarized the Peigan perspective. He stated:

> "The spiritual aspect of the Little Bow is important in its stories, its legends, and that camping area – I guess basically what has happened to our people since we've been placed on – on reserves is the whole area was limited to us, especially in the days of the early 1900's when we were forced – we couldn't leave the Reserve without having a permit to leave the Reserve and then through – of course under the control of the Indian agent. So basically what has happened to us as a people is we've just only received basically a high school education on the Reserve because of our limitation to our territory. We hear of these sites and maybe periodically by some opportunity or another we would have the chance to – to visit those areas. But we were – we've been limited. And I think at this point in time, because of our lifestyles now, the continuing importance that our school children are placing on their own cultural identity, it's important for them to know. So when they start putting pressure on the Elders or people that should have and know of these places, we have to start making our own – expanding our own education for our youth. And I guess when it comes to trying to indicate what area is more – has more significance or another, there's not really a distinction because it's kind of a holistic perspective. The significance behind the whole Little Bow/Mosquito Creek area was that it was a major campground. A lot of ceremonies – one of our sacred ceremonies, called the All-night Smoke Ceremony, originated from a teepee ring. … we may get visions or dreams to fulfil….. So if that's –that's underground, how can we fulfil our spiritual obligations in that regards? Or to those – not just to that area, but to all areas when we are limited."

During final argument the Coalition argued that this project would destroy or interfere with about 155 sites that are archaeologically and spiritually significant while benefiting the Province of Alberta and a few irrigators. They objected to the proponent using research or study standards set by ACD in gathering additional information or collecting artifacts for storage or display. The definition that the First Nations people use regarding these resources is seen as completely different than the one used by the government.

> "We saw that the Blackfoot witnesses, which included elders and political and spiritual leaders and their advisors, all testified to an intimate relationship of the people to the land which…dates back for centuries. The resource is not the thing, it's not the piece of rock, it's not the information to be gained from the rock, but what the resource is is the significance of the area as a spiritual, material, and cultural resource for the contemporary continuation of relationships involving this land for the benefit of future generations and this one living. It's not the thing, it's the relationship to the land which is really contemporary and future oriented which is the resource at issue…. the living textbook."

From the perspective of the Coalition the resource involves the whole area and it is valued and beautiful because it continues to benefit them and preserve them as a people. They are compelled to seek to preserve and protect it. To them, their culture and their culture's survival is involved. They believe that the proponent did not assess the project's impacts on the Blackfoot people and way of life and what the loss of these resources might mean to the people and their societies. In their view the studies that were undertaken have not taken the Blackfoot people into account and have set up "an irreconcilable conflict situation between the Blackfoot people and the rest of Alberta concerning the project."

The Treaty 7 Coalition Counsel also provided the Panel with a number of current pieces of legislation which she perceives supports the Coalition's position that this project should not go ahead because it involves an abrogation of First Nation's people's rights and is an attack on their cultural integrity.

6.8.4.2 Peigan Nation Views on Historical Resource Impacts

It was established that some 155 sites had been identified in the project area and that most of them would be destroyed or affected by either flooding or construction activities. With the exception of the Old Woman's Buffalo Jump, none were identified for preservation but some were identified for additional mitigation work. Mitigation basically means additional study to identify and assess in order to understand more fully the knowledge that sites contain and to recover any artifacts. There was not extensive previous archaeological information available on these geographic areas.

APWSS, ACD and the landowners were contacted prior to the HRIA studies being done. No aboriginal people were contacted before or while the studies were underway since this wasn't common practice in 1989. It was agreed that contact with First Nations would have been a valuable addition to the studies.

The 'study universe' or boundaries were set by APWSS and the project Terms of Reference. They were not set from any cultural or regional perspective. It was not clear to the HRIA consultant whether the adjacent lands would be affected by the project or whether they contained additional archaeological sites. No secondary impacts were studied or identified. Some additional studies outside the original study universe in undisturbed margins or land above the FSL, called the Prairie level above the reservoir, were recommended by the consultant.

According to the *Historical Resources Act*, a historical resource includes paleontological remains, historic sites predating 1874 and First Nation remains predating 1874, and natural sites. The question was raised by the Treaty 7 Coalition as to the resource being for someone's benefit. Benefits from historic resources could include assistance in interpreting the past, tourism, and First Nation's

culture. From the consultants' perspective, the study of sites and the collection and preservation of artifacts could be useful to First Nations by assisting in their understanding and interpreting their past.

However, the First Nations indicated that, for them, sites are more than information but are part of their living culture.

> "…it is certainly not the data which is of value to the First Nations, so much as a contemporary relationship to the land. That is, the resource is the fact that they are connected to the land, and it is really a textbook for their early histories. That is the nature of the debate, that when the First Nations talk about the archaeology as being contemporary and a living part of their culture, versus what you have described, which is to pick the bones or lithic scatter or skeletons out of the land and study them for the sake of the discipline of archaeology."

It was established that the HRIA studies did not assess the historical or cultural importance of the sites to the Blackfoot Nation or to any other First Nation. They did not deal with the cumulative impact that the loss of these sites would have when added to other losses already experienced. These sites were also not studied in any regional or broader context. If the perspectives of First Nations had been included, the Treaty 7 Coalition noted that the study universe would have been different and the nature of the impacts experienced would also have been differently indicated.

The Coalition stressed the scarcity and importance of native grasslands in the area and the plant life associated with it. Though a vegetative inventory was done, it did not identify plants or their usage from any First Nation's perspective.

The Coalition also questioned whether or not the sampling intensity was sufficiently large to provide the best opportunity for discoveries. The consultant indicated that the intensity used was common for Alberta and sufficient for the work that was done. Shovel testing took place in areas where there were and were not surface materials present. Backhoe testing was also done in 136 selected digs (or units) at about 17 sites. The Coalition implied that this was an insufficient level of effort given the apparent significance of so many sites in the area of the proposed Little Bow River Reservoir. They also noted that the intensity and extent of use surprised the consultant.

The Blackfoot believe that most, if not almost all, of the sites in the Little Bow River Reservoir area constitute part of their direct heritage. Their consultant agreed that it was likely so, at least for the last 2,000 years. The Coalition pointed out that, when members of the Blackfoot visited the sites with APWSS and their consultant, they were able to identify additional features (two hearths, stone effigies) than those initially noted in the HRIA. There was some evidence that these were parts of a larger sacred geography.

The Peigan Nation made a plea that the pejorative names involving the Old Woman's Buffalo Jump and Squaw Coulee should be changed. These names continue to be a hindrance when engaging in discussions with Blackfoot elders.

The Peigan Nation were questioned about what the Peigans want done with the identified archaeological sites and how more and better communication could take place. In response, the elder indicated that more consultation with the elders needed to take place in order to receive "proper advice and direction to know how to handle the matter."

The councillor reported that some consultation had taken place before the hearings with the NRCB, APWSS, ACD and one HRIA consultant. The approach taken by the professional archaeologists and the suggested mitigation and future work were described. The councillor noted:

> "In order for us to develop any kind of position, in a sense he would have to have that plan before us taking one approach, and that's the approach that's being used in this Application where – where professional people come in, like archaeologists and so forth, looking at that approach. Looking at another approach, and that approach is not in place right now. And what I had said earlier in respect to sacred sites and historical resources, we have to understand what's happening today in terms of methods that are used and are they compatible with our culture. In addition to that, in the way things are done, such as preservation, in that whole process do First Nations have a role; and from what I can see to date is that First Nations do not have a role. Sacred lands are being preserved and usually it's for academic research, tourism, but in order for us to have our input it's just not there and in a sense it's not recognized. We have two cultures here: One of them is based on a way of seeing things, a way of seeing land. …and from what I can understand of White culture, in order to have an interest in the land you have to be using it. Whereas with our culture, it's very different, it's living with the land."

The Peigan representatives requested dialogue and indicated that they were open to dialogue to promote "better understanding, better relationship", but not just if it implied consent or meant that they must go along or agree with the project "according to the current terms associated with the way of doing things today." …"I don't mean any disrespect, but it is very important to us to maintain our culture. It's not something that is dead and in the past, it's very alive and dynamic today." As an example she noted the Medicine Pipe Bundle and "It's not something that – that's gone with the past, it's still here today and still very important to us" …"and the fact is that we've adapted but yet we've still maintained our cultural identity. It's still very alive today".

The representatives indicated their need for communication and education, including understanding this hearing and the hearing process. "And in a sense what we have to do is we have to learn about your culture, your way of doing things. And when we understand that and we compare it from where we're coming from, then we can start developing ways to improve things." The communication has "to work within a context where there's respect." So far this has not happened with APWSS. "It's not consultation. We're open to working with them, dialoguing with them, but we don't agree with their current methods of doing things."

In so far as the Peigans have come to understand APWSS's approach to the archaeological sites and resources, they are not in agreement. "… that's not what we want. Our – our ways are alive and that land – even though we're not using it the way White culture sees that we should be using it, we still have a connection to that land. And looking at it from that perspective it's – it's a change. It's sometimes a very painful change."

The Treaty 7 Coalition identified a number of matters in their final arguments. The lands in the project area, while considered privately owned by individuals and the province, are not considered ceded land by the Coalition; recent court decisions indicate that these types of land can also be subject to pre-existing Treaty rights. "So it's certainly not settled as a matter of law that all this land has been taken over by Alberta, who then has a complete right to do with it what it will without regard to Aboriginal people's interest in the land. That proposition has certainly not ever been endorsed by these courts. And in fact the decisions are moving in the other direction." However, the Alberta *Historical Resources Act* has not been officially challenged by the Treaty 7 Coalition with respect to the matters that have been brought before the Panel.

> "… the Provincial government is purporting to have this legislation in place that gives them something very special over things that they don't even know anything about. Stories. And so when you're asking for a challenge to take place and you see the absurdness of what's really happening, I think in one sense a challenge would be very inappropriate."

Even though project lands may not have been "used" by Treaty 7 Coalition members in recent years, they maintain their importance and power for the people.

> " and when you look at this area, our people have been here for a long, long time and our people still have the ability to relate to a number of different things that – that maybe people from White society find it difficult to understand. And even though there has been maybe very limited use in the past few years, it doesn't take very much to go to an area and make that connection with the land and to have some very powerful experiences It's in us. Our ancestors have been here for a long, long time."

The courts have acknowledged that there is more than one approach to establish rights or a connection with the land. One approach is by having continuous use and occupation; the other approach is through Aboriginal law, practices and oral histories.

> "…it would be wrong for us to assume that because certain areas such as this area, which is obviously culturally and historically important, is available to be flooded because there's been two or three generations of one of the people's who haven't been able to use it as they might have done in the past or they would like to in the future, that's certainly not a window of opportunity for expropriation according to the Supreme Court of Canada."

The Treaty 7 Coalition submission, as provided by the Peigan First Nation, has not been signed off by all the members of the Coalition in some official way. However much work has gone into communication, and the members generally understand the views presented and all the groups have been supportive of the process that has been followed.

6.8.4.3 Crown Fiduciary Obligations

The Treaty 7 Coalition spent some time in final argument dealing with the question of Crown fiduciary obligations. "… the fiduciary duty on the Crown is real." Counsel provided the Panel with a number of recent legal references and authorities to support her presentation. It was Counsel's contention that the Panel must have regard for this issue whenever Aboriginal and Treaty rights are threatened or interfered with by government or others. Water supply and cultural issues are seen as part of this obligation. The Panel was challenged to advise governments and make recommendations.

In Counsel's interpretation of the legal cases a number of principles were clear, namely:

- the Crown has a fiduciary responsibility to First Nations based on the fact of their original occupation of this land, and their historical relationships, which are reflected in royal proclamations and treaties;

- this relationship involves the honour of the Crown and that all its dealings with First Nations should be trustlike and non-adversarial;

- the Crown has an ongoing obligation to safeguard aboriginal interests in land on and off reserves;

- no province has the right to extinguish aboriginal title and rights; only the federal government can do this;

- the Province therefore also does not have the right to destroy heritage sites of First Nations' people;

- the federal government's fiduciary responsibility can be activated in a variety of ways including failing to act as a protector when Aboriginal ties to the land are terminated or failing to act when the Crown was knowledgeable and could have prevented a harm from occurring;

- the federal government's fiduciary responsibility can be activated when any agency of the Crown enacts legislation or administers legislation which acts to interfere with aboriginal or Treaty rights; and

- any discharging of the federal fiduciary responsibility must involve consultation in good faith and if necessary, compensation.

Having established the above framework, counsel concluded that neither the federal government nor APWSS had met their fiduciary responsibility in terms of consultation or compensation. The Panel was asked to draw a conclusion on this matter and refer its decision to the federal and provincial governments. Counsel then summarized the main arguments made by the Treaty 7 Coalition regarding this project.

> "…the governments have provided no evidence to justify the wholesale destruction of an area which in the words of the *Environmental Assessment Act* is of historical, archaeological significance. We point out the possible economic advantage to new irrigators should not be used to justify interference, especially in the light of the fact that these…irrigators at present have no rights whereas the Coalition's constitutional rights are at stake. …for the Province to flood this area, that would be tantamount to extinguishment, a matter wholly outside provincial jurisdiction. The Federal Government has a duty as protector and intermediary to ensure that the Blackfoot ties to the land are not terminated by the Province's use of the land."

"We say that there is no evidence to justify the possible prejudice to the Band's water rights should this Project proceed to their detriment."

Counsel concluded by referring to the historic apology which the federal minister of Indian Affairs has issued to aboriginal people regarding residential schools. In part the minister pledged to do much better in the future. She also referred to the December 11, 1997 Supreme Court decision and quoted where it said "…we've got to turn a new page in all of this, we have to respect oral histories, the fiduciary duty of the Crown is real." She concluded by stating that …"we've all got to do better. It's not enough just simply to flood this area and build a dam, notwithstanding the harm that you've heard it will be for Aboriginal societies now or in the future, on the basis that there's economic benefit for some people in it."

6.8.4.4 Peigan First Nation's Perspectives on Water Rights

The presentation provided by the technical water advisor sought to demonstrate a number of facts about water deficits for irrigation in the South Saskatchewan River basin using data and a modelling run covering 59 years of record (considered an extreme scenario) provided by AEP. The advisor made the following four major points:

- Historically the Blackfoot or Siksika Reserve would have experienced a much higher level of deficits than did the Eastern Irrigation District.

- If the Peigan and the Siksika developed 6,070 and 7,120 ha (15,000 and 17,602 acres) of irrigation on their reserves, they would also experience a much higher level of deficits than all the other irrigable acres within the basin.

- If the Peigan and Siksika received a senior priority for water use and expanded their combined acreage to 33,185 ha (82,000 acres), there would be a substantial fall in their deficits and an increase in the deficits to all the others in the basin.

- Because there's a fixed supply of water in the basin any reduction in deficits to one party creates an increased deficit for other parties. The parties involved can view these changes as disproportionate, severe and unfair.

The Peigan technical advisor reviewed another set of modelling results which AEP believed were more indicative about what could happen - more "in the realm of possibility" than the one run used previously. The technical advisor made the following major additional arguments in his presentation.

- Even using the newer more viable scenario there would still be water shortages on the Reserves if their priority were junior.

- If the Indian Reserves had a higher or senior priority, then the deficits on the Reserves would be smaller and those off Reserve would go up.

- At this time additional water would have to be found somewhere in the basin to meet the calls for extra water elsewhere in the South Saskatchewan water system.

- This extra water could be called from the Highwood/Little Bow basins and could thereby create deficits there, which have not been contemplated.

- Because of this possibility, the Tribes of the Coalition are asking that this Project not go ahead until there is a resolution of the Treaty 7 claims regarding water rights.

The Peigan advisor reiterated his position "that the Treaty 7 Coalition members may have differences in the amount of acreage or the amount of water that the Province includes in its modelling of the South Saskatchewan basin. And they may also have a different priority than is assigned by the Province. Now, under those circumstances and with a limited water supply in the basin, the progress of Pine Coulee, Little Bow/Highwood, and projects like this are foreclosing the opportunity to resolve exactly the nature and extent of the Treaty 7 Coalition water rights."

Based on those assumptions and the possibility that the native people could have senior water rights, the advisor stated that deficits for non-native water license holders could be far greater than at present. "And for that reason Little Bow/Highwood is in a class of projects that, in my view, should not proceed until these matters with regard to the nature and extent of the Indian water right is – is determined."

The advisor closed his remarks by noting:

> "There is an interest on the part of the Treaty 7 Coalition members to find out exactly what their water rights are, what the nature of them is, what their priority is, and how that affects the development of these projects or, vice versa, how these projects affect their ultimate capability to develop. … We have set out here to try to demonstrate what kind of effects priority and expanded use by the Reserves would have in the South Saskatchewan basin and how the Little Bow/Highwood Project interrelates and is interdependent with – with that process."

During final argument, Treaty 7 Coalition again noted that the Peigan court case had been given a date of October 5, 1998 in the Court of Queen's Bench. Counsel urged the Panel, and indeed those who would invest in irrigation if the project were approved, to take this matter into consideration. In the view of the Treaty 7 Coalition, success by the Peigans in their litigation would create financial uncertainty and even harm those who invested because of the project and certain assumed water rights and allocations. Counsel supplied a number of court cases related to Indian water rights to back up her assertions.

From the perspective of Coalition three truths regarding water are still evident:

- There are shortages of water in the SSRB system no matter which planning scenario you examine;

- Water projects with the lowest priority suffer the greatest impact and, if the Peigan succeed in their litigation, irrigators who rely on water from this project would have a junior priority and would suffer deficits and financial losses in low flow years;

- The Peigan's success will also lead to water shortages for other license holders in dry years but the amount in question has not yet been modelled.

> "And there's no doubt that this project will benefit new irrigators and it's going to benefit Alberta. The Coalition on their part will suffer as their historical and cultural resources will be destroyed and they receive no benefit from the new irrigation and very likely will find themselves in conflict with the new irrigators as an issue of water supply and priority."

The Panel was challenged to act now to improve communication and relationships between aboriginal people and the government and to put pressure on government to respond to their concerns. The Coalition believes that one way to do this is refuse to endorse this project.

> "…but we submit that this Panel should not leave the question of new relationships until all the dams and reservoirs have been built, all sacred and historical resources have been flooded, and the dependable water supplies in the basin have been allocated to non Aboriginal people." …"We urge this Panel to require them to pay attention by refusing to endorse this Project at this time."

Counsel argued that this project or any allocation of water in the SSRB should not go ahead until the litigation between the Province of Alberta and the Peigan First Nation regarding water rights had been resolved.

> "One of the lessons to be learned from the current environmental crisis as well as from the developing awareness of the harm the governments have done to Aboriginal people is that the human survival and well-being depends on our willingness and ability to pay attention to the significance of factors outside the familiar sphere. The Coalition has asked this Panel and the governments to pay attention to their relationship to this area by preserving it, to pay attention to the unresolved issue of their water rights, both the impact of the Tribes' water rights on this project as well as the impact of this project on their rights. This is an item of unfinished business arising from relationships established with the Crown before non-Aboriginal people settled here. It is honourable for the governments to pay attention now and this Panel should require this to occur by refusing to recommend that this project proceed."

Views of APWSS on Water Management Issues Raised by the Peigans

The APWSS experts indicated that it would be possible to meet the water demands of the Reserves by taking water out of "additional storage". The Peigan argued that if they were successful in their litigation, all deficits would then fall on other irrigators including those in the Little Bow/Highwood area were the project to be approved. However, APWSS argued that there still is sufficient unallocated water to meet possible Peigan needs should they win the litigation, and that the outcome of the litigation has nothing to do with Little Bow/Highwood project and the resulting irrigation investment decisions made by farmers.

APWSS indicated that there should be no shortages that will be occurring as a result of the Little Bow project, because the timing of the diversion of the water that would be passing into storage would be occurring at a time when there is spring runoff from the mountains. All licensees in the entire SSRB would be able to meet their requirements, if not all the time, virtually all the time. Any shortages would occur later in the year and would be caused by low natural flows, and "the only way you can remedy that is with storage." Once the acres of irrigation specified by government policy are developed and the waters of the SSRB are fully allocated, the only way to provide water to new or repriorized demands would be either by reallocation among existing licenses or by taking water from additional storage. APWSS indicated that, if the province were faced with the recognition that the Peigan had a senior license to all other licenses, they would then have to deal with it. APWSS presumed that, if all other projects specified in the SSRB Allocation Regulation had been completed (that full allocation had taken place), the only ways of addressing this problem would be through clawing back of water from existing licenses or constructing additional storage in the basin.

Views of AEP on Water Management Issues Raised by the Peigans

A primary concern of the Peigan First Nation was "…how would an old user, say on the Oldman River, receive water relative to a new user?" AEP responded that any new user would receive the licensed natural flow on a seniority basis and perhaps receive some stored water on a discretionary, shared basis after the province had met its instream flow objectives and had supplied senior licenses.

AEP produced two sets of water modelling results; the first was based on monthly data for 1996; the second was based on weekly data from 1996. There were also separate sets of results for the Bow and Oldman basins. Some of these documents were discussed by counsel with the express purpose of trying to determine the degree of shortages in the Oldman basin, how priorities would be set for the allocation of water, how the priorities will affect the Highwood/Little Bow project, and how the priorities would affect the Peigan-asserted water rights. The fundamental conclusions of AEP were that:

- there would be water shortages in some years in the Oldman River basin;
- and these shortages would be at an acceptable level for agriculture;
- the allocation priorities would be set by AEP and they would seek to distribute water on a shared basis to all licensed users and the IFN;
- shortages and allocations in the Oldman River basin would not affect or be affected by the Highwood/Little Bow project; and
- the water rights of the Peigan whether existing or expanded could be accommodated.

AEP basically disagreed with many of the Coalition advisor's assumptions and conclusions and sought to point out the following information:

- there are 12,140 ha (30,000 acres) of potential water rights available now in the Bow basin that the Siksika could apply for;
- it would be unwise for the province to delay all water resources projects until the water rights claims had been settled;
- the time frame for settling the legal case is unknown and unknowable;
- the modelling scenario used by the advisor was only one of the six provided and it was the most extreme scenario;
- the Peigan have not, as yet, utilized the 6,070 ha (15,000) acres of irrigation that is currently available to them;
- stored water can be allocated on a shared basis and not by a license seniority basis;
- the advisor to the Treaty 7 Coalition was not sufficiently familiar with the basis for allocating water in the various modelling scenarios to reach his conclusions;
- the effects on flows in the Oldman River of this Project are "absolutely minimal";
- if the court case decides that the Treaty 7 Coalition has no prior rights, all the people connected to this project would have suffered harm or damage; and
- if the Peigans won their claim, their demands for water could be accommodated within the Oldman basin and involve the acreage not yet taken up for irrigation and through the management of storage in the Oldman River Dam.

AEP argued a number of additional points from their analysis of their data and from their experience in water management. Flows in the Bow River and Highwood River would not be affected by the project. Flows in the Oldman would not be affected. Water needed for the Apportionment Agreement with Saskatchewan would not be affected by this project nor would this project be called upon to make up water for the Apportionment in dry years. Currently there is unallocated water in the Bow and Oldman basins that could partly meet any needs for current allocations and possible new irrigation on the Blackfoot First Nations' Reserves. The water litigation before the Courts now has no set certainty of completion time nor of outcome. This project should not be held up because of that legal case and its possible outcomes. AEP also challenged the Peigan estimates of the land area (21,040 ha or 52,000 acres) on the Reserve that is viewed as suitable for irrigation or economically feasible for development. AEP challenged the amount of water that the Coalition estimates would be required for their development.

AEP further argued that even if the Peigan won their litigation and received additional water rights and a superior right to almost all other licenses, water to meet that eventuality would not come from this project nor be related to allocations or priorities that would result from this project. AEP noted that, if the Peigan succeeded in their litigation, there were a number of ways that additional irrigation and water requirements on the Reserve could be met. These ways included one or more of the following: using current unused water allocations within the basin; using water allocations from the Oldman River Dam and Reservoir storage; reallocating water from natural flow and storage on some shared basis; the development and use of more efficient irrigation technology; or use of different crop mixes. AEP also indicated that the additional water needs of the Blood and Siksika Reserves could also be accommodated assuming that a successful Peigan litigation would be followed by successful litigation and development by other Treaty 7 members. AEP did acknowledge that there will always be some risks in irrigation agriculture and all of these can not be removed, especially in dry years. However, within the guidelines provided by AAFRD, AEP argued that water needs could be met within acceptable risk limits. AEP concurred that, in certain situations, lower priority water users would carry a greater burden than

higher priority users. Additional water storage throughout the South Saskatchewan basin did assist in proving more management flexibility for AEP to deal with low water situations. AEP pointed out that the province is reviewing its irrigation land allocation policy and regulations as part of the Year 2000 Review. That review process will allow all people concerned with water in the basin and in its allocation an opportunity to revisit water management decisions.

AEP believed that the project should proceed largely as recommended by APWSS and that the water issues raised by the Peigans and supported by the Bloods are not supportable or can be dealt with satisfactorily even if their court case was successful.

6.8.5 Emerging Views about Aboriginal Historical Resources

Part of the evidence provided to the Panel by ACD included a discussion of changes or approaches that might be undertaken to bridge the gap between the needs and views of aboriginal people and the requirements and views of proponents, the historical resources legislation, research professionals and the public. The discussion of the Old Woman's Buffalo Jump and other sites in the project area led to the following discussion.

ACD staff were asked if "…the mitigation techniques for most of these sites would be simply to analyze them and catalogue them and then they would disappear under the development?" ACD staff agreed:

> "We refer to this as mitigation and the mitigation consists of recovering some amount of information from a site before the site is to be lost. So it's a salvaging of information prior to the loss of the entire site."

> " Visual impacts are always a bit harder to assess than a physical impact. It's—I think in part because it's in the mind of the beholder as much as anything. As I indicated, there are a number of visual intrusions in the area now, it's certainly not pristine, but the major road nearby that you can see across from the coulee and some buildings and ranches and things. Certainly it would be a dramatic visual change to have a major dam just up the coulee from the actual site. On the other hand, it would be grass—as I understand it, it would be an earthen dam that is grassed and it would not be a giant concrete structure, so it would not be as perhaps dramatic as would be in some cases. … We would be concerned about it, but I don't think it would be a serious concern in our department."

ACD staff were also asked about how they would seek to reconcile the different views that existed between aboriginal people and themselves regarding the recovery and salvaging of information from sites.

> "This is a difficult issue. There are two very different views of how you evaluate historical resources, and we don't claim to be in a position to assess them from a Native perspective. I can't tell you what the significance is to them, I would not pretend to do that, or to try and evaluate historical resources from the point of view of what do they mean to Aboriginal people. We – in recent years our office has worked much more

closely with native groups to try and reconcile sort of a scientific western approach to the study of the past with a more aboriginal and contemporary perspective on that, and that's why I think the very best kind of studies are those that incorporate both points of view in what is typically called a traditional knowledge study.

And this is similar to the kind of thing that was recommended at the Pine Coulee hearing, where aboriginal people are asked to contribute information about a landscape, not so much about an archaeological site, because many of them will admit they have lost many of the memories about specific archaeological sites, but they have memories about a landscape and how it was used and how it figured in their history. And I think the ideal kind of study is one that incorporates both those views, where archaeology and the traditional knowledge are put together in a report of a landscape area and is preserved for – in perpetuity then."

When ACD staff were asked whether they could do something about treating pre-contact places, such as the confluence of the Little Bow River and Mosquito Creek, in a different manner, they indicated that, under the *Historical Resources Act,* this was not possible.

"…It was written in 1972 and the definition of a historical resource then was viewed primarily as a physical entity. So that a teepee ring could be saved, but a place where people maybe collected berries or prayed or offered up ceremonies, if there's nothing physical there to record, our department has great difficulty knowing what our responsibilities are to a feature like that. We don't deny there is historic significance to areas that don't have a physical thing to study, but under the act it's very difficult to – surmise what we would do with such places like that. So typically the interpretation of the act has been to require a study of physical resources on the landscape that can be salvaged or recorded or collected prior to impact. And the more personal interactions with the landscape, while we recognize them as valuable and real, and we encourage, now more increasingly, we encourage developers to take these into account and to try to promote the study of them before they are lost. It has been the interpretation of the act that we can't require that to be done."

In the view of ACD, sometimes sites have to disappear because of the needs of projects. ACD staff "regret the loss of all of them and archaeologists, like anybody else, would like to have their discipline singled out as special and have it studied as much as possible. So we're in the same boat, I guess, in that sense. We watch with regret the loss of sites, but it is happening naturally across the entire province every day and it's a fact of life you have to accept."

When it came to the question of ways to improve communication and site considerations with aboriginal people, ACD recounted a number of useful experiences.

"We have had a number of discussions with individuals over the years about how we might try to improve …including just simple working relations between our groups and also are there any more innovative techniques for working with aboriginal communities to record and preserve historical resources. Something that is becoming a little more common now is trying to train aboriginal people in, not necessarily as archaeologists, but at least as managers of heritage information. And we have worked with a number of

communities to promote their own record keeping on their own reserves of historical resources in their immediate vicinity. That they would then have, say, a computer data base set up that they can access information from elders on the locations of graves and old cabins and places where beaver were harvested or berries were picked. And this becomes for them a data base of heritage that is not only preserving that information but then becomes useful, for example, in directing activities of developers away from resources so they are not encountered on reserves or nearby reserves.

Another representative of ACD added the following note:

"This might also be an issue that could be addressed through some of the enhancement initiatives proposed by the Bloods. I recognize that preservation—that there's no way that we can really address the in situ preservation of the resource, but through some of the enhancement opportunities, either interpretive signage or publication of a book, the information itself will be preserved and made available to a wider group of people, including Aboriginal communities themselves."

When ACD was asked whether or not there were any plans or interest by the government to review the legislation, the answer given was "no" and "…the legislation was passed in 1973 and there's been no full-scale review of that legislation since that time."

Even though the legislation doesn't require consultation or contact with aboriginal communities, ACD now strongly recommends in its HRIA requirement letters to all proponents that affected communities should be contacted. ACD has also worked with other government agencies "to identify burial sites, and other sites that are of particular concern to First Nation communities" on Crown lands. In addition, they may post a notation on any land identified "to alert possible developers that there is an issue that they will have to address." ACD is moving towards some kind of comprehensive program for these initiatives.

ACD pointed out that there is some protection for burial sites if they are registered. With regard to aboriginal burial sites, ACD is aware that this is a "complex and sensitive issue".

"Aboriginal people have lived on this land for at least 11,000 years and in that time period there's almost nowhere in Alberta that they haven't lived, there's almost nowhere that people haven't lived and died.

"Burials in a spiritual sense would cover the landscape, in a real physical sense they're actually quite rare. Because many times during the long prehistoric period in Alberta, people were never buried. They were put in trees, they were put on scaffolds, they were stuffed in rocks. They were treated in a wide variety of different ways that really left nothing to be found, but the land was certainly used for the disposition of the dead, and has been since time immemorial. So there's a character of the landscape that will always be there. In many cases there would be nothing for anyone to find physically but there will be a sentiment attachment to a land that, I agree with you, that I think is real and I think it needs to be taken into account of. But given that in many cases there will not be physical burials, they were actually very rare in Alberta, that's why I tend to recommend

the best approach is to record this as historic information in working with aboriginal elders today and knowledgeable people from the communities who can tell you about the use of the land. In many cases they can't show you them because they don't exist as a physical feature, there are not graves there.

"But the information about this land being used for a certain subject like that, or whether it was a hill that was used for a ceremony or a place where food was gathered, I think these traditional knowledge studies, as they're called, can include a lot of that information and can retain then some of that character of the land that will be lost when these areas are flooded."

ACD acknowledged that, in addition to the above observations, there was also the question of sacred or secret knowledge, which was of concern to First Nations. This created the problem that if some site knowledge is not shared, it's difficult for either the current landowner, the government or the developer to take it into account.

ACD offered the following concluding comments.

"Well, we are concerned that it's a significant project. There are a large number of sites and some of them are valuable in our estimation in archaeological sites across the province. It's our job to make sure that the full treatment of these resources is taken care of before anything is constructed and we intend to carry that out. We are not of the opinion that the historical resources in this project area are such quality and such significance that the project should not proceed for that purpose, that the historical resources are not of national significance and must be preserved in perpetuity, we're concerned with the loss of any of them, as I've said earlier. We intend to take all the appropriate response that we can collect as much information from these before the project proceeds.

"One thing else I would just add… that certainly this is a dynamic process, and during the course of the project there is continuing construction, there's continuing monitoring of construction activities by qualified archaeologists. Were a major discovery still to be made of whatever resources may not have been discovered, those would be treated just like any others. It would be found, studied, and recommended for further action.

6.8.6 Panel Views Regarding Aboriginal Interests and Concerns

The First Nations, as represented by the Blood Tribe and the Treaty 7 Coalition on behalf of the Peigan First Nation, presented the Panel with a series of important issues which can be categorized in three broad areas listed below. Some of these issues are beyond the purview or jurisdiction of this Panel.

- One area dealt with water rights, allocation, water management, and the impact of this Project on the Oldman River, which flows through the Peigan Reserve and on the border of the Blood Reserve.

- A second area dealt with the question of consultation and communication between the proponent, its consultants and other Alberta government departments with the First Nations and the adequacy of the archaeological research done and the subsequent mitigation proposed.

- A third area dealt with archaeological sites, their present day meaning to the aboriginal people, their protection, and the impact on the Blackfoot people of losing any and all of those sites.

The Panel offers the following comments concerning the anticipated harm that this project, if approved, would create for future water rights, allocation and irrigation development on the Peigan and other Treaty 7 First Nation's reserve lands. The Panel is persuaded that this project will have a minimal effect on the flows going into the Bow River. The Panel also believes that the project will have minimal impacts on flows in the Oldman River. The Panel accepts AEP's evidence that the apportionment agreement with Saskatchewan will not be measurably affected by this project.

The Panel accepts that, should the outcome of the long-standing litigation favour the Peigan and they receive more water allocation and a prior right to that water than almost all present rights holders, sufficient water or an appropriate water management plan can be found or already exists to accommodate that eventuality. The Panel accepts AEP's modelling information and interpretations as reasonable in this regard.

In the Panel's view, the Highwood/Little Bow project does not materially affect the allocation of water in the Oldman and Bow basins. The water demands of the Peigan and other possible demands from the Blood and Siksika First Nations could be accommodated in a variety of ways. These include using existing allocations of water not as yet taken for irrigation, using stored water in the Oldman River Dam, reallocating existing water priorities within the affected basins, or changed or co-operative water management practices regarding the sharing of deficits. The Panel accepts AEP's argument that any shortfalls in water during dry months or years, in either the Bow or Oldman basins, will not be made up from the flows or storage connected with this project.

The Panel does not conclude that this project negatively affects the current or future economic well being of either the Peigan or Blood First Nations. The project will allow water taken during periods of high flow (the spring freshet) to be stored and released during times of low or lower flow. Storage provides the province with additional opportunities and tools to manage water for all purposes. The Panel is of the opinion that existing and possible future aboriginal water needs or claims could be more readily accommodated, if there is increased water storage in the SSRB.

The Panel concludes that it is time for all parties involved to engage in a review of communication and consultation requirements relating to all First Nation archaeological resources. The *Historical Resources Act* of Alberta presently does not require consultation with Alberta First Nations when archaeological work connected with projects is undertaken. First Nations attending the 1995 Pine Coulee hearing and this hearing both raised similar issues regarding consultation and communication in relation to archaeological work. In fact, the Pine Coulee Panel made a similar recommendation regarding consultation and communications in 1995 and this Panel is surprised that there has been no serious attention to the problem by all parties.

The Panel concludes that the lack of early, consistent and meaningful consultation with the Blackfoot First Nations is a serious matter and must be addressed. APWSS's archaeological consultant acknowledged that prior consultation had not taken place, nor was it required, when the historical resources inventory work was completed. However, contact was made with both the Blood and the Peigan First Nations after the EIA was released. Some discussions did take place and field visits, including APWSS, the HRIA consultant, and First Nations people, took place in 1997. In the Panel's view, the Treaty 7 First Nations should be included in direct communication and consultation regarding any project in their traditional territories that touches places that are of historic or sacred importance to them. The Panel appreciates that there are positive signs of change in the emerging views and practices on the part of ACD and some First Nations.

The Panel concludes that an on-going communication and consultation mechanism should be established with respect to this project. The Panel is aware that this is not an easy task and there are many difficulties involved. Yet, all parties at the hearing expressed a willingness to meet and talk, to learn from each other, and to try to reach decisions that would have regard for the legitimate needs of each party. At a minimum, this project should require an all party group to oversee any project-related activities including monitoring of construction, removal of archaeological material, preparation of explanatory or educational information, protection of sites and guidance for additional studies or protective actions. This group should consist of the proponent, AEP, ACD, First Nations, local governments and local landowners.

The Panel agrees that the names of the Old Woman's Buffalo Jump and Squaw Coulee should be changed as quickly as possible. The proponent and ACD agreed that this should be done and the First Nations requested it be done. The names suggested would be Woman's Buffalo Jump and Woman's Coulee. This matter has been referred to the appropriate agency and the Panel requires that the NRCB be informed about the review process and any decisions made.

The Panel has decided to defer consideration of the expansion of the existing reservoir at Squaw Coulee pending the receipt of additional information. The Panel is prepared, however, to offer the following comments with respect to the Woman's Buffalo Jump and Woman's Coulee. The Panel agrees that the Woman's Buffalo Jump (EcPl 1) (designated as a Provincial Heritage Resource) and associated features should be more thoroughly studied and protected including the campsite located below the jump. This site is showing signs of deterioration due to erosion and some illegal excavations. In their 1997 work, Bison Historical Resources Limited indicated that information is "sketchy" on the associated sites and the surrounding geographic areas, some of which have been designated as having "Significant Historic Resource Potential." The proponent, ACD and AEP, First Nations and local governments and local residents must develop and monitor a protection plan.

The Panel does not accept that an enlargement of storage on Woman's Coulee (if the Super Expanded Squaw Coulee Reservoir was ever approved) should necessarily be considered as a major negative visual intrusion on the Woman's Buffalo site and therefore not be built. However the Panel does agree that any construction in the area of Secondary Highway 540, or in view of the site, be done in such a way as to minimize any of the possible intrusions on the Woman's Buffalo Jump and campsite.

The Panel agrees that, if the project is approved, further archaeological work should be done in the vicinity of the Clear Lake canal. This should include more intensive examination of the canal route and the area around the route, the junction point of the canal and the region surrounding it at Mosquito Creek. APWSS and the previously identified groups should prepare a research plan for this and development of the plan should proceed as soon as possible.

The Panel agrees that there will be significant loss experienced by aboriginal people, particularly the Blackfoot First Nations, if the development of the Little Bow River Reservoir goes ahead. The Panel concludes that the project will have a significant adverse environmental effect on aboriginal

historical resources. It also agrees that this loss can not be mitigated fully and adds to the loss of other archaeological resources already lost through previous changes to the aboriginal traditional lands off the reserves.

Agricultural, industrial, recreation and municipal developments in southern Alberta have affected a number of prehistoric sites. The Panel appreciates the arguments that the First Nations advanced that continued development in some geographic areas should not take place because this will destroy the availability of those places for current and future cultural and spiritual use. The Panel observes that, under existing legal arrangements and understandings, further water management projects are deemed appropriate and can be in the broader public interest. However, the losses for First Nations people must be acknowledged, and resources must be identified to mitigate and reduce as much of the loss as possible, to preserve sites wherever possible, and seek to keep impacts to a minimum.

The Panel concludes that it is necessary to provide a broader examination and interpretation of the First Nation's history and occupation in the Little Bow area. An interpretive centre and education program needs to be established in that geographic area to document the importance of the area and the losses that have occurred because of changes to it and other adjacent areas, such as the Pine Coulee Reservoir, Travers Reservoir and possibly the Oldman River Dam Reservoir.

To assist in the interpretation of the loss to aboriginal people, the Panel would require extra-ordinary research in a number of areas. The Panel agrees that more archaeological work should be done on the area in and around the confluence of the Little Bow River and Mosquito Creek, if the project is approved. This would include some of the area above FSL as well as more intensive examination of the river valleys. The two hearth site (EbPi 51-52) should be relocated.

The Panel agrees that a focussed ethnobotanical study should be undertaken within and around the proposed Little Bow River Reservoir area, if the project is approved. The study should identify plants used by First Nations' people and clarify their uses where it is permissible. This study should begin as soon as possible and requires the guidance of ACD.

The Panel agrees that some research attention needs to be given to the issue of trails in the area and the Old North Trail in particular. A regional overview needs to be taken on this subject and then a determination made regarding further research. The Panel observes that if trails are not deliberately searched for, the remaining portions of those trails may never be identified. ACD has already indicated that some work on this has been requested.

The Panel notes the fiduciary obligations of the Crown and the assertion that such obligations include ensuring that cultural and religious rights of First Nations' people are protected. The Panel particularly notes the concern regarding the treatment of culturally significant sites. The Panel notes again the Blood position regarding the need to re-evaluate how aboriginal culture and religion are viewed and treated. The Panel realizes that Alberta legislation regarding historical resources has some relevance to certain aspects of this concern. However, the matter is much more complex and pervasive than the purview of this legislation or the review of this Panel.

The Panel heard extensive technical and historic evidence on archaeological resources in the area of the confluence of Mosquito Creek and Little Bow River, including detailed questioning and discussion about this research and its implications. The Panel commends the Applicant, ACD and their consultants for their careful and thorough research work. It also commends them and the aboriginal participants for the way they sought to address the issues of archaeological and historic resources during the hearing.

The Panel is concerned that the religious, spiritual and cultural significance of the archaeological sites at the proposed Little Bow River Reservoir be fully identified, understood, and reflected in the planning and development of the Project, should it proceed. The Panel accepts that the

confluence of the two rivers was an important meeting place and camping area that has historical and contemporary significance to the interests of the aboriginal people.

The Panel notes that, for a variety of reasons based on past experience, aboriginal participants were reluctant to identify and explain the importance and significance of various sites. The Panel also notes the request to re-evaluate how aboriginal culture and religion are viewed and treated, and the request for a maturing process and a commitment to examine existing views and relationships between aboriginal people and the dominant culture. Whatever decision is reached by this Panel, work needs to proceed on establishing ways that incorporate both views of archaeological resources.

The Panel believes the presentations made by the elders and band members are an important part of the process. Protection and recognition of cultural and religious freedoms depends upon awareness and understanding. The aboriginal presentations to the Panel have emphasized that the site of the confluence of Mosquito Creek and Little Bow River has special religious, spiritual, and cultural significance to elders.

The Panel is cognizant that the criteria used to assess the significance of the sites at the proposed Little Bow River Reservoir area from a research perspective may not reflect the criteria used by aboriginal elders. The Panel also notes that the objective of ACD's heritage resources program is to ensure that significant artifacts are protected and preserved, and that the department has been working more closely with aboriginal people in identifying, assessing, and managing historical impacts associated with proposed developments.

The Panel has considered the issue of the entire complex of sites that were found in and around Little Bow River Reservoir area and their cultural significance. The Panel accepts that many of the archaeological sites, such as teepee rings and campsites, are common in Alberta. However, the Panel notes that further archaeological assessment remains to be completed and that the evidence from the aboriginal presentations indicated that, based on their traditional knowledge, the sites contained more information than was known to the archaeologists. The Panel notes that the researchers may not have recognized some important features of the sites, and that the aboriginal people had a different understanding of the sense of place, the artifacts and their interpretation. The Panel is concerned that the aboriginal people mentioned cultural information not made known to the researchers, and left the Panel with the impression that the sites may have more spiritual and religious significance than known or understood through the research conducted to date. The Panel believes that, in the face of uncertainty, a more prudent and cautious approach should be taken before any final conclusions are drawn regarding the significance of the various camp sites and meeting places found in the vicinity of the confluence of the two rivers. In this case, where it is recognized that undisturbed camping areas and summer meeting places are becoming more significant at provincial and regional levels, conservative assumptions regarding mitigation should be made about them and nearby sites until sufficient evidence has been considered to warrant reaching other conclusions.

The Panel has concluded from the evidence currently available, there is a need to require that APWSS, in a manner satisfactory to ACD, undertake additional archeological research beyond the strict legal requirements of the HRA and to consult with aboriginal elders, should the project be approved. The Panel is not satisfied that the Applicant has made significant progress in developing a new way of working together with aboriginal people. The Panel is prepared to put aboriginal people in a position to provide greater influence over the investigative work to be undertaken.

The Panel concludes that, if the project is approved, there should be multi-stakeholder aboriginal input to monitor and manage the Little Bow River Reservoir and area archaeological resources. This includes monitoring the mitigation process during project construction and subsequent operation,

and any future educational or spiritual use of either the sites or artifacts. The Panel will require the development of an aboriginal interpretive area and program as part of the project. The Panel believes that the aboriginal people should be given the opportunity to lead the development of such a program. The Panel is confident that they will use this opportunity to give appropriate treatment to their sense of loss of an important place such at the confluence of Little Bow River and Mosquito Creek. The Panel believes multi-stakeholder aboriginal input should be sought about the interpretive area and program nature, development, and management. Stakeholders include any Treaty 7 people that wish to participate. Others in the project area could play supportive roles in facilitating the aboriginal people in their development of the interpretive area and program. The Panel appreciates that a spirit of cooperation will be required to support such a process from ACD, APWSS, AEP, the Public Advisory Committee, and representatives from the M. D. of Willow Creek and County of Vulcan, and other communities.

In cases such as the proposed project, the HRIA would, in the Panel's opinion, have benefited from a requirement to notify the public, including aboriginal people, of the work involved and the results, with appropriate opportunities for consultation. Therefore, the Panel recommends that ACD establish public participation requirements for HRIAs for projects that are consistent with, and complementary to, similar requirements now mandatory for environmental impact assessments in Alberta.

The need to make these changes has been apparent for some time. While legislative authority might ultimately be required, the Panel believes that all parties involved, including the proponent and aboriginal people, would be more than willing to cooperate with ACD in initiating a new approach to public consultation associated with HRIAs. The failure to incorporate public consultation procedures that are now so common place in other aspects of resource development is causing real difficulties in developing trust and respect between aboriginal people and those responsible for initiating resource developments.

The Panel received evidence that the Little Bow River Reservoir area was in the traditional territory of the Blackfoot Confederacy, which included, among others, the Peigan Nation and the Blood Tribe. The Panel was informed and understands that it is difficult, if not impossible, to associate any of the prehistoric sites conclusively with any particular present-day aboriginal group. The Panel believes that discussions should continue to take place between APWSS, ACD and the Treaty 7 aboriginal people about the identification, proper treatment, ownership and use of all Little Bow River Reservoir archaeological and historic sites, and artifacts. The Panel understands that such discussions are already taking place and believes that more discussion would be of value to all parties.

The Panel notes the assertion of the Peigan Nation and Blood Tribe that the Old North Trail was a part of their culture. The Panel believes that further research would be required to establish its location along the Eastern Slopes of the Rocky Mountains and this is far beyond the scope of the proposed project. The Panel believes that the testimony before the Panel from both the Peigan Nation and Blood Tribe, that the Trail passed through or near the Little Bow River Reservoir, should be given further consideration by ACD and APWSS to decide whether further investigation is appropriate. The Panel believes that should the Trail be identified in Little Bow River Reservoir area and if required, this matter could be properly attended to with appropriate mitigation measures and would not have an effect on the project.

The Panel was asked by the Blood Tribe to consider whether or not the two-hearth teepee ring could be removed from its present location and moved to ground above the reservoir. As noted, should the project proceed, the Panel would require that the two-hearth tee-pee ring be moved to the location of the interpretive area to assist in the explanation of the importance of the area to aboriginal people. The Panel believes that with appropriate interpretation the loss associated with flooding this former meeting area and campsites at the confluence of the upper Little Bow River and Mosquito Creek

would be recorded by the Blackfoot Confederacy. The Panel concludes that this loss must be considered in a regional context along with the other sites that have been lost to the aboriginal culture. The interpretive area and program could include reference to the Pine Coulee Reservoir, Travers Reservoir, the Old Man River Reservoir, and other similar locations that have been disturbed as a result of various forms of development.

The Panel concludes that if the proposed project were to proceed, it should be clearly recognized that it would mean the loss to the aboriginal people of another important feature of the landscape that plays a central role in their culture. Information on the actions and initiatives relating to the conditions and recommendations concerning the aboriginal interests will be included in the Mitigation Progress Report required by the Panel.

The Panel is aware that many serious matters with respect to the relationship between First Nations' people and other Albertans and their government have been brought before it. Though the Panel is not empowered to resolve many of the issues raised in the presentations from the Blood and Peigan First Nations, it would like to offer the following observations.

The effects of development on the traditional territories of the Blackfoot have taken place ever since, if not before, Treaty 7 was signed. Since the earliest days, water projects of various kinds have been proposed and built in southern Alberta, some related to the Highwood and Little Bow basins. Most of the lands required for the three-component project are privately held and have already been altered in a variety of ways. For example, it was stated in evidence that the lands above the valley of the Little Bow in the vicinity of the proposed reservoir have been largely farmed to the edge. It was also stated by some local people giving evidence at the Hearing that over 40,000 arrowheads and other artifacts have been collected by some 70 individuals across southern Alberta. This group also identified over 800 discovery sites catalogued by the province through a program developed by ACD called the Trace program.

These examples are provided to indicate that the Panel is aware that considerable change has occurred on the lands previously occupied by the Blackfoot, before the signing of Treaty 7. These changes continue.

The Peigan litigation with the Province of Alberta has, as its goal, the acquisition of a prior water right and allocations that might enable the Reserve to develop up to 21,040 ha (52,000 acres) of Reserve land. This would make the Peigans one of the largest irrigation operations in the whole SSRB. If more acreage was added for the other Treaty 7 Reserves, this would certainly also be the case. Thus it is clear that the Peigan value the economic importance and benefits that irrigation development brings, particularly if there's a relatively stable supply of water in most years. Such a massive development of irrigation agriculture on the Reserve would have profound effects similar to, but likely greater than, those discussed in this project. Even if the Peigan sold these rights to others or had others develop their own Reserve acreage, it would involve extensive impacts on land. The Panel makes these observations because in either case water is being sought to provide economic benefits and will involve changes to land.

Treaty 7 First Nations have also dealt with both the loss of many sites and the preservation of a few special sites within southern Alberta. Sites such as Writing-on-Stone, Head-Smashed-in-Head Buffalo Jump and Waterton Park were cited as examples in the hearing. With proper consultation and more archaeological work, the Panel concludes that a way can be found to deal with the identified losses that this project could entail.

6.9 Social Effects and Public Consultation

Since the early 1980's residents in the Highwood and Little Bow river basins have been involved in a variety of public consultation processes. Residents, government officials and consultants have attempted to plan appropriate water management projects and deal with many water-related issues. A strong sense of community, commitment and the willingness to try and accommodate all interests has been evident in many parts of the project-affected areas.

For many years the focus was on a three-component project and an associated diversion or operating plan. This included a Little Bow River Reservoir, an enlargement of the diversion works in the Town of High River, and the diversion works associated with the stabilization and restoration of Clear Lake, including the development of associated wetlands. In the early 1990's, additional storage through enlarging the existing Squaw Coulee works and reservoir was added for consideration.

The public consultation processes by themselves constitute a significant social effect because they involved and affected many people over a long period of time. During the hearing the Panel heard evidence about the effects of these processes and received an assessment of their strengths and weaknesses from various participants. Interveners also provided suggestions as to how to improve future public consultation because there would be an on on-going need for resident involvement if the project is approved and subsequently built.

6.9.1 Panel Views

Based on the evidence before it, the Panel draws a number of general project-related conclusions about public consultation. There were a number of positive and constructive public consultation aspects to developing parts of this project and it benefited greatly from them. This is demonstrated in the planning and site selection for the Little Bow River Reservoir and dam and the planning to stabilize Clear Lake and develop wetlands.

There were a number of negative effects on the community due to the length of time involved and the uncertainty created by delayed and altered commitments. Promises were made and were not kept. This lack of consistent follow through in all aspects of the project's development led to some stresses within the communities involved. The discussions around transportation routes in the Little Bow River Reservoir area, agreements with respect to the IFN, and protracted discussions with the Hutterites demonstrate this.

There were a number of noteworthy consultations that were not done well or were overlooked. These have also left a poor legacy of distortion and frustration. This includes the type and level of involvement of First Nations with respect to archaeological sites and the involvement of residents around Squaw Coulee and Baker Creek with respect to the proposed enlargement of works in those areas.

Some people felt that they were appropriately consulted and they were still supportive of one or more project components. These interveners did acknowledge that the public consultation included both successful and unsuccessful elements. Others felt that they were not appropriately involved and, while they acknowledged that some excellent consultation had indeed occurred, this was not their experience and they could not support one or more of the project components.

Many interveners acknowledged that their long-term desire was for a win-win solution to the water management issues in the basins and were distressed that all parties had not been consulted to the same degree. There was even some wavering of support by people who still saw many components of

the project positively, due to the differences in public consultation and the lack of the fulfillment of certain agreements.

6.10 Concluding Comments Regarding Social Impacts

The proposed three-component project is intended to improve water supply in the Little Bow basin and at Clear Lake. The diversion and storage of freshet water is expected to support beneficial use of water for variety of purposes. The proposed three-component project would also result in a variety of social effects, some of which are positive and some that are adverse. In the preceding discussion the Panel has identified and considered the nature of the social effects of the proposed project.

For the proposed three-component project, the social effects most relevant to the Panel's deliberations are those that pertain to the effects on: the Little Bow Hutterian Brethren, Treaty 7 aboriginal people and culture, archeological resources, transportation, water use for municipal and domestic purposes, municipal wastewater disposal, recreational water use, irrigation water use, land use planning, navigation, and public safety. Having identified the social effects of the three-component project, the Panel in the next section of the decision report will identify the economic effects of the project. After all environmental, social, and economic effects of the proposed project have been identified, the Panel will summarize those effects and draw its conclusions regarding them, before determining the public interest in the proposed three-component project.

7.0 ECONOMIC EFFECTS

APWSS provided two types of assessments of the economic effects of the proposed project and associated diversion plan. First, they presented the results of a benefit-cost analysis that assessed whether the project represents an efficient use of public funds. The benefit-cost analysis compared the total of all quantifiable future benefits with all quantifiable costs to determine the resulting rate of return on the public funds being invested. The second analysis considered the economic impacts of the project in terms of the regional and provincial employment and income effects that would result directly and indirectly from the construction and operation of the project.

7.1 Benefit-Cost Analysis

To help demonstrate that the proposed project is in the public interest and represents a socially acceptable investment of public funds, APWSS prepared a benefit-cost analysis. This analysis was used to assess whether the project is economically feasible from a provincial perspective by comparing the stream of social benefits and costs, with and without the project.

7.1.1 Methodology

Preparation of a benefit-cost analysis involves six key steps:

1. Identify all incremental benefits and costs associated with the proposed project. For this project, the benefit-cost analysis presented in the EIA employed a base case consisting of conditions under the 1986 operating plan. Incremental impacts were defined as any project-induced changes from this base case.

2. Estimate the extent of these benefits and costs in monetary terms over the life of the project. The analysis assumed a project life of 50 years and value estimates ignored the effects of inflation. Various assumptions were made to predict future conditions. For some effects, such as increased agricultural production due to irrigation, project impacts were relatively easy to measure using economic terms, because there are market-based prices for these values. However, project-related improvements in Highwood River flows are much more difficult to quantify in monetary terms because the resulting types of benefits and costs are not directly addressed in economic markets.

3. Adjust values based on market prices to account for possible distortions whereby social values are different from market values. Such adjustments were made for two types of project costs. In one case, APWSS argued that the social cost of labour required for project construction is lower than market-based labour costs because some of this labour would otherwise be unemployed. Second, APWSS calculated the project's land costs in terms of lost agricultural productivity, rather than actual purchase costs, because the market prices for land in the study area are highly inflated due to speculation.

4. Convert the streams of future benefits and costs into their present value equivalents. Since project benefits and costs will occur at different times in the future and there is

greater uncertainty associated with events in the more distant future, economists discount these future values to determine their present value. For their analysis APWSS believed that the discount rate would fall in the range of 4 to 10 per cent to reflect the opportunity cost of capital, and used a rate of 7 per cent in their analysis because this represents the mid-point of the range. These rates are believed to reflect the amount of interest that would have to be paid to convince consumers to save for the future rather than spend now.

5. Perform various tests to determine whether the project represents an efficient use of social resources. APWSS used three such tests. They calculated net present value, which is determined to be the present value of total benefits minus the present value of total costs. They determined the ratio of benefits to costs. APWSS also determined the internal rate of return, which is the discount rate at which the net present value of benefits is equal to the net present value of costs.

6. Conduct a sensitivity analysis to determine whether changes to any of the various assumptions used in the economic evaluation would have a significant effect on the results or conclusions of the analysis.

In their analysis, APWSS showed that the major costs of developing the project were associated with constructing and operating the dams and canals. However, significant private-sector investment in new irrigation infrastructure would be required before any irrigation benefits would result. The major benefits identified in the economic analysis were associated with irrigation expansion, but some recreation and municipal water supply benefits were also predicted.

During the hearings there was some discussion of whether using the 1986 operating guidelines to portray the base case was appropriate. The Little Bow River Basin Water Users Association suggested that the 1994 operating guidelines, which are currently in effect, were more appropriate as the base case. They indicated that, operating under 1994 guidelines, irrigators would be subject to higher deficits than in 1986 and would then benefit from the project when this risk of deficit is eliminated. This would increase the extent of project benefits and would make the project even more economically desirable than portrayed in the analysis provided by APWSS.

In response, APWSS provided some additional interpretation of the deficits associated with the 1994 operating guidelines which were updated to eliminate water quality concerns related to dissolved oxygen. They showed that irrigation deficits calculated for the 1986 and 1994 guidelines were nearly identical, so there would be no change in project benefits. In addition, APWSS indicated that irrigators were only accepting the more restrictive 1994 guidelines on the assumption that implementation of the Little Bow project would proceed and thereby resolve problems resulting from water shortages. In the absence of the project, APWSS believes that Little Bow irrigators would likely initiate legal proceedings to resolve issues related to water rights and water shortages. Consequently, APWSS stated that the base case for the analysis is the 1986 operating guidelines.

7.1.2 Project Construction and Operation Costs

The EIA indicates that the total cost of implementing the three-component project is $52.3 million, of which 61 per cent would be for construction, 10 per cent for engineering, 5 per cent for mitigation/EIA, and 24 per cent would be for land acquisition. However, this amount includes sunk costs of $3.7 million and land acquisition costs of $12.5 million and APWSS chose not to include these in the benefit-cost analysis. Thus, for evaluative purposes, project implementation is estimated to cost $36.1 million (in 1992$) and would be spread over a 5-year period, with the bulk of the construction occurring in years 3 and 4. The present value of construction costs is estimated to be $26.8 million (based on a 7 per cent discount rate). The analysis assumed that the Project would have a 50-year economic life and that the dam and canals would have a residual value of $19.3 million at the end of that time.

During the hearing, APWSS presented a revised project cost of $53.3 million in 1997 dollars, although they acknowledged that real costs would be higher and will not be known until the project is tendered. The revised estimate was based on engineering and construction costs of $37.1 million, land acquisition costs of $12.4 million, environmental mitigation costs of $2.5 million, and $1.2 million for environmental studies.

Although the actual costs of land acquisition were not included in the analysis, APWSS did consider the value of the land that would be flooded by the project. According to the EIA, some 2,642 acres of agricultural land would be flooded. Presently 65 per cent of this is used for cereal production and the balance for grazing. Since the project would prohibit agricultural activity on this land, the value of this lost agricultural production represents a cost of $60 thousand per year or a total cost of $0.7 million over the life of the project (7 per cent discount rate). This amount is substantially less than the expected $12.4 million that it would cost to purchase all the land required for the project.

The EIA predicts that some labour used in construction would otherwise be unemployed so the actual social costs of this labour would be less than the actual wage cost. The analysis assumed that the real cost of labour is only 80 per cent of the actual wage cost, but noted that this will depend on regional unemployment rates and the position of the economy in respect to business cycles. Reducing wage costs by 20 per cent represents a $2.8 million reduction in the social cost of the project. During the hearing, it was noted that levels of unemployment in the construction industry are currently very low in comparison to the long-term average. Depending on the demand for labour resulting from other construction projects in Alberta in the next few years, the real cost of labour may prove to be equivalent to wage costs, so no adjustment in labour costs may be warranted. However, valuing labour according to wage costs would not have a significant effect on the overall results of the analysis.

Annual operating costs are estimated to be equivalent to 0.5 per cent of the capital costs of the physical facilities proposed, adjusted downward to reflect the use of underemployed labour. These costs are estimated to be $185,600 per year or about $1.9 million in total (using a discount rate of 7 per cent).

7.1.3 Irrigation Benefits and Costs

The principal benefit of the project will be increased agricultural production in the province because the project will provide sufficient water supplies to support 8,090 ha (20,000 acres) of new irrigation. According to the EIA, this new irrigation is to be phased in over 12 years, with about 45

per cent of this occurring within the first five years. In order to irrigate, farmers will initially have to invest about $100,000 per quarter section to purchase the centre-pivots, pipes, pumps and energy connections necessary to convey and apply water on 55 ha (135 acres). Additional investment of about $92 per hectare ($227 per acre) will also be required for additional farm machinery, buildings and grain storage facilities. Total irrigation-related capital costs are estimated to be about $46.1 million over the life of the project, and this investment is nearly the same as the amount of public investment needed to construct the dam and canals.

The operating costs associated with irrigation are estimated to be about $37 per hectare ($91 per acre) for the first 14 years after irrigation commences. These costs include $9 per hectare ($22 per acre) for actually pumping water, plus $28 per hectare ($69 per acre) for the additional fertilizer, chemicals, and fuels required for irrigation, rather than dryland farming. With irrigation, crop revenues are predicted to be considerably higher than with current dryland farming. Farmers would shift their crops to barley, alfalfa and soft wheat, and would experience higher yields (consensus yields) than under dryland conditions. The average revenues during the first 14 years of irrigation would amount to $132 per hectare ($327 per acre), which is about $108 per hectare ($266 per acre) higher than the corresponding revenues under dryland farming.

The analysis assumed that, based on past experience, farmers tend to under-water their crops until they learn how to irrigate effectively. Consequently, the analysis assumes that by Year 15, farm management will have improved and farmers will be using more water to produce a higher crop yield (target yields). Annual operating costs are estimated to be about $45 per hectare ($112 per acre) to cover the higher costs of pumping and fuels for farm equipment. However, gross revenues are predicted to increase to $161 per hectare ($398 per acre) once farmers have learned to optimize their use of irrigation water.

Irrigation of an additional 8,090 ha (20,000 acres) of land in the Little Bow River and Clear Lake basins is predicted to generate significant new economic revenues. Total incremental agricultural revenues are predicted to total $306 million over the life of the project. This translates into a present value of $53.1 million (using a 7 per cent discount rate). However, this revenue gain is contingent on farmers investing a total of $46.1 million in irrigation and related infrastructure and facing increased operating costs of $101.4 million over the life of the project. The net present value of these costs is $17.8 million and $17.6 million, respectively, when discounted at 7 per cent.

The EIA suggests that farmers in the region are financially able to undertake this level of investment. APWSS calculated that the pre-tax, real, internal rate of return for farmers investing in irrigation expansion would be 15 per cent and noted that this is a reasonable rate of return on an investment. The internal rate of return was calculated by comparing the costs of investing in and operating irrigation with the benefits of increased agricultural production for all 20,000 acres over the full 50-year life of the project. The analysis notes that the real rate of return for individual farmers in any given year will vary from this average.

During the hearings, there was considerable discussion of the extent to which implementation of the project and diversion plan would adversely affect existing irrigators, particularly in the lower Highwood River and upper Little Bow River. According to the EIA, operating according to the diversion plan would result in increased deficits to existing irrigators but that these would be too small to quantify. In contrast, testimony from various irrigators suggests that any increase in the frequency of deficits during dry years could have significant cost implications for their operations, especially if they have junior water rights. This debate over costs to existing irrigators is not relevant at this time, however, because increased deficits would result from the proposed Diversion Plan which the Panel is not prepared to accept. Continuation of the current operating regime should result in no changes in water availability to

existing irrigators so implementation of the three-component project should not result in any costs to existing irrigators.

There was also some discussion as to whether irrigation expansion would lead to increased livestock production in the region. APWSS indicated that they had considered livestock expansion as part of the economic evaluation. However, based on economic conditions at the time of the analysis, it appeared more advantageous for farmers to sell their increased hay crops, rather than use the crops to feed more livestock on their own operations. Several interveners contradicted this conclusion and argued that diversification into intensive livestock operations provides more farm stability and economic benefits. Members of the Upper Little Bow River Basin Association indicated that their irrigation requirements are related directly to their livestock herds. Members of the Little Bow River Basin Association noted that, with a more secure supply of feed and water, farming operations would evolve into more diversified and more intensive operations. They argued that, although the economic analysis assumed a continuation of past management practices, switching to intensive livestock operations would actually yield more economic benefits than continuing to grow hay and cereals. APWSS conceded that given current market conditions and government policies supporting livestock expansion, the economic evaluation may not provide a complete assessment of project benefits and costs.

7.1.4 Other Benefits and Costs

The other major benefit of the three-component project would be increased recreational opportunities. The re-establishment of Clear Lake and the creation of new recreational facilities at the Little Bow River Reservoir are each predicted to attract about 6,500 parties per year. The EIA included proposals to develop day-use sites at three possible sites on the reservoir at a cost of between $0.5 and $1.2 million. However, at the hearing, APWSS indicated that it was now planning to develop one site to handle expected recreational demands at the reservoir and that the cost of this site was about $0.5 million. In the EIA, APWSS also concluded that implementation of the project and associated diversion plan would increase flows in the Highwood River and that the resulting improvements in recreational quality would lead to a 14 per cent increase in the number of recreational visits to the lower reaches of the river.

Parties using these new or enhanced sites would face reduced travel costs to reach existing sites having similar characteristics and would therefore enjoy cost savings. These travel cost savings were calculated to be about $0.38 million per year. If the value of reduced travel time is included, these travel cost savings would amount to $0.55 million per year. On the assumption that the regional population would increase by 1.4 per cent per year, the total travel cost savings, including travel time, are estimated to be $42.1 million over the life of the project. The net present value of these recreational benefits is calculated to be $6.7 million when discounted at 7 per cent

During the hearings, the Fisheries Coalition stated that the benefit-cost analysis did not consider all the recreational impacts since angling guides operating on the lower Bow River could benefit from any increase in fisheries populations that might result from improved flows and better habitat in the Highwood River. They presented evidence concerning the magnitude of the guided angling industry but were not able to quantify the extent to which this group might benefit. APWSS agreed that such benefits could well result from implementation of the project and diversion plan, and concluded that their inclusion would simply add support to the argument that project benefits outweigh project costs.

It is important to note that some of the recreational benefits included in the analysis are based on the assumption that, with the proposed diversion plan, flows in the Highwood River would increase during the summer months, resulting in improved recreational quality. However, the Panel is not

prepared to approve the proposed Diversion Plan. Continuation of the existing operating guidelines means that flows in the Highwood River would not change, so there would be no impact on recreation to anglers or boaters on the Highwood River, or on angling guides on the lower Bow River. Thus, project benefits as described in the benefit-cost analysis are overstated but, the relatively small size of these recreational benefits would not significantly affect the results of the overall benefit-cost analysis.

The benefit-cost analysis also includes some possible benefits and costs associated with the development of a cottage subdivision on the Little Bow River Reservoir. Development of this subdivision would cost $320,000 and would occur in the fifth, seventh and ninth year after project commencement. This estimate is based on development costs of $4,000 per lot for each of 80, one-acre lots. The lots are assumed to sell for $10,000 each, at a rate of 16 lots per year starting the year after construction has been completed.

The benefit-cost analysis considered other costs and benefits related to economic stability, flood control, domestic and municipal water security, water quality, and impacts to the local road network and travel costs. However, APWSS expected these impacts would be relatively small or would cancel each other out, so they were not quantified in the analysis.

At the hearing, the Little Bow Basin Water Users Association made an attempt to quantify the potential benefits of the project in terms of municipal water supplies. They argued that, without the project, the cost for regional communities to obtain a secure supply of good quality water from another source (Travers Reservoir) would be about $6 million. However, with no details of the actual costs that municipalities would incur to develop new water supply systems based on water from the Little Bow River Reservoir, it was impossible to quantify the net benefits of the project in terms of municipal water supplies.

7.1.5 Results

According to APWSS, the results of the benefit-cost analysis indicate that the proposed project represents an economically viable use of public funds. Based on the use of a seven per cent discount rate, the project would have a net present value of -$5.08 million and a benefit-cost ratio of 0.92. The various project benefits and costs used in the analysis are summarized in Table 7.1.

The analysis suggests that, for the selected discount rate of 7 per cent, the quantifiable benefits and costs are nearly equal. The selection of a lower discount rate, such as 4 per cent, would place a greater emphasis on future benefits and, under this assumption, the project would yield net benefits in excess of $24 million and benefits would outweigh costs by a factor of 1.26 to 1. The internal rate of return for the project is estimated to be 6.2 per cent. This represents the break-even point where benefits equal costs. Since this rate of return is equal to or greater than the long-term yields on other types of public investments, APWSS concluded that the project is a reasonable investment for Alberta.

APWSS undertook a range of sensitivity analyses using different assumptions for some major factors. In none of these scenarios did the rate of return drop much below 5 per cent. This further supported their conclusion that the project is economically efficient.

TABLE 7.1
SUMMARY OF PROJECT BENEFITS AND COSTS
(THOUSANDS 1992$)

	Undiscounted Values	Present Value @ 7%	Present Value @ 4%	Present Value @ 10 %
Project Capital Costs	$33,992	$26,826	$27,616	$24,909
- Residual value	19,300			
- Net capital cost	14,692			
Project Operating Costs	9,076	1,933	3,353	1,252
Lost agricultural production	3,148	733	1,217	497
Irrigation				
- Infrastructure	30,453	11,210	15,926	8,539
- Other capital costs	15,695	6,550	8,754	5,257
- On farm irrigation	25,496	4,394	8,414	2,578
- Other operating costs	75,899	13,210	25,182	7,781
- Revenues (income)	305,904	53,115	101,362	31,252
Recreation Benefits	42,093	6,659	13,133	3,815
Net Present Value		-$5,082	$24,034	-$15,745
Benefit-Cost Ratio		0.92	1.26	0.70

During questioning, APWSS's expert indicated that discount rates on the order of 6 to 8 per cent were more likely estimates of the social opportunity cost of capital than the extremes of 4 per cent and 10 per cent. However, he also confirmed that, if a longer time frame were to be used to assess the economic viability of the project, the use of lower discount rates is warranted. In their evidence to the Panel, the Fisheries Coalition supported the use of a discount rate of less than 7 per cent. They argued that lower rates are acceptable for public sector projects and, at the present time, interest rates are near historic low levels. Use of lower discount rates would make the project more economically efficient and socially desirable than is suggested by the analysis presented by APWSS.

7.2 Economic Impact

APWSS also presented the results of an economic impact assessment, which examined how project construction and operation will affect regional and provincial employment and income.

7.2.1 Methodology

Typically, construction and operation of a project will provide some direct income and employment impacts. However, total economic impacts are usually larger due to the effects of economic spin-offs. Indirect employment and income is generated in those industries that supply goods and

services needed for project construction and operation. In addition, some induced employment and income impacts occur when people who are directly or indirectly affected by the project spend their incomes on various goods and services. Thus, total economic impacts are usually estimated as some multiple of the direct employment and income associated with a new project.

For the Little Bow Project, the extent of provincial economic impacts was determined using multipliers from the 1984 Provincial Input-Output Tables prepared by Alberta Treasury. To estimate direct and total economic impacts, these multipliers were applied to the total costs of project construction and operations and to the total value of new agricultural production. Estimates of regional effects were calculated by making assumptions about the extent of construction and agricultural activity generated locally and then applying the provincial multipliers. This approach is known to overstate the extent of regional impacts. The region used in the analysis comprises parts of Census Divisions 3, 5 and 6 which, in 1991, had a population of 19,050 people.

At the hearing it was noted that Alberta Treasury had produced a more recent set of provincial economic multipliers for 1991. Although the inter-relationships among economic sectors are known to change with time, the rate of change tends to be slow. For the agricultural sector, however, economic multipliers were found to have decreased by 28 per cent from 1986 to 1991. As a result, the predicted provincial economic impacts would have been significantly less if the more recent 1991 multipliers had been used in the analysis. Regional economic impacts would also be less than predicted in the EIA.

7.2.2 Provincial Economic Impacts

Implementation of the project and the related agricultural expansion are predicted to produce $423 million (1992$) in terms of Alberta Gross Domestic Product (GDP) over the life of the project. The majority of this (87 per cent) would result from increased agricultural activity, while the remainder is associated with project construction. Irrigation expansion resulting from the project is predicted to contribute a total of $357 million toward Alberta GDP over the life of the project. This suggests an annual impact of about $7 million.

Project construction would directly create the equivalent of 187 work-years of employment, and 633 work-years of indirect and induced employment. Irrigation equipment purchase and start-up would generate 1,580 work years of employment. Project operation and increased agricultural activity would then generate 8,929 work-years of employment over the life of the project. This is equivalent to creating about 210 full-time jobs for the 50-year life of the project.

7.2.3 Regional Economic Impacts

APWSS predicts that about two-thirds of provincial GDP impacts would be experienced in the local area. This amounts to $279 million over the life of the project. They estimate that, during project construction, $12.3 million would be spent locally; this represents 31 per cent of total project costs. APWSS noted that they undertake various initiatives to maximize Alberta content for labour and supplies during project construction and to provide opportunities for regional contractors. They predict that residents of the local area would account for 84 of 187 work-years of direct employment or 45 per cent of the total. This workforce would be housed in one or more of the nearby towns rather than in a construction camp.

Once the project is operating and irrigation expansion has been fully achieved, APWSS predicts that some $264 million in economic activity (measured in terms of provincial GDP) would occur in the region over the life of the project. This represents 80 per cent of the predicted impact on total provincial GDP. The corresponding employment impacts would amount to 7,151 work-years or the equivalent of 145 full-time jobs. Actual operations of the project dams and canals would require the equivalent of 1½ full-time jobs. APWSS did not indicate what proportion of these new jobs would be filled by local residents or to what extent these employment opportunities would attract new workers and their families to the region.

Many interveners commented on the economic impacts that project implementation would generate for the region. According to the County of Vulcan Economic Development, a major impact would be the direct employment of regional residents on dam construction and operation. In addition, the project would give the municipalities the water supplies they need to attract industry and provide higher quality water for local residents. With an improved road system and new water storage reservoirs, regional tourism opportunities would expand. More reliable water supplies would also help stabilize farm incomes and provide new opportunities for diversification and intensification. These types of impacts are not captured in the economic impact assessment prepared by APWSS.

Interveners also noted that the region currently has a fairly small population base, and most young people are leaving the area in order to find work. The rural population is declining and, while the urban population has been fairly stable, the loss or gain of one or two families can have a large effect. There are concerns about whether current education and medical services can be maintained if the population decreases. With development of the project, the potential addition of up to 140 full-time jobs in the region is seen as means of creating some economic growth for the region, stabilizing community services, and providing a reason for young people not to leave their community.

7.3 Panel Views on the Economics of the Project

The economic analyses submitted by APWSS provide a useful starting point for the Panel to assess whether, from the perspective of its economic effects, the project is in the public interest. Benefit-cost analysis and economic impact assessments are recognized evaluation tools that have evolved to help decision-makers assess the economic efficiency of a proposed public investment and understand the distribution of project benefits and costs. However, these evaluation tools only describe some of the economic effects that the Panel must consider when establishing the public interest. Furthermore, each of these evaluation tools requires the use of various assumptions that must be critically examined to ensure that the resulting estimates of project benefits and costs have been measured appropriately and accurately.

In terms of the benefit-cost analysis, the Panel recognizes that the analysis presented by APWSS does not provide a complete analysis of project benefits or costs. Although the project is characterized as a multi-purpose water project, only benefits associated with irrigation expansion and, to a lesser extent, recreation have been incorporated into the economic analysis. The EIA provides a much longer list of project benefits: more secure municipal water supplies, improved municipal and domestic water quality, improved domestic and agricultural water supplies, improved security of water supplies to existing irrigators, restoration of fish and wildlife habitat, and improved water quality and instream flows in the Highwood River. While these benefits are described qualitatively in the EIA, their exclusion from the benefit-cost analysis suggests that the true benefits of the project have been understated. The Panel recognizes the difficulties in quantifying these benefits in dollar terms. However, during the hearings, the Panel heard ample evidence from various interveners that the lack of secure supplies of reasonable quality water in the region represents a significant constraint to economic development, environmental protection, and quality of life in the region.

The Panel also believes there are other reasons why the evidence provided by APWSS understates the real economic benefits of the project. First, the Panel believes that, in the context of sustainable development, a greater emphasis should be placed on future benefits. Discount rates based on investment-based criteria may not adequately reflect recent changes in social and environmental policies that show increasing concern about impacts on future generations. The Panel supports the use of a lower discount rate since this will better incorporate longer-term benefits and costs in the analysis. The evidence provided by APWSS shows that, with a discount rate of 4 per cent (rather than 7 per cent), project benefits substantially outweigh project costs.

Second, the Panel believes that, because of an outdated description of the base case, some project benefits have been overlooked. During the hearing APWSS and various interveners provided evidence concerning uncertainty about the status and priority of water rights in the Little Bow River basin. In the absence of the project, legal action has been recently proposed as the only means of resolving this issue. The costs of undertaking legal actions can be considerable for both private citizens and government. Since development of the project would obviate the need to this action, the resulting avoidance of legal costs can be considered as a benefit of project implementation.

Third, the Panel believes that the benefit-cost analysis, which reflects market conditions during the early 1990s, does not capture some of the irrigation benefits that would result because of recent changes in agricultural markets and provincial agricultural policies. In the analysis presented in the EIA, it was assumed that irrigation farmers would choose to sell their hay rather than use it as feed for expanded livestock populations. This is inconsistent with evidence provided by some of the potential beneficiaries of irrigation expansion who are intending to expand their livestock in keeping with recent market opportunities and provincial agricultural policies supporting livestock intensification. Given these current market conditions, estimation of project benefits on the basis of an integrated livestock grain operation, as was done in analyzing the benefits of Pine Coulee, would seem appropriate and could yield even larger project benefits.

While the Panel is concerned that these three types of benefits were not addressed in the benefit cost analysis, it is also aware that some costs have not been included in the analysis. For example, during the hearing, APWSS agreed that they would pay the costs of relocating the water intake for the Town of Vulcan. This cost was estimated to be about $1 million but was not included in the cost of the project.

Of greater concern, however, is that the full cost of land acquisition - some $ 12.4 million - is not included in the benefit-cost analysis. The analysis does include a cost for the value of agricultural production that could be sustained on land that would be flooded, but this is substantially less than the estimated land acquisition costs. APWSS argued that the real value of agricultural land is captured in its price, which should reflect the net present value of future agricultural production on that land. They noted that undertaking projects of this type tends to raise land prices, even though there has been no change in the agricultural productivity of that land. They therefore concluded that land costs are correctly valued in terms of the value of agricultural production.

An alternative view is that the price at which a farmer is willing to relinquish a specific piece of land for a government project reflects more than just land productivity. In giving up this land, a farmer will also expect compensation for impacts on the welfare of his family and the continued viability of his farming operation. The amount of compensation demanded could reflect impacts on the landowner's well-being as a result of having to sever family or emotional ties to a specific piece of land, find replacement agricultural land at some other location and incur higher costs to work that land, or give up the farm lifestyle. The land purchaser may also be prepared to pay more than market value in order to

maintain good relations with the community or to secure a willing transaction that avoids costs that would arise if lands were acquired through expropriation instead.

Since benefit-cost analysis is supposed to consider total changes in social welfare that would result from the project, the Panel believes that land acquisition costs are the better measure of project impacts on land and landowners. As a result, the benefit-cost analysis should reflect an estimated capital and associated social cost of about $48.6 million[3] rather than $36.1 million. According to APWSS, use of the higher number would reduce the internal rate of return on the project by about 1.1 percentage points. However, the resulting 5.1 per cent internal rate or return would still be above the minimum rate considered reasonable for public investments.

The Panel's decision not to approve the proposed Highwood Diversion Plan also has some implications for the interpretation of the Applicant's benefit-cost analysis. As noted above, construction of the project while maintaining the current operating regime would not change the flow regime in the Highwood River. As a result, neither the quantifiable nor non-quantifiable benefits of attaining improved flows in the Highwood River can be attributed to the project, so the estimates of the recreational benefits described in Table 7.1 are slightly overstated. At the same time, interveners indicated that implementation of the proposed diversion plan would have imposed costs on some irrigators located on the lower Highwood River and upstream of new storage on the Little Bow River and Mosquito Creek. Although APWSS considered such costs too small to quantify, the debate over the real significance of these costs has become irrelevant at this time because the Panel is choosing not to approve the proposed diversion plan.

Despite concerns about the extent to which some project benefits and costs were adequately quantified in the economic evaluation, the Panel concludes that, on balance, project benefits will exceed costs. The Panel heard abundant evidence from both APWSS and most interveners that the construction of the three-component project will create the water supply conditions necessary to stabilize and expand economic and social development in the region. Construction of the project will provide some employment opportunities for regional residents. More importantly, project operations and the resulting irrigation expansion will directly and indirectly lead to a significant increase in regional employment and economic activity. The Panel notes that the re-establishment of Clear Lake and the new Little Bow River reservoir will provide new recreational opportunities that will further enhance the quality of life in the region, and become a regional tourist attraction.

As noted earlier, the Panel's conclusions concerning the economic effects of the project relate to its responsibility for determining whether the proposed project is in the public interest. A conclusion that the project is in the public interest does not commit the Government of Alberta to actually investing public funds in the project. Should the Panel determine that a project is in the public interest, it remains the responsibility of the Government of Alberta to actually decide whether an investment of public funds is warranted.

3 Total capital costs of $52.3 million less sunk costs of $3.7 million.

8. SUMMARY AND CONCLUSIONS

8.1 The Proposed Little Bow Project/Highwood Diversion Plan

The proposed Little Bow Project/Highwood Diversion Plan is the first project reviewed by a Joint Review Panel under the *Canadian Environmental Assessment Act* and the *NRCB Act*, and the second Joint Review Panel involving the NRCB.

Alberta Public Works, Supply and Services (APWSS or the Applicant) requests approval to construct a water management project (the Project) to convey and store water diverted from the Highwood River, consisting of four interrelated components.

First, the construction of a canal and diversion works in the Town of High River and in the Municipal District of Foothills No. 31. This proposed $6.2 million component would triple the capacity of the existing diversion and canal to allow more water to be diverted from the Highwood River to the Little Bow River during peak flows.

Second, the construction of the Little Bow River dam and reservoir in the Municipal District of Willow Creek No. 26 and in the County of Vulcan No. 2, approximately 20 km (12 mi) west of Champion. The proposed $38.8 million dam would be 25 m (82 ft) high and create a reservoir that would hold 61,675 dam3 (50,000 ac-ft) of water. It would be filled from the natural runoff in the Little Bow River basin and water diverted from the Highwood River.

Third, the construction of the proposed $5.1 million Clear Lake diversion and canal in the Municipal District of Willow Creek, about 15 km (9 mi) east of the Town of Stavely. The 10 km (6 mi) long canal would allow the lake and 12 wetlands along the route to be filled when flows in Mosquito Creek are high.

Fourth, the proposed $7.1 million enlargement of the existing Squaw Coulee Reservoir in the Municipal District of Foothills No. 31 from 361 dam3 (293 ac-ft) to 6,283 dam3 (5,175 ac-ft) by constructing upper and lower dams and a return canal to the Highwood River.

From time to time, the Panel will refer to the first three components as the three-component project.

APWSS identified the following multi-purpose objectives for the Little Bow/Highwood project:

- reduce diversions from the Highwood River during critical summer periods improving water quality and instream flows to benefit fish and recreation in the lower Highwood River;
- secure water supplies for Vulcan, Carmangay, and three water co-operatives;
- give Champion an alternative or second water source which would provide a year round supply and lower pumping costs;

- reduce turbidity in the raw water supply for Vulcan, Carmangay and three water co-operatives and reduce treatment costs; improve domestic and stock water supply for users along Mosquito Creek, the Little Bow River and around Clear Lake;

- secure water supplies for 4,660 ha (11,500 acres) of existing irrigated farming and for 8,100 ha (20,000 acres) of additional irrigation; and

- restore and stabilize levels in Clear Lake and nearby wetlands for recreation and fish and wildlife habitat.

APWSS also stated that the project reflects the principles established by the Alberta Water Resources Commission for water management in the South Saskatchewan River basin in 1986 as it would:

- use water to stabilize and maximize agricultural economies while sustaining natural resources;

- support the multi-purpose use concept;

- secure domestic water supplies;

- enhance the use of water resources, fish and wildlife habitat, and recreation needs;

- allow irrigation development which in turn would help stabilize the agricultural community and lead to improved economic and social well-being for residents of the region;

- use water storage and flow regulation to stabilize variable water supplies; and

- sustain the integrity of the Highwood River ecosystem by improving instream flows during critical water supply periods.

The Applicant filed an Application, including the EIA Report, with the Natural Resources Conservation Board (NRCB or the Board) on May 7, 1996, to obtain approval for the Project under Section 5(l) of the *NRCB Act*. In addition to submitting an Application to the NRCB, the Applicant also applied to Fisheries and Oceans Canada on May 9, 1996 under Section 5(1) of the *Navigable Waters Protection Act* for approval of three individual water management components of the project comprising the proposed Little Bow Project/Highwood Diversion Plan, and the fourth involving the Squaw Coulee component. On August 19, 1996 the Applicant also applied to Fisheries and Oceans Canada under Section 35(2) of the *Fisheries Act* for authorization to construct works affecting fish habitat associated with the project.

The public hearings by the Joint Review Panel were held on 19 days during the period extending from November 12, 1997 to January 9, 1998 in Vulcan and High River, Alberta. Submissions to the Panel touched on all facets of the proposed development and contained a wide range of views and extensive supporting information. This information is available for review at the NRCB Office.

8.2 Project Need and Justification

The Panel has considered the reasons for the proposed project provided by the Applicant as well as the views of the participants. The Panel accepts that water management action is required for the Highwood, Little Bow, and Mosquito Creek basins. There is a need to protect the instream flow requirements of the Highwood River, particularly downstream of the proposed diversion works on the Highwood River, from the perspective of both water quantity and quality. The Panel also accepts that there is a need to provide increased security of supply for existing municipal, domestic, livestock and irrigation water users. There is strong local support to restore and stabilize Clear Lake. There is also need to accommodate irrigation expansion.

The Panel has considered the reasonable alternatives to the proposed project. The Panel is satisfied that the water management options within the Little Bow basin and at Clear Lake have been appropriately examined through a public planning process that included consideration of both structural and non-structural alternatives to meet the needs of the basin residents. The Panel particularly notes that many local participants directly affected by the proposed three-component project were in agreement that those components would be preferable to other water management options that have been considered. The Panel also notes that alternative locations for the proposed three-component project and a variety of within-project options have also been examined through a process involving the public and is satisfied that the relevant options have been considered. The Panel is satisfied that the Applicant has the ability to implement the three-component project. Alternatives to the development of the Squaw Coulee component of the project have been considered in a manner that is less thorough. The Panel is not satisfied that the Squaw Coulee component has received adequate attention by the Applicant.

The Panel acknowledges that the matter of the economic viability of the proposed three-component project is not a major issue among participants. Economic viability is one of a number of factors that the Panel believes it should have regard for and a quantitative economic analysis must be considered along with non-quantifiable, qualitative and non-economic variables. The Panel has also noted that the decision to proceed with the financing of a proposed project that might receive an approval from the NRCB, is a separate and independent decision that would be made by the Government of Alberta. There are no plans for any capital investment by the Government of Canada in the proposed project.

The Panel recognizes the fundamental role that water plays in sustainable development and the quality of life of all people, including the many uses of water in human settlements and the environment. The Panel believes the conflicts, demands and competition for the equitable sharing of available water supplies is increasing with increasing population, agricultural production, industrial development, and concern for the environment. In areas such as the Highwood, Little Bow, and lower Mosquito Creek basins that have limited or variable water resources with consequent water shortages, the Panel believes it is important to have comprehensive management strategies and procedures to determine, and at times to adjudicate on, the allocation or sharing of these limited water resources. The Panel believes that sustainable development in the Highwood, Little Bow, and lower Mosquito Creek basins is possible with the development of water storage facilities. The Highwood, Little Bow, and lower Mosquito Creek basins, with their extremely variable flows, are basins in which comprehensive water management strategies and procedures can be applied to achieve sustainable development based on multi-purpose water management objectives.

8.3 Cumulative Effects Assessment

Cumulative effects assessment is required under Canada and Alberta legislation. The Panel agrees that it is important to address developments in terms of the baseline socio-economic and ecosystem conditions found within the basins, as well as the additional effects a project would have on existing conditions. The Board believes that the sustainability of ecosystems over time is the proper frame of reference when assessing environmental impacts. Sustainable development is recognized as a purpose of the *Alberta Environmental Protection and Enhancement Act*. The Panel believes it appropriate to determine the public interest with the assistance of the framework of sustainable development. An ideal development would be one that brings long-term social and economic benefits and has a beneficial or neutral effect on the environment. Developments can be planned and operated to minimize adverse impacts on the environment. However, where adverse effects on the environment are likely, the Panel believes social or economic benefits should be weighed and balanced with them.

The Panel has had regard for the sustainability of the riverine ecological resources in the Highwood, Little Bow, and lower Mosquito Creek basins, taking into consideration existing and future use of those and related resources.

The proposed development must be considered within the river basins on an ecosystem basis. The Panel also believes that the individuals and communities that depend on the water in the basins would be potentially affected by the proposed development, and their social and economic needs must also be considered in determining the public interest.

The NRCB has recognized in its past decision reports that in order to determine the public interest, it must consider a project in the context of the region in which the project would be located and the cumulative effects which the project may have in the region. Because societies, economies and ecosystems incorporate many components that are inter-related in a complex manner, the potential social, economic and environmental effects of projects cannot be understood by considering only the effects of the projects on the immediate locale. Projects can have a wider impact and must be considered in light of the "baseline" or background condition of the society, economy and environment of the regions in which projects could have significant effects.

In the case of the proposed project, the Panel found it impossible to consider the overall effects without considering, within the context of the South Saskatchewan River basin, the overall management of water in the Highwood, Little Bow, and lower Mosquito Creek basins. The Panel has had particular regard for the state of the aquatic environment in the basins.

The Panel emphasizes the links between the state of the environment, long-term economic viability and welfare of society. For example, the Panel heard from many participants as to the value of water to the regional economy and the potential contribution of the project to the development of sustainable ecosystems, communities, and agriculture. The Panel heard that the potential exists for both continuing economic benefits from the proposed project and long-term social benefits of stable rural and urban communities in particular, but that the potential would not be realized without effective management of the water resources of the basins. The Panel also heard about potential negative social impacts on some basin residents and aboriginal people. These matters provided part of the basis for the overall conclusions reached by the Panel in determining whether the project is in the public interest.

The sustainability of the riverine ecological resources of the Highwood River basin has been expressed in the Application in terms of the concept of instream flow needs, which in turn is used as

a framework for the diversion plans set forth in the Application. The Panel considered both the basis for the diversion plans, and the plans themselves, before examining the effects of the proposed project.

8.4 Sustainable Development Principles

The concept of sustainable development has been described as the use of resources and the environment today that does not impair prospects for their use by future generations.

In applying a sustainable development framework to the project, the Panel must determine whether a proposed project is in the public interest, having regard for the social, economic, and environmental effects. Ideally, social, economic and environmental effects complement each other rather than conflict in sustainable resource development projects.

The Panel adopted a sustainable development frame of reference for the consideration of the proposed project based on a few key principles that are strongly supported by most residents of the basins.

First, water management projects must respect existing riparian rights and water licenses, and should not result in the loss or injury to existing water rights.

Second, water management projects must be able to meet basic environmental criteria to avoid significant adverse effects.

Third, water management projects must be able to meet current and future needs for domestic, riparian, and municipal needs, and other consumptive uses.

These environmental, social, and economic considerations are basic to the determination of the public interest. A project must be able to meet these three criteria to be worthy of detailed consideration by the Panel with respect to project effects.

The community places a very high priority on meeting current and future consumptive needs for water, with special priority on meeting the need for reliable and high quality drinking water. Similarly, basin residents place a very high priority on the social and economic importance of respecting and maintaining water rights. In using IFN as an environmental criterion, the Panel recognizes that this is only one variable or indicator of riverine ecosystem health. Fish and people both require clean water, and water suitable for cold-water fish is also suitable as a source of water for domestic, municipal, and other uses. IFN is used as a key indicator because the Panel believes that other quality indicators are intrinsically met within the scope of meeting the IFN, and because it reflects the value placed by basin residents and government policy on having a viable fish population.

8.5 Instream Flow Needs

In most cases, flow regulation, storage and diversions are proposed to provide additional opportunities for beneficial use of water over and above the basic requirement of environmental protection and meeting existing allocations of water. In the current circumstances in the Highwood, Little Bow, and lower Mosquito Creek basins, where there are highly variable flows and demands that far exceed supply during low flow conditions, the Panel finds that the concept of instream flow needs (IFN)

takes on a slightly different meaning. In essence, the IFN proposed for the Highwood basin can be considered in the context of overcoming pre-existing deficits of water and determining whether additional water allocations for other purposes can be accommodated.

The Panel has examined the degree to which the preliminary IFN and the proposed instream flow objective (IFO) for the Highwood River meet the broad policy criteria established for the South Saskatchewan River basin.

Under the current *South Saskatchewan River Basin Water Management Policy*, regulated streams are to be managed so that the instream flows drop to minimum levels only for short periods of time under drought conditions. The Panel believes that the existing situation in the lower Highwood River below the diversion to the upper Little Bow River may not conform to this policy during low flow conditions when the current diversion operating guidelines are applied. Under such conditions, Highwood River flows may be far less than the minimum instream flow needs when licensed water withdrawals take place. The Policy does not contemplate instream flows dropping below *minimum* instream requirements and it provides no guidance in this regard. Instream Flow Needs were developed for the Highwood River in response to this government policy. The process used to develop the criteria for the protection of the aquatic environment of the Highwood River was called the Highwood River IFN Study.

The Panel emphasizes the realities of the existing flow conditions in the basin. In that context, the instream flow needs that are identified in the Application indicate that a significant improvement over the existing circumstances is needed. The Panel believes that a relatively high level of environmental protection would be achieved if a science-based IFN were to be attained. It believes the work done in this regard serves to advance overall management of water in the Highwood basin.

8.6 Water Management

Flows in the Highwood River are typical of east slope rivers and creeks with mountain headwaters. There is considerable seasonal variability in flows as a result of a large spring freshet caused by snowmelt in the headwater areas. Only a small portion of the Little Bow River basin is located in the foothills region while the balance of the basin is situated in the prairies and receives less annual precipitation. As a result, flows from the Little Bow River and its major tributary, Mosquito Creek, are equivalent to less than 10 per cent of the flow of the Highwood River. Due to its size and location, the Little Bow River does not exhibit the same pattern of seasonal variations in annual flows that are characteristic of mountain-fed rivers like the Highwood. Mosquito Creek is the primary contributor to flow in the lower Little Bow River.

The high variability of flows in the Highwood and Little Bow rivers has had a significant impact on the development of the two basins. Attempts to manage water through human intervention have been a consistent theme since before the turn of the century, and continue to be a focal point of community action today. The current Application and the recent floods at High River are examples of this ongoing focus of attention. The recurring floods and droughts have been a constant reminder of the basic hydrological and climatic characteristics of the basins.

In these drought prone basins, water is a critical element in the development of the area and vital to the residents and the stability of the communities. The socio-economic fabric of the area depends on the water licences that authorise and provide legal protection to various water uses. A total of 183 licences for water use have been issued in the Highwood and Little Bow basins for domestic, municipal, agricultural, industrial, irrigation, and other purposes.

The Government of Alberta has played a central role in the development and management of the water resources in the two basins. Alberta Environmental Protection (AEP) is the government department responsible for licensing water diversions. AEP is also the holder of the major water licences in the basin, and controls the diversions from the Highwood to the Little Bow through diversion works into Squaw Coulee and at High River. Demand for water has increased dramatically over the past two decades, primarily as a result of water licences being issued in the past by AEP for the expansion of irrigation. Current growth and potential future growth related to industrial and domestic demand will continue to impact water quality. Due to climatic and hydrologic characteristics of the basins, the water available during drought or low flow conditions has limited growth in irrigation and placed a cap on development that is dependent on intensive use of water. The Highwood/Little Bow basins are among the few basins in Alberta where a water licence moratorium has been in effect over a long period of time.

8.6.1 Diversion Policies

Water is vital to the communities within the basin, and during low flow, the stability of water supply becomes a critical issue. Diversions from the Highwood River play a key role in the supply of water to the Little Bow basin, and have a major influence on the condition of the Highwood River since at low flows diversions can constitute a major fraction of the available supply. The policies governing the operation of the diversion works controlled by AEP have been a focal point for attention of the communities that depend upon the water in or from the Highwood River. New information has developed about the environmental requirements of the Highwood River, along with changing public attitudes about sustainable resource management. At the same time there has been increasing pressure to accommodate expansion of irrigated agriculture, residential and industrial developments in the basin.

The policies governing the operation of the diversion works have been referred to as the Diversion Operating Guidelines. The diversion works from the Highwood River are some of the most intensively managed diversion facilities in Alberta. The Diversion Operating Guidelines have evolved and changed over the years as circumstances and knowledge changed. However, one compelling fact remains regardless of the changes that have occurred in the guidelines. Water is in short supply during hot and dry summer months in some years, and the demands on available supply outstrip the water that is available. Attempts to manage the scarce resource among competing demands have not met and can not meet all demands. At times there is just not enough water.

It is important to keep in mind that the licences governing the diversion of water from the Highwood River to the Little Bow basin place an upper limit on the amount of water that can be diverted from the Highwood River. Policies adopted by AEP, as the operator of the diversion works, restrict diversion to amounts less than those legally authorized during low flows. The policy is intended to provide protection to the lower Highwood River and to ensure a minimum diversion for downstream purposes in the Little Bow basin.

8.6.2 Degradation of World-Class Bow River Fishery Habitat

The Highwood River supports one of the best fisheries in Alberta. The upper Highwood and Sheep river systems provide an estimated 90 per cent of the available spawning and rearing areas for Bow River rainbow trout. The world-class Bow River trout fishery depends on maintaining a suitable

habitat in these systems. The Highwood River also supports a healthy resident population of mountain whitefish, which is a favourite species for local anglers. Other sport species include bull trout, cutthroat trout, and brook trout, which are known to inhabit primarily the upper reaches of these rivers.

The Highwood River also supplies water for many uses including domestic, municipal, industrial and agricultural. The major consumptive use is for irrigation water. Two diversion canals carry water from the Highwood River to the Little Bow River basin.

During the summer months, heavy irrigation demands often deplete the flow in the river to the point where fish habitat conditions below the town of High River deteriorate to an unacceptable level. The removal of water from a river to the point that habitat is severely reduced constitutes the destruction of fish habitat. The Government of Canada has responsibility for the protection of fish habitat and has established policies in this regard referred to as the Policy for the Management of Fish Habitat. Legislative authority for this policy is found in the *Fisheries Act* (Canada). Specifically, Section 35(1) states the following: "No person shall carry on any work or undertaking that results in the harmful alteration, disruption, or destruction of fish habitat."

The Applicant has acknowledged that historic water management activities during the open-water season on the Highwood River have had a major adverse effect on fish habitat. In the opinion of the Panel, water management practices that lead to such significant adverse environmental effects are inconsistent with the intent of the Policy for the Management of Fish Habitat and the principle of sustainable development. Current water management practices that enable water withdrawals and diversions under low flow circumstances can not be considered to be sustainable if they result in major habitat changes that constitute the harmful alteration, disruption, or destruction of fish habitat. The Joint Review Panel has serious concerns about the existing situation regarding the management of fish habitat in the Highwood River, and does not believe it should be considered acceptable to allow the current practices to be carried forward into the future. In short, current water management practices in the Highwood River appear to be inconsistent with the federal *Fisheries Act* and the Policy for the Management of Fish Habitat. The practices are also inconsistent with provincial policies.

To meet basic human needs for water for consumption, and other social and economic needs that provide the basis for the current way of life for basin residents, water has been allocated and licensed for various purposes. It is clear now, and it has been recognized for some time, that the licensed use of water in the Highwood basin is inconsistent with sound resource management practices and is not protective of fish habitat in a stream that is essential to support a world-class sport fishery. Understanding the current status of the water resource provides the basis for considering the complex problems faced in managing the resource in the face of competing demands.

8.6.3 Over-Allocation in Droughts

The Panel notes that the Highwood River has been the subject of public concern regarding water allocation and management since at least the early 1980's. Water quality concerns associated with the Town of High River treated sewage discharge, fish kills and demands for irrigation have been central issues. Recently, outflows from Frank Lake into the Little Bow basin have been of concern to the people in the upper Little Bow River. The Highwood River has been the subject of intensive examination and study during much of the past two decades. Unfortunately, the management of the Highwood River has proceeded without the benefit of an overall management plan, without the benefit of an approved set of management objectives, and without the benefit of a clear understanding of how current and future demands will be managed. The Panel concludes that the circumstances found

within the basin require that a comprehensive and integrative perspective be adopted to achieve sustainable development.

The Panel also concludes it is important to focus upon the circumstances when more extreme events occur, while keeping in mind the typical situation found within the basins where water supply is adequate for now. The Panel is aware that flooding does occur in the basin and it heard evidence regarding the recent flood on the Highwood River in 1995.

In the context of the Application before the Panel, the state that is of particular interest is low flows and flows associated with droughts, when water is in short supply and demands are accentuated for consumptive and environment requirements.

During low flows, the Panel believes that the existing licence commitments can not be met, and under the priority system, some users would experience serious deficits and social and economic hardships. In extreme cases, even domestic and municipal water requirements could be placed at some risk. This is evident from the deficits predicted by the AEP water prediction model for low flow years.

The licence commitments, when combined with AEP's operating guidelines, do not provide for the IFN to be met. Under low flow conditions the IFN essentially requires all of the natural flow. If flows in the Highwood in a very dry year were 3.96 cms (140 cfs), the flow below the diversions could be less than 1.42 cms (50 cfs), leaving a very substantial IFN deficit of 2.55 cms (90 cfs) which is 64.3 per cent short of the IFN. Such major deficits to the IFN at a critical period would occur even with the protection provided by the 1994 Operating Guidelines constraining AEP licensed diversions to Squaw Coulee and the Little Bow River. Licences have been issued that legally entitle the water licence holder to divert water for various purposes. Meeting the IFN under low flows technically means that no water would be available for diversion for any purpose, including human consumption. Meeting basic domestic and human consumption requirements and other licence obligations makes it impossible to meet the minimum IFN requirements under the *South Saskatchewan River Basin Water Management Policy*. The Panel believes that failure to meet the IFN is not acceptable in the context of sustainable development or the *Fisheries Act*. It also believes that meeting basic human consumption needs is essential. The two ought not to be played off against each other.

Past resource allocations require current resource managers to meet basic human requirements for drinking water and to honour licensed water rights knowing that in doing so they are risking the habitat that supports a world class sport fishery. In the view of the Panel, the imposition of the moratorium on further licences by the Controller in 1977 and again in 1983 reflected a belated recognition that the resource had been over-allocated. Without the moratorium, the situation would have become even worse. Without remedial action in the basins, the Panel sees no possibility of lifting the moratorium. The Panel also adopts the view that the existing situation in the event of an extremely dry year is intolerable and does not reflect sound management of one of our most important resources.

The need to remediate the existing situation was recognised in 1990. After the Highwood River IFN Study was completed in 1991, the AE Planning Director sent a five-page progress report (the MacLock letter) on the IFN, Diversion Plan and EIA to all people who had attended previous meetings or expressed an interest in the Study. In the opinion of the Panel, the progress report is central to the understanding of the background leading to the current Application before the Panel and the issues raised during the hearing. MacLock, in his 1991 letter, highlighted the situation:

The analysis undertaken by the TSC and government staff indicated that because of the great variability of Highwood river flows over the course of a year and from one year to another, it is not possible, with existing management capability, to simultaneously meet the IFN in the lower Highwood and the demands of consumptive uses licensed to withdraw water from the river….. To alleviate these problems the TSC recommended the following supplemental measures:

1. the implementation of measures to reduce the water supply deficits of existing uses reliant on the Little Bow River or Mosquito Creek that are located above and thus not supplied from the proposed Little Bow River Reservoir, and,

2. the development of a plan for water management in the Highwood basin that would seek means to improve flow and quality conditions in the lower Highwood and reduce the water supply deficits of existing licensed irrigation uses.

The Panel believes that the two conditions contained in the MacLock letter were a clear and accurate expression of the public's views, and those views were repeated in the current hearings held by the Panel six years later. The Panel believes that these consistently articulated views from the community are the hallmarks of the basic project that the community expected and still expects to be developed. The Panel believes that steps need to be taken to remediate the existing situation, irrespective of the current Application. The Panel made the following observations regarding the MacLock letter:

1. The objectives clearly indicate that meeting the IFN and the needs of existing licensed water uses were considered requirements of TSC acceptance;

2. It was recognized that without storage within the Highwood River basin it was not possible to simultaneously meet the IFN in the lower Highwood, and the licensed demands for consumptive uses in the lower Highwood River and the upper Little Bow River;

3. The scenario to expand the existing management capability involved development of additional storage, which could occur through expansion of the previously developed Squaw Coulee Reservoir. While additional storage was seen by the various parties as being promising, the smaller amount of storage being considered at that time had the capacity to meet only identified IFN requirements. At that time, the storage proposed to be developed through the expansion of Squaw Coulee would be unable to meet the other requirement of fulfilling existing licenced uses;

4. The smaller expansion of Squaw Coulee was not acceptable to all those involved, since it did not have the capacity to also meet existing licenced uses, which could have been met by a larger reservoir expansion;

5. Expansion of the Squaw Coulee required supplemental measures to improve flow and quality conditions in the lower Highwood and reduce the water supply deficits of existing licenced irrigation uses;

6. Perhaps most importantly, the precise nature of the supplemental measures that were required to make the diversion plan viable were not identified at that time, and were not brought forward by APWSS in the current Application; and,

7. Stakeholders anticipated that the Highwood River Basin Water Management Plan would be developed in short order.

The Panel characterises the current situation as unsustainable and potentially serious if we see a return of the severe drought conditions that have already been experienced. Conditions may even be more severe in the future. In very dry years when August flows of 3.96 cms (140 cfs) or less would be experienced in the Highwood River, the basic criteria of sustainable resource management are not met. The current circumstances in the Highwood basin stand as an example of what can happen when a resource is over-allocated.

In the Panel's opinion, the subsequent attempts to resolve the water shortages that inherently involved trade-offs between criteria that cannot and should not be compromised, were fundamentally flawed. Specifically, the Panel does not believe that it is appropriate to attempt to trade-off water rights protected in laws and provincial policies, domestic and municipal water requirements, and IFN supported by federal laws.

8.6.4 The Proposed Diversion Plans

The Highwood/Little Bow Project has multi-purpose objectives. To accomplish the multi-purpose objectives, specific diversion plans were prepared for the project. The Diversion Plan is based on the predicted preliminary IFN, and the Expanded Diversion Plan was identified to alleviate predicted IFN deficits modelled in the examination of the Diversion Plan.

APWSS used two general criteria to evaluate the effectiveness of proposed diversion plans in meeting water demands in the two river basins. One criterion was the size of deficits to irrigation demands, while the other was the ability of the diversion plan to meet instream flow objectives. A third criterion, namely deficits for municipal, industrial and agricultural demands, could have been used but such deficits seldom occurred because of the high priority assigned to these demands and their relatively small size. The ability of the system to provide conveyance flows could also have been used as an evaluation criterion. However based on the 0.28 cms (10 cfs) conveyance flows assumed in the model, and the high priority assigned to this use, these demands were always met under the Diversion Plan.

The frequency of major deficit events would increase substantially were the Diversion Plan to be implemented. Along the upper Little Bow River, irrigators would have experienced a three-fold increase in major drought events had the Diversion Plan been implemented. The incidence of deficits similar to those of 1977 or 1985 would at least double for irrigators in the lower Little Bow River or along Mosquito Creek. Deficits would be almost the norm in the Highwood basin where shortages greater than those in 1985 would have occurred in 38 of 39 years.

The Diversion Plan proposed by the Applicant does not meet the minimum, much less the preferred, Preliminary IFN used in the evaluation. If the evaluation had been based on the scientific criteria alone, instead of the Preliminary IFN, the results would have been even worse. The Expanded Squaw Coulee Reservoir was proposed to overcome these shortfalls in meeting the basic criteria of the IFN. The Expanded Diversion Plan is able to meet the minimum criteria successfully, but would not meet the requirements of a more stringent science-based IFN.

From the interveners' evidence for low flow conditions, the proposed Diversion Plan does not meet the basic project objectives since licence commitments are not met, flows in the Little Bow River are inadequate, and the Preliminary IFN for the Highwood River is not met. The proposed operating

plan does not respect existing license commitments, and those commitments, if fully exercised, would result in most of the water available during low flow being stripped from the Highwood and Little Bow rivers to meet consumptive uses. Both diversion plans represent an improvement of instream conditions in the Highwood River from the currently unacceptable situation, but the Diversion Plan would fail to meet even the minimum Preliminary IFN fairly frequently. Irrigation deficits projected under the proposed diversion plans are totally unacceptable to those affected. There is simply no support for a diversion plan that makes existing water users worse off as a result of the plan being implemented. All interveners rejected the concept of diversion plans that ignore the existing priority of water rights. Interveners also questioned the modelling interpretation that deficits were not serious since the model tended to overstate water use based on licensed diversion rates instead of actual use under water mastering conditions.

Most interveners expressed serious reservations about the proposed interim operating plan suggested by AEP and adopted by APWSS as a means of getting to the Diversion Plan and questioned whether this plan could actually work. Most felt that the interim operating plan implied a recognition that the Diversion Plan as proposed can not succeed. In short, interveners indicated their opinion that the proposed diversion plans wouldn't work and would not satisfy the project objectives stated by the Applicant.

The Panel concludes that the proposed Diversion Plan fails to remedy the current deficits and fails to meet future needs for water. It would not meet the basic criteria of sustainable development, since it would not meet existing licence commitments; it would not meet Preliminary IFN requirements; and it would not meet environmental and consumptive water quality requirements in the Little Bow basin. The proposed Expanded Diversion Plan does meet the minimum Preliminary IFN used in the analysis. However, it also does not meet the other basic criteria of a sustainable development, since it did not contemplate meeting existing license commitments, and it does not meet ecosystem and consumptive needs due to the poor water quality associated with low conveyance flows. The Panel finds serious concern with the Diversion Plan and the Expanded Diversion Plan. The Panel concludes that the Applicant's proposed diversion plans are not sustainable and could not remedy the problems that already exist.

8.6.5 Storage is Required in the Highwood Basin

There are very few alternatives to deal effectively with the demand for consumptive uses of water during low flows. Demand management is one option. Cancelling existing licence commitments and paying compensation, changing current agricultural management practices, and capping future population and agricultural growth and development in the basin would be possibilities. There is little or no support for these alternatives in the evidence.

In the context of sustainable development, the Panel concludes that there is a need for storage for the Highwood basin.

The Panel made the following comments regarding the potential role of the Expanded Squaw Coulee Reservoir project to meet this need for storage in the basin. The Panel believes that the first priority for consideration of storage is to remediate the current over-allocation of water during low flow. This implies that natural flows in the Highwood River would be maintained to meet IFN requirements, and that existing consumptive demands, ignoring any future demands, would be met from storage. In the view of the Panel, the consumptive demands within the upper Little Bow basin and in the Squaw Coulee/Mosquito Creek area probably require summer flows of at least 0.85 and 0.57 cms (30

and 20 cfs) respectively and preferably 1.13 to 0.85 cms (40 to 30 cfs). These flows should provide sufficient conveyance flows, provide adequate flows to yield good quality water, and meet domestic, municipal and licenced irrigation demands. Consumptive demands in the lower Highwood River include existing licenced users for domestic, agricultural and irrigation purposes. The proposed Expanded Squaw Coulee Reservoir project falls far short of having the capacity to meet these current demands. It can only meet the minimum Preliminary IFN used in the Application, if conveyance flows are reduced to 0.79 cms (28 cfs) for both the upper Little Bow and Mosquito Creek combined, and other licensed water uses incur various levels of deficit.

Due to the inherent limitations associated with the proposed diversion plans, there was interest in alternative diversion plans predicated on the development of storage for the Highwood basin. Attention focussed on the site of the existing Squaw Coulee Reservoir, but with a reservoir size that was larger than the proposed Expanded Squaw Coulee Reservoir. In its review of the Application and its Report of the Pre-Hearing Conference, the Panel directed the proponent to explore Squaw Coulee alternatives that could be viewed as sustainable development proposals predicated on compliance with instream flow needs, meeting licence requirements and conveyance flows, and meeting identified future demands for water.

8.6.6 Super Expanded Squaw Coulee Reservoir

APWSS produced model runs that showed that a Super Expanded Squaw Coulee Reservoir with a storage capacity of 16,208 dam^3 (13,140 ac-ft) would:

- eliminate all deficits to current and future irrigation,
- meet 100% Fish Rule Curve values at all times,
- provide a 0.28 cms (10 cfs) conveyance flow down the Little Bow River and Mosquito Creek at all times, and
- significantly augment flows in the Little Bow River and Mosquito Creek much of the time but not to reliably supply 0.85 cms (30 cfs) to these streams.

A further model run based on an IFN that includes the 80% Fish Rule Curve plus flow reservations for temperature and for flushing showed that a Super Expanded Squaw Coulee Reservoir with a storage capacity of 16,208 dam^3 (13,140 ac-ft) would:

- eliminate all deficits for municipal, industrial and domestic demands,
- meet all existing water licences,
- meet the 80% Fish Rule Curve,
- achieve improved Little Bow (mean deficit of 0.15 cms [5.2 cfs]) and Mosquito Creek (mean deficit of 0.07 cms [2.4 cfs]) instream flows, but still below 0.85 and 0.57 cms (30 and 20 cfs) targets respectively,
- show small deficits in irrigation expansion downstream of the Little Bow River Reservoir (0.46 per cent) and Clear Lake (2.85 per cent), and
- not support Highwood irrigation expansion since deficits would be on average 48.6 per cent.

Most interveners were uncomfortable with the process used by APWSS to involve the local public in the development and evaluation of the Expanded and Super Expanded Squaw Coulee Reservoir and associated works. However, by the end of the hearing there was a general consensus that

additional storage for the Highwood basin was needed to meet the 1991 commitments and to remove the acknowledged deficiencies from the current project proposal. There was also recognition that the Super Expanded Project seemed to have the capacity to fulfill all original project objectives.

Many interveners acknowledged their sympathy for local residents and their concerns. Squaw Coulee and Baker Creek area residents identified a major concern with the proposed location of the return canal to the Highwood River. Alternative routings were presented during the hearing to seek to mitigate the potential impacts. This included the option of avoiding disturbances in the Baker Creek area by replacing a surface canal with a buried pipeline. There was an additional major concern about the quality of the water that would be returned to the Highwood River after it had been stored in the reservoir for any length of time.

Other concerns expressed about the impacts of the Super Expanded Squaw Coulee project related to the possible loss of historic and archaeological sites; the loss of native grasslands; disruption to local farming operations; disruptions to local transportation routes; environmental impacts on people and wildlife in the Squaw Coulee and Baker Creek areas; and the lack of an up-to-date assessment of impacts on new area residents.

Regarding public consultation there was concern expressed about the lack of timely and appropriate consultation, the lack of clarity in the information provided, the lack of sufficient time allowed for public review, the lack of an adequate EIA, and the lack of a complete assessment of alternative storage sites and other alternatives.

It appears that the major drawbacks associated with the Super Expanded project as identified by many interveners were its inadequately documented social, economic and environmental impacts, the less than comprehensive assessment of alternative storage options, and the weak public consultation process for these local residents.

The Panel concludes that, on the basis of the information currently available to the Panel, the Super Expanded Squaw Coulee Reservoir could meet *current* requirements for water in the basin and remedy the currently unsustainable over-allocation of water. The Panel tentatively concludes that the modelling currently available shows that the development of storage equivalent to the Super Expanded Squaw Coulee Reservoir may fall short of meeting all *future* water needs while providing sufficient protection to the environment. Taking into consideration the need to provide for winter IFN, provision for other unforeseen contingencies, and an updated IFN that is solely science-based leads to the conclusion that storage may be needed in the future that exceeds the capacity of the Super Expanded Squaw Coulee Reservoir.

The Panel concludes that there is a need to consider a continuum of storage options to meet current and future needs. In the view of the Panel, the question is not whether or not the Expanded or the Super Expanded project should be built, but rather whether the development of storage such as or equivalent to the Super Expanded Squaw Coulee will meet the long term needs in the basin.

In the opinion of the Panel, the Super Expanded Squaw Coulee Reservoir presents a feasible option that appears to meet most project objectives. Further evidence is needed for a Panel to come to a final conclusion regarding the Super Expanded Squaw Coulee Reservoir. The Panel agrees with the Squaw Coulee and Baker Creek area residents that alternative sites require further investigation and consideration. The Panel also agrees that a more in-depth analysis of other water conservation practices needs to be done.

Based on evidence presented at the hearing, the Panel identifies the following possible evaluation criteria for storage alternatives in the basins.

- Highwood River on-stream storage is not acceptable due to conflicts with fisheries requirements.
- Total reservoir capacity must be equivalent to or larger than the Super Expanded Squaw Coulee site.
- The cost of developing storage should be equivalent to or less than the Super Expanded Squaw Coulee site expressed on a cost/acre foot basis.
- Predicted water quality effects on the Highwood River must not be significant adverse effects.
- The outlet to Highwood River from the storage site is above the Little Bow diversion at the Town of High River.
- The adverse social and environmental impacts should be less than or equal to those associated with the Super Expanded Squaw Coulee Reservoir.

From the evidence currently available to the Panel, it appears that Squaw Coulee is the best single site for creating storage for the Highwood basin, taking into consideration storage capacity, location, environmental effects, cost, and water management flexibility.

The Panel has already concluded that additional storage is required and can be developed for the Highwood basin. The Panel concludes that the Super Expanded Squaw Coulee Reservoir could provide sufficient storage to remedy the current situation. As previously stated, the Panel believes that the first priority for consideration of storage in the basin is to remediate the current over-allocation of water during low flow. This site would also meet the basic principles of the development of a sustainable water resource project, having regard to waters rights, environmental effects, and capacity to meet almost all currently identified future demands for water. Having accepted the need for additional storage for the Highwood basin to meet current water demand, the Panel adopts a perspective that a series of storage opportunities may ultimately be needed in the basin over the long term to meet future water demand. In this context, the Super Expanded Squaw Coulee Project, and other storage options such as at Tongue Creek and Stimson Creek Site 8 are possibilities that need to be examined now.

8.6.7 Highwood River Basin Water Management Plan

During the course of the hearing it became evident that most parties believed that an acceptable diversion plan had not been provided by the Applicant. It also became evident that most parties believed further investigation of storage opportunities within the Highwood River basin was required before an acceptable diversion plan could be approved. The failure by the Applicant to resolve the issue of the diversion plan and to provide a conclusive solution in response to the need for additional storage for the Highwood River basin resulted in many parties looking at the Highwood River Basin Water Management Plan (HMP) as the solution to these outstanding issues.

However, prior to the hearing AEP clearly indicated that it expected the Joint Review Panel to deal with the diversion plan and the need for storage for the Highwood River basin before it

would initiate the HMP. AEP acknowledged that the terms of reference for the HMP would be altered substantially if the Application is or is not approved.

In their closing remarks, AEP indicated the water supply issues raised in the hearing that would be considered in the proposed HMP. The specific issues included: fully meeting the Highwood River summer instream objective; establishing and meeting the Highwood River winter instream objective; providing additional flows in the Little Bow basin to benefit the Little Bow River and Mosquito Creek water quality; and water supplies for future uses along the Highwood River. Within the context of the HMP, AEP identified some measures that could be considered to address these issues. Specifically, AEP identified the following measures: the expansion of storage at Squaw Coulee and other storage opportunities in the Highwood River basin; instream works to improve fish habitat; and non-structural actions such as water right transfers.

The Panel has a number of concerns regarding the deferral of consideration of the diversion plans and the need for storage to the HMP. The Panel believes that the proper operation of diversion works on the Highwood River is fundamental to the public interest. The evidence before the Panel is compelling with respect to the need to resolve water management issues associated with low flow in the Highwood River. Diversion plans compatible with the concept of sustainable development are required, and given the three criteria adopted by the Panel in considering such matters, it is now apparent that respecting existing water rights, observing the IFN, and meeting current and future needs will require the development of storage for the Highwood basin.

The Panel believes that addressing the need for storage in the Highwood River basin and the associated diversion plans during low flow within the context of the current Application is necessary to determine the public interest. Therefore, the Panel will not defer consideration of these matters to the HMP. In doing so, the Panel fully recognizes that it is adopting an approach to these matters that is contrary to the recommendations of some parties during the hearing. The Panel also recognizes that there is a public interest in the early resolution of these matters given the lengthy delays that have already occurred and a significant investment by all parties in bringing these issues before the Joint Review Panel.

The Panel acknowledges that there are information deficiencies regarding alternative sites and the Super Expanded Squaw Coulee Reservoir that precludes this Panel from coming to a definitive conclusion at this time regarding all aspects of the storage potentially available in Squaw Coulee.

8.6.8 Required Further Investigations of Storage Options

The Panel directs APWSS to update the comparative analysis of the potential storage sites, including the Super Expanded Squaw Coulee site, Tongue Creek Site 4 and Stimson Creek Site 8, and show comparative data regarding environmental, social and economic effects. The Panel requires additional information that is sufficient for a Panel to conclude whether or not the Super Expanded Squaw Coulee Project is in the public interest. Therefore, the Panel further directs APWSS to complete the assessment of the environmental, social and economic effects of the Super Expanded Squaw Coulee project. Public consultation is required as an integral part of the further analysis and assessment. Particular attention is to be directed toward finding appropriate routes for return flows to the Highwood using pipelines, since the Panel sees little merit in the further consideration of a large canal through a country residential development when less disruptive equivalent alternatives exist.

The Panel further requires that the diversion plans for the management of water in the Highwood River be revised to meet the basic criteria of a sound water management project. Specifically,

the Panel concludes that the objectives of the revised diversion plans should be to ensure that the science-based IFN is observed in the Highwood, that existing license commitments are upheld, that flows are maintained in both the upper Little Bow River (0.85 to 1.13 cms or 30 to 40 cfs) and lower Mosquito Creek (0.57 to 0.85 cms or 20 to 30 cfs), that known future demands are met, and that consideration is given for reserving water, if possible, for future requirements that are unknown at this time. The Panel requires that the diversion plans for the Highwood diversion works be revised on the basis of incorporating the improved flexibility available as a result of developing storage for the Highwood basin. Additional modelling is required to demonstrate the degree to which the above criteria can be met under various low flow scenarios.

The Panel requires that the completed assessment of environmental, social, and economic effects for the Super Expanded Squaw Coulee Reservoir, including the comparative analysis of alternative storage sites and a revised diversion plan, be filed with the Board within 12 months of the release of this decision report.

The Panel requests that the additional information required to complete the review be filed with the NRCB/CEAA and Alberta Environmental Protection. The Alberta Director of Environmental Assessment will then be in a position to confirm that the supplemental information filed with the NRCB/CEAA is, in his opinion, suitable for the purposes of further public review of this component of the Application.

The Panel requires that the detailed process plan for completing the Highwood River Basin Water Management Plan be filed with the NRCB/CEAA for public discussion and consideration at a public hearing that will be needed when the additional information is filed. The process plan for the HMP should be developed recognizing the need for storage. The Panel believes that the Panel's three sustainable development criteria should be considered in developing the detailed process plan.

Additional criteria suggested by interveners and endorsed by the Panel, include:

- The HMP must include the upper Little Bow and lower Mosquito Creek basin.
- The planning process must strive for balanced and representative public consultation with an independent facilitated process.
- The HMP should require no longer than one year for design and one further year for implementation and decision-making.
- The plan must address all sources of pollutants including non-point agricultural sources and Frank Lake outflows.
- Significant future development in the basin and associated growth and demand for water must be anticipated.
- Fisheries management considerations, including the need for habitat improvement, must be addressed.
- The winter IFN requirements must be addressed.
- The need for IFN for the Little Bow River and Mosquito Creek must be re-examined.
- Flood protection and planning must be considered.
- The role of the Highwood River basin must be considered in the context of the Bow River basin.

The Panel further recommends that the HMP process be initiated at this time. The Panel accepts that the HMP process may extend beyond the time within which the NRCB and the CEAA will be

considering the alternative storage sites in context of the Little Bow Project/Highwood Diversion Plan. However, the Panel concludes that the consideration of the alternative sites associated with the Highwood Diversion Plan should include an understanding of the HMP process. In order that the NRCB and CEAA review process may have regard for the HMP efforts, the Panel requires that APWSS provide a detailed update on the HMP at the time it files the completed assessment of the effects of Super Expanded Squaw Coulee and alternate storage sites. The update shall consist of a detailed design and implementation progress report that describes the consultation process, stakeholders and their community representation, accomplishments to date, objectives and timelines, detailed cost estimates of related consulting studies, and schedules for completion within a period of two years.

8.6.9 The Little Bow River Reservoir and Clear Lake

The Panel is deferring the consideration of the diversion plans for the Highwood Diversion works until additional information is received. However, the Panel has given consideration to whether or not the construction of the Highwood Diversion works and canal, the Little Bow River Reservoir, and the diversion works and canal to Clear Lake also need to be deferred pending the development of a revised operating plan for the diversion works.

The Panel made an important distinction between two basic issues presented during the hearing:

- Meeting the expansion plans for irrigation, in the lower Little Bow River basin and around Clear Lake, through the diversion of water during the spring freshet and times of high flow, and storage of this water; and

- Resolving the critical water needs during low flow in the upper Little Bow River basin, in the lower Highwood River basin, and in the lower Mosquito Creek basin.

The Panel has carefully examined the relationship between the operation of the Highwood Diversion works and the expansion of irrigation through the proposed Little Bow River Reservoir and near Clear Lake. The Panel believes that consideration can be given to the construction of the diversion works and their operation on the basis that the expanded capacity of these diversion works will be used to divert and store the spring freshet. The location and size of the works have been determined on the basis of criteria that are relevant to the operation of the works during high flow events. Regardless of the operating plan required to guide diversions during low flows, the same size and type of works would be required to capture the spring freshet flows. At low flows in the Highwood River the water required for irrigation expansion would be available from storage. The Panel notes that the additional diversion capacity required to convey the spring freshet to support expanded irrigation is not used during low flows. Therefore, the expanded storage capacity in the Little Bow River Reservoir and Clear Lake is not relevant to the capacity and operating guidelines required during low flow diversions from the Highwood River.

With the appropriate conditions, the Little Bow River Reservoir and Clear Lake components appear to respect riparian rights and water licences, to meet basic environmental criteria, and to meet current and future demands for water. Diverting freshet flows from the Highwood River and Mosquito Creek does not infringe upon existing water rights and licences since at that time there is enough water to meet all license requirements. At the time of the freshet, environmental concerns are minimal, and the diversion of a fraction of the freshet flow is not expected to have significant adverse environmental effects on the Highwood River. The evidence before the Panel indicates that the three-

component diversion works, canals, and reservoir are based on meeting existing and future needs that are known at this time, and there is no evidence to suggest that they are not capable of meeting the purposes for which they are proposed.

The Panel concluded on a preliminary basis that the Expanded Highwood Diversion component, the Little Bow River Reservoir project component and the Clear Lake project component could meet the basic characteristics of a sustainable water management project. The Panel therefore considered in a more detailed fashion the social, economic and environmental effects of the construction and operation of the Little Bow River Reservoir and related facilities, and the Clear Lake project.

The Panel is cognizant of the fact that the construction of the Highwood Diversion works at High River and the associated canal enlargement, the construction of the Little Bow River Reservoir, and the construction of the Mosquito Creek diversion works and canal to Clear Lake will take some time to complete. Depending on when construction commences, the availability of funds and other factors such as weather, the construction may take two or three years to complete before an operations plan would be required to commission and start operating these works.

The Panel concludes that there is sufficient time to complete the review of the supplemental information regarding storage for the Highwood basin, and to consider revised diversion plans, before construction is completed.

The Panel believes that the construction of the three-component project, based on detailed consideration of the social, economic, and environmental effects, could proceed at the same time as the matters of the additional storage and a diversion plan for low flows are being resolved.

8.6.10 Concluding Comments Regarding Water Management

The Panel has given detailed consideration to the overall nature of water management in the Highwood and Little Bow basins. The Little Bow River Reservoir and Clear Lake components appear to respect water licenses, to meet basic environmental criteria, and to meet current and future demands for water. On a preliminary basis the Panel concluded that the Expanded Diversion Works, the Little Bow River Reservoir and the Clear Lake components do meet the three basic sustainability criteria adopted by the Panel. Therefore, in the opinion of the Panel, the Little Bow River Reservoir and Clear Lake components warranted detailed consideration of the social, economic, and environmental effects that might occur should the three-component project proceed.

The proposed diversion plans, however, do not meet the three basic sustainability criteria adopted by the Panel. The Panel finds serious concern with the Diversion Plan and the Expanded Diversion Plan, and does not believe that the plans as proposed would be in the public interest.

The Panel concludes that water storage is required for the Highwood River basin.

The Panel also considered the potential role of the Expanded Squaw Coulee Reservoir in meeting the need for storage. The Panel concludes that the limited positive benefits provided by the smaller expanded storage alternative would fall far short in meeting current demands. Given the limited capacity of this proposed reservoir, the Panel has decided not to give further consideration at this time to the more detailed aspects of the social, economic, and environmental effects of this small reservoir as currently described in the Application.

The Panel believes, after considering various storage sites available in the basin, that storage can be developed for the Highwood basin. The Panel further concludes that the Super Expanded Squaw Coulee Reservoir might provide sufficient storage to remedy the current situation. The Panel concludes that the first priority for consideration of storage in the Highwood basin is to remediate the current over-allocation of water during low flow. The Super Expanded Squaw Coulee would meet the basic principles of the development of a sustainable water resource project, having regard to water rights, environmental effects, and capacity to meet almost all currently identified future demands for water. However, at this time, the Panel acknowledges that there are information deficiencies in the evidence and deficiencies in the public process involved that preclude this Panel from coming to a definitive conclusion regarding the expansion potential and impacts of the storage currently available in Squaw Coulee.

The Panel defers consideration of the public interest with respect to the Squaw Coulee component of the Application pending the receipt of additional information assessing the environmental, social, and economic effects of the Super Expanded Squaw Coulee project. The Panel also defers further consideration of the public interest regarding the diversion plans pending receipt of revised diversion plans, which may create improved flexibility as a result of developing storage for the Highwood basin. The Panel requires the completed assessment of the social, economic, and environmental effects for the Super Expanded Squaw Coulee Reservoir, including the comparative analysis of environmental, social and economic effects of alternative storage sites, and the revised diversion plans, be filed with the Board and CEAA within twelve months of the release of this decision report. The Panel does not think that it is advisable to refer the consideration of additional storage and related matters to the HMP. The Panel does support the idea of an independent third party facilitated process for assisting all parties to work on a number of remaining planning issues.

8.7 Environmental Effects

The Panel recognizes that water is fundamental to life and all aspects of environmental quality. Water is also essential to sustainable development. The proposed three-component project is intended to improve water supply through the diversion and storage of water in the proposed Little Bow River Reservoir and at Clear Lake during high flows for subsequent release. The diversion and storage of water is intended to support beneficial uses of the water for a variety of purposes. The proposed three-component project would also result in a variety of environmental effects, some of which are positive and some of which are adverse.

The Panel has considered the environmental effects of the proposed three-component project. Consideration of the environmental effects of the further development of storage in the Highwood River basin through the expansion of storage at Squaw Coulee or at some other storage site is deferred. The Panel has considered the environmental effects of the proposed three-component project that are relevant to the Panel's deliberations, particularly water quantity and quality, fisheries, vegetation and wildlife, and soils and lands.

The Panel recognizes that natural systems are dynamic. The nature and extent of impacts of proposed developments are not independent of the state of the ecosystem or component at the time the development takes place. During the hearing, the Panel heard evidence about historical, current and possible future states of the ecosystem found within the lower Highwood River, the upper Little Bow River and Mosquito Creek basins and especially the riverine components. The Panel understands that these ecosystems and the aquatic components have been subject to natural stress and numerous impacts since settlement and that some of the impacts during drought conditions have been severe. These ecosystems have exhibited resilience in rebounding from many adverse impacts but evidence before the

Panel about the past management of scarce water resources suggests that the riverine ecosystems have not always returned to a state similar to that which existed at the time of impact. The frequency, and increasing number and extent, of water demands makes it necessary to recognize that the aquatic ecosystem in the lower Highwood River, the upper Little Bow River and Mosquito Creek basins is already under pressure. Whether or not the proposed three-component project can improve the sustainability of aquatic ecosystems has been considered by the Panel.

In past decisions, the NRCB has taken the view that examination of potential social, economic, and environmental effects of a project must include consideration of cumulative effects because project impacts do not occur in isolation from the many other effects influencing social systems, economic systems, and ecosystems.

The Panel concludes that it would be unwise to review the potential effects of the three-component before it in any other than a cumulative and basin context. This is particularly the case given the historical development of the lower Highwood River, the upper Little Bow River and lower Mosquito Creek basins, and the relatively high water demands to which the aquatic ecosystems are subjected.

The Panel is also aware that most development projects give rise to secondary impacts in addition to the direct or primary impacts that occur at or adjacent to a project site. APWSS, in its Application, dealt in detail with potential direct impacts within the immediate project area of the proposed Little Bow River Reservoir, the Highwood River diversion works and canal, and the Mosquito Creek diversion works and canal. The Panel believes that it should have some regard for the inevitable secondary impacts arising, for example, from the provision of water from the proposed three-component project. The effects of changing the flow regime in the upper Little Bow River might be an example of a *direct effect* having potential consequences in the upper Little Bow River basin. Increased availability of a stable water supply, previously difficult to obtain, might be an example of an *indirect effect* having potential consequences in the basin.

In past decisions, the NRCB has recognized that the fundamental properties of ecosystems and populations of living organisms make predicting responses to impacts difficult and in many cases impossible. Even where prediction is theoretically possible, lack of information, lack of understanding of ecological processes or practical difficulties may obstruct determination of the probable effects of an impact. The Panel has dealt with this problem by concentrating on the potential response of ecosystem components about which more is known, by examining evidence before it about the historical record of the ecosystem under consideration and similar ecosystems elsewhere, and by making conservative assumptions in the face of uncertainty. By these means, the Panel has arrived at qualitative assessments of the risk that ecosystems will undergo changes of state and has examined the potential of management measures to control or avoid unwanted changes.

Riverine ecosystems are dynamic and will undergo natural stress and change with or without interference by people. Naturally, the Panel is most concerned about the risk of large, potentially undesirable changes that may be difficult or impossible to reverse. The risk to the regional ecosystem from current water demands and the associated risks to individuals and communities were identified by many participants in the hearing. The Panel believes that the approach the NRCB has adopted in past decisions is appropriate to its examination of that risk.

The Panel has examined the effects of the proposed three-component project on the various components of the regional ecosystem that would be most affected by the project. It has considered the effects of the project as a whole in terms of cumulative effects in the Little Bow River, lower Mosquito Creek, and lower Highwood River basins.

Environmental effects considered by the Panel associated with operations primarily pertain to the diversion of spring freshet flows from the Highwood River to the Little Bow River and from Mosquito Creek into Clear Lake, and the storage and use of that water. The main focus of the Panel was on the environmental effects of the Little Bow River Reservoir and Clear Lake projects utilizing water stored from freshet flows. The Panel has also highlighted the environmental consequences inherent in the current situation where the scarce water resource has been over-allocated. The Panel believes that a stable water supply is essential to sustainable development. The importance of more water availability from a Highwood River storage site or sites is vital, as there is not enough water to meet current demands in the Highwood River during low flow. Therefore, securing sustainable development involves the inter-relationship between what is best for people and the environment.

The Panel's consideration of environmental effects focused upon the public concerns expressed throughout the public hearing regarding water quality and aquatic ecosystems with special emphasis on fisheries. It also focused on prairie terrestrial ecosystems including vegetation, wildlife, soils and land capability. In examining environmental effects the Panel has had regard for the need to enhance water supply while maintaining water quality; the need to conserve existing aquatic, riparian, grassland, wetland, and terrestrial ecosystem characteristics; and the need to retain and maintain community support and involvement in achieving environmental protection.

The environmental effects of the proposed three-component project are inherently tied to the diversion of the spring freshet, since this would determine the flows in the Little Bow River and the related effects on water quantity, water quality, riparian vegetation and fisheries. The effects on water quality and quantity that result from particular flows in the upper Little Bow River have further effects, both positive or negative, on other matters such as the availability of water for use for domestic, municipal, stock-watering and irrigation purposes. Changes in stream flow characteristics can affect riverine characteristics and can lead to alterations along the channel that can affect archeological sites, adjacent land uses, and other matters.

The Panel notes the extreme variability of both the annual water yields of the Highwood, Little Bow, and lower Mosquito Creek basins and the maximum and minimum average weekly stream flows. The Panel concludes that storage can moderate these extreme variations and lead to greater multi-use options for this valuable natural resource. The multi-use needs for water include those of human settlements, instream flows for aquatic and riparian ecosystems, irrigation of agricultural lands, wildlife, recreation, natural areas, industrial use, water conservation, and other demands. Avoiding or reducing direct withdrawals from the Highwood River becomes particularly important during low-flow conditions. The Panel recognizes that the existing flows are not dependable for sustainable multi-purpose uses. The Panel concludes that the proposed three-component project could provide the necessary storage to better manage a significant amount of the available water resources for consumptive and other demands in the Little Bow and lower Mosquito Creek basins.

8.7.1 Water Quantity

The proposed three-component project would result in improvements in meeting the requirements for consumptive uses such as municipal downstream water supply on the Little Bow River and irrigation demands at and downstream of the Little Bow River Reservoir and at Clear Lake. The Little Bow River Reservoir and Clear Lake do not have sufficient capacity to store enough water to eliminate all risks associated with drought conditions, but the reduction in the degree of risk would improve with the storage and management of water. In capturing the spring freshet the direct physical impact on flows within the Little Bow River and the associated implications for the stream bed, channel

and aquatic environment are not considered by the Panel to constitute significant adverse environmental effects. The Panel fully recognizes the dynamic nature of the riverine environment along the upper Little Bow River. The Panel believes the historical variations in flows that characterized the upper Little Bow River within each year, and from year to year, are relatively small. The changes in flows that are associated with the operation of the existing diversion works are less than those that would be associated with the three-component project should it proceed.

With respect to water quantity in the Highwood River, the Panel concludes that the storage features inherent in the proposed three-component project would primarily have a small positive or neutral effect on the flows in the Highwood River. The ability to capture and store water in the Little Bow River Reservoir and at Clear Lake for subsequent use could remove part of the low flow demand and may result in an improvement in the amount of water available to meet instream flow needs in the Highwood River, and related requirements for environmental protection of the aquatic and riparian environment.

The Panel heard arguments that the downstream flows in the Highwood River, the Bow River, and the flows of the Oldman River below the Oldman River Dam would be affected by the operation of the proposed project. The Panel heard that the Oldman River flows could also be affected by water allocations made for instream flow needs, water quality, irrigation, domestic and other consumptive water uses in the Oldman and the broader South Saskatchewan River basin. Flows from all sources can become more important during low-flow conditions. The Panel recognizes that there could be some minor interaction between the two operating regimes of the Oldman River Dam and the proposed project. The Panel notes the flows in the Highwood River can only indirectly affect the flows in the Oldman River. Should the project proceed, there are is a slight possibility that the flows in the Oldman River may be indirectly affected in a very small way through the interaction between the operating regime of the Oldman River Dam and the operating regime of the proposed project. The Panel has considered the significance of the indirect effects of the proposed project on flows in the Oldman River below the Oldman River Dam. In the opinion of AEP, APWSS, and the Panel the magnitude of the increases or decreases in flows would be insignificant.

The SSRB contains many water management structures with their own operational regimes that may interact to varying degrees to determine overall management strategies. The Panel finds that the proposed project could have a very small positive effect on downstream flows in the SSRB particularly during low flow periods. The Panel finds that, in regard to water flows, the benefits of the proposed project are largely confined to and should properly accrue to the various water demands in the Highwood, Little Bow, and lower Mosquito Creek basins.

8.7.2 Water Quality

The Panel stated its concerns regarding the current over-allocation of water in the Highwood River and the associated deterioration in available fish habitat during low flow. The Panel has described such circumstances as being intolerable and unsustainable. The Panel expresses an equivalent level of concern with respect to the deterioration of water quality currently found in Mosquito Creek and the upper Little Bow River. Mosquito Creek and the upper Little Bow River exhibit polluted water quality characteristics at certain times during the year. Non-point sources of pollution associated with increased livestock production are having significant effects on water quality. Point sources are the subject of regulations and a detailed licensing system intended to prevent polluted water quality in receiving streams. Treated sewage from local municipalities is adversely affecting surface water quality in

the region. Rural and urban sources of pollutants both factor significantly as contributing sources to the poor quality of water found in the Little Bow River and Mosquito Creek.

The Panel is particularly concerned that the benefits associated with the innovative Frank Lake wetlands project are being overshadowed by the lack of attention to the need to manage the wetland as an effective tertiary treatment system. Ducks Unlimited, as the manager of the wetlands project, requires the support and guidance of AEP in responding to the significant increases in effluent loading directed into Frank Lake. Far more diligence will be required to effectively balance climatic variations and effluent loading. The Panel views the primary responsibility for immediate corrective action to rest squarely with AEP. AEP encouraged the development of the Frank Lake wetlands project based on accepting adequately treated effluent from the Town of High River and Cargill, and their technical evaluation of the capacity of Frank Lake to effectively polish the effluent. There never was, nor should there have been, any expectation that the protection of the Highwood River from High River effluent discharge would lead to the current circumstance where the residents along the upper Little Bow River must cope with pollutants that originate at High River. The current situation regarding overflow discharges from Frank Lake requires immediate remedial action.

The Panel recommends that AEP complete the evaluation of alternative mitigation options to reduce pollutants discharging from Frank Lake to the levels that would have been experienced prior to the receipt of effluent from the Town of High River, Cargill, Blackie, or other point sources. The Panel concludes that setting a target of returning water quality discharged from Frank Lake to background levels is appropriate and necessary as part of an overall basin-wide water quality initiative. The Panel further recommends that AEP should present a report, the Frank Lake Water Quality Mitigation Plan, to the directly affected public, stakeholders and local municipalities. The Frank Lake Water Quality Mitigation Plan should include a description of planned measures, the proposed timing of those measures and the expected effects of the proposed efforts to mitigate the adverse effects of Frank Lake discharges.

The potential multi-purpose benefits associated with the Little Bow River Reservoir will not be adequately realized without clear action to control current or future sources of pollution in the region. Pollutants discharged throughout the region from various sources will tend to accumulate in the proposed reservoir. The Panel concludes the effects on the reservoir associated with this pollution could cause a significant adverse environmental effect. Past practices that avoided effectively managing the various sources of pollution should not be carried forward into the future. The new reality of a reservoir capable of trapping pollutants from sources within the region means that the behavior of those responsible for generating and managing the wastes should change. Only a limited amount time is available before the reservoir will become operational. AEP, both rural and urban local municipalities, and local farmers and industry should act now to control pollution within the region. The immediate objective of the actions should be to ensure that the existing situation is corrected so that downstream water users no longer are the recipients of their neighbors' wastes. Accomplishing this immediate objective would also result in better than predicted water quality in the proposed Little Bow River Reservoir. The costs associated with controlling the pollutants should be borne by those responsible for generating them, consistent with the polluter-pays principle. The water quality in the reservoir should be rated at the mesotrophic level to obtain the full range of multi-purpose benefits associated with the significant public expenditure involved in creating this project. Continuous water quality monitoring will provide information necessary to ensure that regional sources of pollutants are properly managed.

The Panel recommends that AEP, as the regulator of water quality and as the operator of the proposed Little Bow River Reservoir, be responsible for leading the Little Bow/Mosquito Creek watershed water quality initiative with the goal of achieving and maintaining mesotrophic water quality in the Little Bow River Reservoir. The Panel recommends that this Little Bow River Reservoir Water Quality Protection Plan be commenced immediately to ensure the multi-purpose objectives of the

proposed Little Bow River Reservoir are realized. Basin-wide public participation and stakeholder involvement will be required to identify and manage point and non-point sources of pollution that could adversely affect water quality in the proposed Little Bow River Reservoir.

During reservoir construction there is potential for impacts due to the introduction of sediment or the accidental introduction of toxic materials. The Panel concludes that the Applicant can successfully mitigate these potential impacts. Operating the three-component project under current 1994 guidelines pending the development of Highwood River basin storage should result in no material changes in water quality in the Highwood River, Squaw Coulee Reservoir, Little Bow River, or Mosquito Creek. There may be a seasonal positive impact on water quality in these streams associated with freshet flushing. Water quantity in Clear Lake is expected to be restored in one to two years, depending on the availability of Mosquito Creek and Highwood freshet water for diversion. Water quality in Clear Lake is expected to improve over a 3-5 year time frame as residual salinity is reduced through irrigation withdrawals. Hypereutrophic conditions may impair its use for a fishery and recreation.

Water quality downstream of the Little Bow River Reservoir will be influenced by the biochemical and physical effects of impounding water in the reservoir and by the schedule of water releases. Water temperatures, suspended solids and bacterial contamination should all be lower than at present. Phosphorous levels could decrease, prompting a marginal decline in aquatic plant biomass and a significant decline in benthic algae, but only if the trophic status of the reservoir can be improved from the predicted hypereutrophic status to eutrophic or better. The Panel recommends that the Frank Lake Water Quality Mitigation Plan and the Little Bow River Reservoir Water Quality Protection Plan be developed expeditiously and implemented before the reservoir is filled.

The Little Bow Reservoir itself was not given an impact rating, but the predicted hypereutrophic water quality would impair its intended multi-purposes uses for a fishery, recreation, and municipal water supply, and irrigation.

Significant adverse impacts to local groundwater are not expected in the vicinity of the reservoir, Clear Lake, or upper Little Bow River. Project implementation requires monitoring for groundwater effects in potentially susceptible areas.

The Panel accepts that some incremental mercury contamination of fish will be associated with the creation of the proposed Little Bow River Reservoir. Should the project proceed, the Panel would require that the operator, in a manner satisfactory to AEP, monitor and report on mercury levels in fish from the reservoir and below the reservoir in the Little Bow River. The Panel understands that AEP, in consultation with appropriate health authorities, ensures that the public is aware of any health risk associated with the consumption of mercury-contaminated fish, and provides advice on the steps the public should follow to minimize any potential adverse health effects. Having regard for the role and responsibilities of other authorities with respect to the consumption of mercury contaminated fish, the Panel is satisfied that the effects of the project with respect to mercury bioaccumulation in water would not lead to significant adverse effects.

Heavy metal concentrations may increase and an appropriate monitoring program is required. Elevated ammonia and low dissolved oxygen in water released from the reservoir can be mitigated to some extent by physical aeration of the outlet water. The Panel would require, should the project proceed, that APWSS design the reservoir outlet works and carry out its operations in a manner, satisfactory to AEP, that minimizes the potential adverse effects on dissolved oxygen and ammonia levels in the Little Bow River. The Panel concludes that the quality of water in the reservoir will be acceptable for recreational uses most of the time with the successful implementation of the Frank Lake Water Quality Mitigation Plan and the Little Bow River Reservoir Water Quality Protection Plan. The proposed

Little Bow River Reservoir is likely to support a sustainable cool-water fishery under the proposed reservoir's operating plan. Over the long-term, the Panel expects that the watershed and reservoir will be managed to obtain a mesotrophic level of water quality.

The Panel notes that agricultural discharges such as effluent from cattle grazing and intensive livestock operations are of concern. The Panel concludes that these matters, if properly regulated, would not constitute a water quality concern. The Panel has made recommendations regarding this matter in the context of watershed protection for the Highwood River, Little Bow River, and Mosquito Creek basins.

The Panel has considered the water quality implications of diverting water from Mosquito Creek through the proposed canal and into Clear Lake. The predicted water quality in Clear Lake is dependent upon a number of factors present in the watershed. Of the factors identified, the proposed diversion of water from Mosquito Creek into Clear Lake has the potential to have a major impact on the water quality in Clear Lake. Maintaining acceptable water quality in Clear Lake will depend upon the rate and quantity of water withdrawn from the lake for irrigation purposes. If irrigation expansion of at least 1,418 ha (3,500 acres) occurs adjacent to Clear Lake, then modelling predicts that the water quality in the lake will be acceptable since the water in the lake will be turning over through use.

The Panel recommends that a Clear Lake Irrigation Development Plan be prepared. The Panel believes that this plan could provide the framework for identifying private and public sector expectations regarding the development of a stable water supply and that addresses the water quality issues. Participants in the preparation of the proposed irrigation development plan should include future irrigators, Alberta Agriculture and Rural Development, AEP, and APWSS. Evidence before the Panel clearly indicates that the rate of irrigation expansion in the Clear Lake area will be sufficient to ensure that the water is of acceptable quality. The Panel is confident that the irrigation expansion will occur and that the water quality in Clear Lake will be acceptable. The Panel recognizes the importance to the local community of a stabilized water supply in Clear Lake and that to some local residents the presence of any water quality in Clear Lake is far better than having no water at all.

With respect to water quality, the Panel concludes that the effects of the proposed project would not be adverse in the Highwood River during low flow conditions. The Panel is also of the opinion that the proposed project would not result in significant adverse water quality effects to the Little Bow River. The Panel concludes that without clear steps to stop the discharge of poor quality water from Frank Lake, water from Frank Lake could contribute to poor water quality in part of the upper Little Bow River and in the Little Bow River Reservoir, and reduce the potential of the reservoir for fisheries, recreation, and municipal supply purposes. The Panel accepts the commitment made by AEP during the hearings that it would address and rectify the discharge from Frank Lake as a source of pollutants to the Little Bow River. The Frank Lake Water Quality Mitigation Plan and The Little Bow River Reservoir Water Quality Protection Plan are intended to protect water quality in the Little Bow River basin.

8.7.3 Aquatic Habitat and Fisheries

Fish populations in the Highwood River, the upper Little Bow River, and Mosquito Creek have been affected by activities in the watershed over the past decades. These activities include construction and operation of the diversion works for Squaw Coulee and for the upper Little Bow River, municipal and domestic water use and effluent disposal, agricultural development and associated water withdrawals for irrigation. Major environmental impacts have already occurred from the reduction of

habitat in the Highwood River due to water diversions and withdrawals. The Highwood River supports the world class sport fishery in the Bow River. Water management policies require that the proposed project be operated to realize potential positive fisheries benefits while meeting overall multi-purpose operational objectives. To the extent that the proposed three-component project avoids low flow diversions from the Highwood River, there will be no adverse impact on the habitat available to support the fishery in the Highwood River.

An issue that affects the Highwood River fishery is the question of fish screens at the diversion works. Should the project be approved, the Panel would require that the design and construction of the diversion works on the Highwood River incorporate fish screens. The Panel recommends that AEP adopt as a general policy the requirement for fish screens on all water diverting facilities owned and operated by the Province of Alberta on rivers with significant fisheries.

Should the project proceed, the Panel requires that APWSS, to the satisfaction of AEP, prepare and implement a fisheries mitigation and enhancement plan as an integral component of the project. The fisheries mitigation and enhancement plan should be prepared at the earliest opportunity so that fisheries management decisions may be appropriately reflected in the final design and operation of the facilities. APWSS should seek appropriate input from the public and the various federal and provincial agencies in the preparation of the fisheries plan. The plan should be reviewed by AEP, in consultation with the Department of Fisheries and Oceans Canada.

The fisheries mitigation and enhancement plan associated with the three-component project, in the opinion of the Panel, should address several issues and options raised during the hearing. Specifically, the Panel would require that the plan address, among other relevant factors, the following:

- the feasibility and desirability of managing fisheries upstream of the Little Bow River Reservoir in the Little Bow River for cool-water species, taking into consideration the role of the diversion works on the Highwood River, diversion canal, and implications of flow fluctuations for cool-water species;

- the feasibility and desirability of the establishment of a sustainable cool-water fishery in the reservoir, particularly pike and walleye, taking into consideration creating spawning habitat; the minimum water level and quality that would be required to ensure a sustainable fishery; the effect of mercury contamination; and the effect on reservoir water quality and fisheries of non-point sources of pollution;

- the feasibility and desirability of managing fisheries downstream of the Little Bow River Reservoir, for cool-water species, taking into consideration the flows from the Little Bow River Reservoir works, the design of the outlet channel from the reservoir, the need for pike spawning habitat below the Little Bow River Reservoir, and the water quality discharged to the Little Bow River below the Little Bow River Reservoir;

- plans to monitor salmonid entrainment in the Highwood diversions, including an assessment of the feasibility of curtailing diversions during the peak of whitefish fry downstream migration;

- the feasibility of maintaining a self-sustaining pike fishery in Clear Lake;

- the fisheries habitat compensation requirement of the Department of Fisheries and Oceans; and

- the ongoing monitoring of the effectiveness of mitigation and enhancement.

The Panel would also require APWSS to conduct such further modelling and water quality monitoring as is needed to confirm in a manner satisfactory to AEP that water released from the reservoir is of sufficient quality to meet water quality and fisheries management objectives established for the reach of the Little Bow River above Travers Reservoir.

The federal Department of Fisheries and Ocean's *Policy for the Management of Fish Habitat* provides general guidance on the application of the habitat protection provisions of the *Fisheries Act*, and applies to all projects that have the potential to harmfully affect fish and fish habitats that contribute to a fishery. The policy requires that losses to the productive capacity of habitat caused by a project must be avoided if possible or balanced by gains elsewhere to ensure no net loss of habitat. The long term objective of the policy is to achieve an overall net gain in the productive capacity of fisheries habitats.

APWSS stated that the three-component project would result in a net increase in fish habitat and the inclusion of Squaw Coulee would result in a further marginal improvement. The Panel concludes there is enough uncertainty about the Applicant's predictions to warrant a careful assessment of the claim by fisheries regulators when they evaluate the Applicant's completed fisheries mitigation and enhancement plan.

The Panel notes the policy of no net loss of productive capacity of fish habitat. The Panel recognizes that the Department of Fisheries and Oceans would require the fish habitat compensation component of the fisheries mitigation and enhancement plan. With respect to cool-water fisheries habitat, the Panel notes that the area that would be flooded by the Little Bow River Reservoir would replace some riverine pike-spawning habitat. The Panel accepts the need to replace this habitat loss to meet the requirements of the no-net-loss policy. Therefore, the Panel would require that, should the project proceed, the Applicant design and implement a program to establish pike and walleye spawning habitat in or above the Little Bow River Reservoir. In the Panel's opinion, these mitigation measures could help in the compensation for any loss of pike spawning habitat loss due to the creation of the Little Bow River Reservoir. The stabilization and restoration of Clear Lake would result in the net gain in the cool-water fisheries habitat in the region.

With respect to fisheries, the Panel concludes that the project would not result in any net loss of fisheries productive capacity after various mitigative measures required by the Panel were implemented. The Panel further concludes that the requirement for fish screens on the diversion works in the Highwood River, the re-establishment of a fishery in Clear Lake, and establishment of a reservoir fishery could result in a beneficial effect on the fishery resource in Highwood River, upper Little Bow, and Mosquito Creek basins.

8.7.4 Prairie Environment Vegetation and Wildlife

Expansion of the diversion works at High River to convey 8.50 cms (300 cfs) during the freshet instead of the current 2.83 cms (100 cfs) will remove some riparian poplar forest. The increased spring diversions are not expected to have significant adverse effects on vegetation and wildlife along the

Highwood River below the diversion point. There are, however, environmental effects associated with increasing the diversion peak flow to 8.50 cms (300 cfs) down the Little Bow River. During peak discharge 54 ha (133 acres) of grassland and low shrubs would be affected by over bank flooding. The loss of shoreline vegetation would reduce the amount and diversity of habitat available to riparian species. Most of the cattails recently established along the upper Little Bow River will likely be lost due to the higher peak flows. The loss of cattails will reduce the suitability of the area for waterfowl nesting and brood rearing.

Construction of the Little Bow Reservoir will affect 133.4 ha (330 acres) of land, some of which is currently in a natural or semi natural state. Flooding of the reservoir will inundate 885 ha (2,187 acres) of the Little Bow River valley. The loss of this large contiguous area of mixed grass prairie is a serious matter because little of the mixed grass prairie remains. Flooding will remove about 33 km (20 mi) of riparian waterfowl staging and nesting habitat, fawning habitat for mule deer, nesting habitat for ducks, ferruginous hawks and song birds, in-transit habitat for neo-tropical migrants songbirds, and small mammal habitat. It will reduce prey populations for raptors and mammalian predators such as long tailed weasel. Some limited mitigation of these adverse effects is possible if grassland sites near the reservoir are managed to restore native flora and fauna.

The Clear Lake project component will cause habitat loss and the conversion from one kind of habitat to another. Approximately 75 ha (185 acres) of mixed grassland would be eliminated by canal construction. A further 106 ha (262 acres) would be flooded in the wetlands. The loss of mixed grass habitat will adversely effect songbirds, upland sand-pipers, long billed curlews and ferruginous hawks among other grassland species. The Panel concludes that the Clear Lake component of the project could substantially compensate for loss of waterfowl habitat on the Little Bow River, but would do so by converting a substantial contiguous area of mixed grass prairie and shorebird habitat. Among the species that would be adversely affected, some are rare and endangered.

The Panel recognizes the loss of a contiguous block of mixed grassland must be considered a major adverse effect because so little of this native ecoregion remains. The loss of riparian habitat must also be given great weight because the biological significance of riparian zones is known to be disproportionate to their area. A significant number of prairie birds and mammals require access to riparian habitat.

APWSS has offered to create a Habitat Compensation Plan to mitigate these effects. The plan would involve preserving as much native grassland as possible around the proposed reservoir and managing lands near Clear Lake, and possibly elsewhere, to enhance the value of the habitat. The proposal to protect and enhance existing habitat would therefore entail a net loss of habitat area but a gain in the value of the preserved habitat, potentially achieving no net loss of habitat, expressed as the product of habitat value and area.

The Panel is of the view that the proposal to balance losses of habitat quantity with gains in habitat quality would only partially compensate for the loss of grassland and riparian habitat. What is lost permanently, even with mitigation, is the potential value of the area inundated or otherwise occupied by the project, either as agricultural land or native vegetation. Losses of native vegetation and wildlife habitat at the reservoir site and the Clear Lake project are major, long-term adverse impacts of the project that can not be fully mitigated. This residual impact would be the unavoidable consequence of a decision to go ahead with the project. The Panel will have to weigh this adverse impact against the project's benefits in assessing the public interest with respect to the entire Application.

The Panel does not believe it would be feasible to mitigate the loss of habitat area in the sense of replacing lost habitat with new habitat, that is, habitat reclaimed from cultivated land, on the

scale that would be required for full compensation in this instance. It therefore supports the proposal to partially mitigate the loss of native vegetation and wildlife habitat by preserving, enhancing, and perhaps adding habitat near Clear Lake and elsewhere.

Should the project be approved, the Panel would require APWSS to implement a Habitat Compensation Plan approved by Alberta Environmental Protection. The goals of the plan should be to:

- Ensure that there are no further losses of native grasslands in the river valley associated with the upper Little Bow River;

- Encourage the establishment of riparian shrubs and wildlife cover along the upper Little Bow by reducing livestock impacts and other adverse management practices. A plan to restore the riparian zone should be developed by APWSS and reviewed and approved by Alberta Environmental Protection and Alberta Agriculture, Food & Rural Development;

- Achieve no net loss of mixed grassland habitat based on HEP models for a selection of wildlife species to be developed or adapted in co-operation with Alberta Environmental Assessment and Environment Canada.

The Panel recommends that the cost of the Habitat Compensation Plan be included in the project capital and operating budgets, and be implemented as soon as possible.

As with other mitigation of the proposed project, the Panel wishes to establish goals without being too prescriptive about methods so as not to fetter those who must find ways to achieve them. The Panel is concerned by APWSS's account of the difficulties it encountered when a comparable Habitat Compensation Plan was attempted at Pine Coulee. The Panel believes that the residual environmental impacts of the project could be substantially mitigated by a successful compensation plan. However, that assumption will only be warranted if an adequate plan is successfully implemented. In view of the difficulties encountered at Pine Coulee, the Panel recommends that alternative methods such as conservation easements be explored in addition to those suggested in the Application. The Panel also supports Environment Canada's request that the compensation areas duplicate to the extent possible the topographic and biological features of the lost habitat. If this cannot be done in the immediate vicinity of the project, the Panel would support the inclusion of sites further afield.

To underscore the seriousness with which it views the need for the Habitat Compensation Plan – should the project be approved, the Panel would require APWSS to report on progress toward a compensation plan one year from the release of this decision report. The Panel also believes it is appropriate to verify the Application's predictions of low or negligible impact with biological effects monitoring and to re-evaluate predictions and management practices if predictions are not borne out. The Panel notes the commitment of APWSS to implement a monitoring program as outlined in the EIA.

The Panel believes that some care must be taken to understand the trade-offs that may be involved in the alteration of habitat associated with the Application. This is particularly true at Clear Lake where duck habitat may be gained at the expense of mixed grass and shorebird habitat. The Panel concurs with the Applicant's assessment that the north end of Clear Lake could provide waterfowl habitat and would agree with its proposal to manage the area as an enhanced wetland and waterfowl habitat. The Panel would require APWSS to manage the north end of Clear Lake for water fowl and shorebird habitat. The Panel further would require that intensive recreational activities in this area be limited during times when these species are most prone to disturbance.

The Panel agrees with Environment Canada's suggestion to manage the wetlands in the area of the Clear Lake canal for shorebird habitat to mitigate the expected loss of shorebird habitat that will be the result of lake stabilization. The Panel will condition the project approval to incorporate this mitigation. The Panel believes that with the co-operation of Ducks Unlimited there will be a significant improvement in the waterfowl habitat capability in the area. The Panel also would recommend that a Clear Lake Wildlife Management Plan be prepared. The Panel concludes that this plan would provide the framework for identifying expectations regarding the management of wildlife habitat to support the variety of species, particularly along the 12 km of the diversion canal. Participants in the preparation of the proposed wildlife management plan might include local land owners, Ducks Unlimited, Environment Canada, Fish and Wildlife, and other conservation interests.

The Panel also agrees with the Applicant that field-oriented guidelines should be prepared as a practical means of implementing specific mitigation measures. Should the project proceed, the Panel would require APWSS to prepare a field-oriented operations plan, to the satisfaction of Alberta Environmental Protection, to ensure that all personnel involved in the construction and operations of the project would be informed of their responsibilities in implementing the environmental mitigation undertaken by APWSS.

8.7.5 Soils and Land Capability

The Panel notes that irrigation expansion within the Little Bow basin would not be limited by the availability of irrigable lands.

The Panel understands that land use classification for irrigated lands is extensively addressed in the current regulatory framework. The Panel is also very conscious of the limited water resource in this basin. The Panel has confidence that the relevant authorities responsible for water and land resources would carefully review future resource allocations and development to optimize the benefits from this project.

The Applicant has identified the potential sources of seepage from the project and the mitigation options available to avoid directly related salinization problems. The Panel believes that the project can incorporate appropriate mitigation measures in the design and operation of the diversion canals, reservoir and Clear Lake to prevent project related salinization of agricultural land in the vicinity of the project.

The Panel confirms its requirement for sustainable use of land resources. The Applicant has proposed groundwater monitoring in the vicinity of the upper Little Bow River and Reservoir, and Clear Lake. In the Panel’s view this would be sufficient to detect, at an early stage, changes in groundwater levels that might increase the risk of salinization and/or water-logging on adjacent lands. The Panel accepts the Applicant’s proposals regarding mitigation and if necessary, compensation for lands that may be affected by project-related seepage.

The Panel does not believe that the Applicant should be responsible in any way to implement measures that might be taken to resolve any pre-existing salinization or land-use problems that are independent of the project.

With respect to soils and land capability, the Panel concludes that should the project proceed, the proposed project would not result in significant adverse impacts to soils and land capability provided that the mitigation programs, and the conditions of the Panel, are implemented.

The Panel further notes a number of detailed matters raised by the land owners in the upper Little Bow and Mosquito Creek areas during the hearing. The Panel would require that APWSS:

- mitigate the effects on lands adjacent to the River of the increased flow through the upper Little Bow River to accommodate flows up to 8.50 cms (300 cfs); and
- monitor water levels in groundwater wells and mitigate any project-related groundwater problems experienced by domestic users.

8.7.6 Cumulative Environmental Effects

The environmental effects of the three-component project must be considered in the context of the cumulative effects of prior developments and activities in the basins.

Current baseline conditions in the Little Bow basin bear witness to over a century of resource use, not all of it sustainable. In common with much of southern Alberta, the basin has lost most of its native grassland vegetation and along with it most of the habitat for prairie animal species that were once abundant. Diversions of water from the Highwood River have given the Little Bow River greater flows than it had before European settlement, but pollution from several sources has created such poor water quality conditions that municipalities have difficulty treating the water. The numerous diversions and withdrawals of water from the Highwood River have reduced fish habitat during late summer low flow conditions and may have reduced fish habitat in winter. The Panel also understands that land use practices near Clear Lake were partially responsible for the lake's disappearance in the dry 1980s. The Panel believes that the current over-allocation of water resources (Section 4) and the failure to control water pollution (Section 5) place the natural environment, agriculture and the communities that depend on water resources at some risk. Archaeological sites have also been altered in many ways by settlement, agriculture, industry and other landscape changes. This is the environmental context in which the current application must be reviewed.

In this context, the Panel concludes that the first priority for any further development is to effect a transition from current unsustainable practices to sustainable practices. Water supply and consumptive demands must be brought into balance and this must be achieved without compromising the Little Bow River. The unsustainable burden of pollution from point and non-point sources must be curtailed and this effort must be integrated basin-wide. In short, the cumulative effects on the Little Bow River of water withdrawals on the one hand and pollution of the river on the other must be understood and managed within acceptable limits that reflect the natural capacities of the environment.

The incremental impacts of the three-component project will include a further loss of mixed grassland. In the context of the regional decline of this ecoregion, the impact must be regarded as a major adverse effect. The Panel has required a range of mitigation including habitat compensation but recognizes that habitat area will be lost; the residual effect is adverse. As previously stated, the Panel believes the residual adverse effects of the project on some species, including some COSEWIC-listed species – the burrowing owl, ferruginous hawk, and long-billed curlew, can be reduced to insignificance

by a successful habitat compensation plan and appropriate species-specific mitigation. The Applicant has made a commitment to undertake the required mitigation and the Panel requires APWSS to report on progress in one year.

The project alone cannot remedy all of the water shortages in the Little Bow basin, but it can improve the water supply. The project alone cannot resolve the basin's water quality problems. The Panel notes, however, that the full benefits of the project will only be realized if baseline phosphorous loading is curtailed before the reservoir is filled. The Panel has therefore recommended water quality mitigation which it believes will improve water quality conditions in the basin. The three-component project, with these additional measures, would make better quality water available to residents of the Little Bow basin.

The project will both destroy and create fish habitat. The Panel is confident that the Fisheries Mitigation and Enhancement Plan will, at a minimum, ensure compliance with the federal no net loss of habitat policy. The quality of the new reservoir habitat can be enhanced if baseline phosphorous loading is mitigated and spawning habitat is created. The three-component project will not mitigate the cumulative effects of water withdrawals on fisheries habitat in the Highwood River. It will, however, set the stage for the completion of upstream storage capable of mitigating those effects, at least for the open water season.

Through programs such as the "cows and fish" and other conservation programs, attention is already focused on the interaction between cattle grazing and the riverine ecosystem through the joint efforts of various participants. The Panel notes that water quality data indicates high fecal coliform levels exist in the upper Little Bow River and Mosquito Creek during the summer and fall that largely relate to unrestricted grazing. The evidence also indicates the critical role played by riparian vegetation in the ecosystem, and the need to protect and in some cases restore this important resource. Riparian vegetation is important to maintaining diversity within the ecosystem and plays an important role in maintaining both aquatic and terrestrial ecosystem components. Wildlife habitat and vegetation mitigation programs associated with the proposed project should involve careful consideration of the riparian vegetation. Fishery management objectives are dependent upon the protection of the watershed, especially streambank protection. While other examples could be noted, the Panel believes that the importance of the valued water resources and riverine ecosystem suggests that more effort should be devoted to ensuring its long-term integrity. The Panel recommends, therefore, that the M.D. of Willow Creek, the M.D. of Foothills, and the County of Vulcan take a leadership role in focusing the attention of basin residents on the importance of protection and maintaining the valued riverine ecosystem.

The proposed three-component project was not designed to remedy all of the ills of the Highwood and Little Bow basins and it is clear to the Panel that it will not mitigate all adverse cumulative effects of prior developments and activities. In this context, many of the anticipated benefits of the project can be realized only if the cumulative effects of other activities, particularly those that harm water quality, are also addressed. The Panel, within its jurisdiction, has required that responsible agencies mitigate water quality impacts. In cases where the Panel does not have direct jurisdiction, it has recommended mitigation measures to improve the prospects of achieving the anticipated project benefits. These are the first steps toward a coordinated basin-wide approach to the management of water resources.

The three-component project with the proposed mitigation and operated under the 1994 guidelines will address some of the cumulative impacts of prior development. It will bring water supply in line with demand in the lower Little Bow basin, while allowing the expansion of irrigated agriculture. It will not address all irrigation deficits. It will initiate the process of improving water quality in the basin. It will not address the adverse cumulative impact of development on fish habitat in the Highwood River - that can only be done with additional storage. In the context of basin-wide water management, the current

project is part of the solution. The restoration of Highwood fish habitat requires storage in the Little Bow basin to alleviate the need to divert large amounts of water during the irrigation season and storage for the upper Highwood to replace the water that must still be diverted to the Little Bow.

In conclusion, the three-component project with mitigation will have an adverse effect on vegetation and wildlife, a near-neutral effect on fish and fisheries, land and soils and a positive incremental effect on water supply and water quality. The Panel also recognizes the residual cumulative significant environmental effects that this project will have upon aboriginal historical resources. Given the nature of the anticipated impacts, the Panel does not expect any indirect socio-economic impacts of the adverse environmental effects of this project.

Future development in the basins will be affected by population growth, and limited by the availability of water to support further growth. The Panel reviewed information supplied by the Applicant about the potential for further development in the basins and weighed these projections in light of known constraints to further growth.

In deciding that the three-component project is in the public interest, the Panel concluded that the cumulative impact of this project and all other existing water uses in the basin would not cause additional significant adverse impacts on the aquatic environment of the Little Bow and Highwood river basins. Furthermore, the allocation of sufficient water for 8,090 ha (20,000 acres) of irrigation expansion in the Little Bow basin and Clear Lake is consistent with the SSRB Allocation Regulation which served to limit the extent of irrigation development in the Bow River basin.

For the future, the Panel recognizes that increasing demands for water in the Highwood and Little Bow River basins is inevitable, especially in terms of municipal growth. However, the Panel has concluded that the establishment of an IFN for the Highwood River and an approved operating plan for the project is the best way of ensuring that environmental water requirements are better met in the future. For this reason, the Panel has deferred their decision on the proposed operating plan pending refinements to the Highwood IFN and an assessment of opportunities for additional storage for the Highwood River basin.

The Panel has expressed its view that the current level of nutrient and particularly phosphorous loading of the Little Bow River is unsustainable and has recommended a basin-wide program to reduce the cumulative effects of both point sources and non-point sources, particularly agricultural runoff. In the future, population growth will increase the assimilative demands placed on the Frank lake wetlands, particularly if a proposal to divert municipal sewage from Okotoks to High River is adopted. The Panel cautions that the sewage diversion proposal should only be considered if it can be demonstrated that Frank Lake can assimilate the added load without increasing loading to the Little Bow River. The Panel is not aware of any specific proposals to site new intensive livestock operations in the Little Bow basin or to expand the meat processing industry beyond its recently increased size at this time. In the Panel's view, any additional load to the system would have to be considered very carefully within the context of the basin-wide assessment and remediation plan recommended by this Panel. The Alberta government is currently reviewing the regulation of siting of intensive livestock operations.

8.8 Social Effects

Lack of a secure and stable water supply in these drought prone basins is, in the opinion of the Panel, a major underlying factor affecting the social stability and well being of the residents of the basin.

A consistent theme throughout the public hearings was the desire to achieve a win-win solution to the water management problems in the basin. This is particularly evident in the concerns expressed for the residents along the upper reaches of the Little Bow River. It was expressed most strongly in connection with the need to maintain adequate conveyance flows in the Little Bow River. Downstream water users did not want to see their upstream neighbors adversely affected by the proposed development. This concern was demonstrated when project supporters indicated that their support was conditional upon the project not adversely affecting their upstream neighbors. This same concern extended to the residents along the lower Highwood River and the closely related concern that the fishery habitat in the Highwood River be protected. The manner in which these concerns were expressed indicates to the Panel that there is a strong sense of community in the basins and that many residents are prepared to put community needs before their individual priorities.

The Panel concludes that, if approved, the proposed project would have positive social effects on the area's municipal districts and counties and the communities within them, and on irrigation agriculture and as well as the larger farming community. A secure and stable water supply would provide assured water to local communities and complement their current water supply systems, particularly in times of drought and low flows. Present irrigators would have their uncertainty reduced and would experience more stable agricultural productivity. New irrigators would add investment and employment opportunities to the local area. The negative impacts of drought and crop losses would be reduced in frequency. Recreational use will increase and there will be economic spin-offs from that increase.

The proposed project, with its range of benefits including those of fisheries and recreation, would also add to the economy of the area and the stability of the population. The Panel believes the project, if approved, will result in local and regional economic benefits and is persuaded that the social stability and quality of life for residents of the region will be increased.

The Panel finds positive social effects of the proposed project in maintaining employment, with some possible employment growth, expanded recreation and community stability is positive and compelling. The Panel concludes that the potential social stability of the area must be given regard in reaching its overall decision regarding the Application. The Panel recognizes that the Treaty 7 First Nations do not view the project as positive for them and believe that it would harm their communities.

8.8.1 Little Bow Hutterian Brethren

The Panel believes that the relocation to the Little Bow Hutterite Colony is perhaps the largest single adverse social impact of the proposed Little Bow River Reservoir development. The Colony is home to more than 100 residents who will have to be up-rooted and relocated if the project were to proceed. In Alberta's extensive history of resource development there are very few examples where an entire community has been relocated to facilitate the development of a natural resource. In this case, the community being disrupted is relatively unique due to its religious beliefs and cultural practices. Due to these extraordinary circumstances, the Panel has given extensive consideration to the effects of this project on the residents of this Colony.

The fact that this Project has been in a planning phase for over 10 years has placed the Colony in a peculiar situation. The effect of the uncertainty surrounding the relocation of the Colony has, in itself, had a significant social impact on its residents. Hutterite colonies are created in the normal course of events when circumstances in the founding colony so require. In this case, the delay in reaching

a decision on the Little Bow/Highwood project and the resulting uncertainty has had a material effect on the division of the Colony and the development of new housing and agricultural facilities at its current location. To meet the proposed construction schedule, it may be necessary for APWSS and the Colony to engage a variety of contracted services to construct the new buildings required and to relocate those buildings which can be moved. Hutterite colonies tend to develop their facilities through direct labor provided by Colony members and the involvement of contracted services is not the normal way that Colony buildings and facilities are developed.

The Panel recognizes that the various effects on the Hutterite Colony can not be avoided if the project is to proceed. The Panel is aware that there are plans emerging to successfully relocate the Colony at an identified site on the Little Bow River and relatively close to the existing Colony site. While the successful relocation of the Hutterite Colony would be intended to make the Colony whole again, the Panel recognizes that the forced relocation will inevitably involve residual impacts for which there can be no compensation. These unmitigated effects are the direct consequence of the proposed project, and are over and above the unquantified effects associated with the uncertainty regarding the need to relocate that occurred during the planning of the project.

The Hutterites questioned whether or not APWSS had the authority to build this project and whether or not AEP, as the future owner and operator of the works, would be bound by the conditions accepted by APWSS. A similar situation also arose during the Pine Coulee Project review. The Panel believes that the viewpoint and decision taken then are also applicable to this Project and meet the concerns raised by the Interveners.

> "The Panel notes as well that the two departments are involved in the design, construction and operation of the proposed project and act on behalf of Her Majesty the Queen in right of Alberta. For the Panel's purposes, it will adopt the view that the Government of Alberta will be the entity responsible for the design, construction and operation of the proposed project. Where convenient, the Panel will refer to the specific department involved in various phases of the project. But such references are not intended to imply that the obligations of the Government of Alberta for the project are divisible nor does the Panel adopt the view that the commitments of APWSS are binding only on that specific agency; rather, as indicated in the hearing, commitments made by APWSS are made on behalf of the Government of Alberta." (Pine Coulee Decision Report, page 3-3)

Further, the Panel, in drafting the form of approval for Pine Coulee and this Project made an effort to use the word "operator" in certain sections rather than proponent, applicant or APWSS. This is intended to indicate that AEP was included in the conditions stipulated.

All participants recognize the credibility of the review process depends on the implementation of the conditions determined by the Panel. This issue was raised by the Hutterites and other interveners. The NRCB legislation does provide for the Board's ongoing involvement, on a limited basis, even though it has not exercised this aspect of its jurisdiction for previous approvals. The Panel encourages the NRCB to take an active role where appropriate.

The Panel accepts this advice from interveners and will require that a report be filed with the NRCB on the progress of negotiation with the Hutterites as part of a mitigation progress report within one year of the release of this decision report. The Panel requests that APWSS indicate how and when the various matters raised by the Hutterites in their final argument have been dealt with. In particular the Panel wishes to be informed on the relocation process and whether or not the appropriate permits and licenses have been acquired.

Counsel for the Hutterites asked for a number of conditions. As a general principle the Panel points out that almost all of the conditions requested by the Hutterites are normally dealt with by other decision-making bodies. In the case of compensation, it could either be the Applicant, the Land Compensation Board or the Court; in the case of permits and licenses, it is the body with a particular authority; and with respect to water rights and diversion it is the Controller of Water Resources. The Panel respects the jurisdiction of these bodies. Indeed, evidence was heard that these bodies were prepared to deal with the Colony in full awareness of the Colony's contribution to the Project and the unique needs involved in their relocation.

The Hutterian Brethren asked the NRCB to maintain an interest in the negotiations that are now under way. The Panel asks both parties to participate in intensive, good faith negotiations and recommends that APWSS report the general results to the NRCB within one year. The Panel further recommends that no expropriation proceedings be undertaken during this time and that every effort be made to relocate the Colony and its agricultural businesses.

On easements versus fee simple, the Panel appreciates that the Crown operates in many areas of its jurisdiction using easements rather that fee simple. It also appreciates the Hutterite argument that they are willing to provide reasonable easements for the life of the dam and reservoir. The Panel believes that these matters are part of the negotiation now on-going between APWSS and the Hutterites and should continue to be dealt with there. It would encourage the parties to find an acceptable way of meeting each of their legitimate needs.

On permits, licenses and approvals, the Panel urges all the regulatory bodies involved to expedite these after the Hutterites have made the appropriate applications. The Panel requires that APWSS keep the NRCB informed as to both the success and difficulties involved in the various applications. The Panel recommends that APWSS assist the Colony wherever possible to obtain these necessary approvals.

The Panel believes that it is reasonable that landowners adjacent to the Little Bow River Reservoir retain riparian water rights or be granted water licences to replace these rights. However it leaves the manner and way that this can be done to be included in the negotiation process. The Panel accepts the APWSS and AEP information that there are remaining, unallocated irrigation rights that can be applied for around the reservoir. The Panel believes that these costs and any possible losses involved are properly included in the negotiation. The Panel does not agree that people who lose lands to the Project should be given special irrigation water rights, but it does agree that they should be properly compensated and given opportunities to apply for project related benefits.

The Panel has provided specific comment on the recommendations made by the Colony regarding the details of the proposed land acquisition and other matters raised by them. The Panel believes that the successful relocation of the Hutterite Colony will take special care and attention on the part of the various parties involved, including APWSS, local jurisdictions, area residents and the Colony itself.

8.8.2 Transportation

The Public Advisory Committee, with input from the Applicant, dealt extensively over several years with the need to provide for replacement roads and roads to accommodate new land uses in the immediate vicinity of the proposed Little Bow River Reservoir.

The Panel notes, should the project as proposed, with a new road around the south end of the reservoir, be approved, that the existing rural road system in the immediate vicinity of the project would need to be revised. The Applicant would need to provide replacement roads and also need to accommodate existing uses and potential future needs of water-based recreationalists and non-agricultural users.

The Panel has considered the requests of the Applicant, the M.D. District of Willow Creek, the County of Vulcan and other participants to provide guidance on the transportation implications of the proposed project. The Panel believes that such matters are normally dealt with in a satisfactory manner through consultation between the Applicant and various local parties and authorities. However, in this case such a resolution has not been reached.

The Panel concludes that transportation issues are an important component of the overall project that must be resolved to ensure that the long-term public interest is met.

The Panel has been asked by some affected parties to recommend the best transportation development plan for the region from several alternatives offered by APWSS and various public interest groups. However, local municipal governments clearly indicated to the Panel that they felt they were both responsible and in the best position to make local decisions regarding local transportation issues. They gave no indication that they were prepared to abdicate their responsibility to the Panel with respect to transportation route selection. The local municipalities, in cooperation with Alberta Transportation and Utilities, clearly wish to retain responsibility for transportation matters within in their respective areas of jurisdiction.

With respect to the East-West regional transportation route directly impacted by the Little Bow River Reservoir, the Panel believes it has the jurisdiction to decide on transportation mitigative measures that are directly related to the proposed Little Bow River Reservoir. However, the Panel believes that secondary route status and routing preferences related to subsequent road upgrading and/or construction are decisions most appropriate for local community residents, the Applicant, the M.D. of Willow Creek, the County of Vulcan, and Alberta Transportation and Utilities. The Panel is not, therefore, prepared to impose specific transportation mitigation conditions on the Applicant that would prejudice or preclude the decisions that will be made by the appropriate authorities. However, given the extensive evidence presented on this matter, the Panel is prepared to offer specific recommendations that may assist in the resolution of the required transportation mitigation decisions.

Taking all factors into account, the Panel believes that a direct crossing of the proposed Little Bow River Reservoir best meets the needs of the community affected the most. Crossing the reservoir requires the construction of a bridge that is capable of passing a major flood that primarily originates in the Highwood River basin. A combination of a bridge and a causeway, similar to the solution found at Pine Coulee but with a larger bridge, might provide a more efficient but more expensive transportation solution. The Applicant has not pursued this option due to cost and safety considerations. Instead, the Applicant has proposed a new route around the south end of the dam. This new route places the burden of cost and inconvenience on the local municipalities and area residents. The Panel recommends the transportation route directly across the proposed Little Bow River Reservoir. This transportation solution has and would have the support of the Alston community and place the financial obligation for mitigation squarely on the shoulders of the Applicant. The municipal authorities would then be responsible for those costs required to ensure appropriate roads lead up to the reservoir crossing. This would allow the long-postponed upgrading of the existing secondary highway in the M.D. of Willow Creek to proceed.

In the Panel's opinion a direct crossing of the proposed Little Bow River Reservoir at or near the location of the existing SH 529 would provide the most effective mitigation of the transportation effects of the proposed reservoir. The Panel has no evidence before it that it is not technically feasible to build a causeway/bridge across the proposed reservoir that is safe and capable of passing the predicted maximum probable flood of the Little Bow River. Based on the evidence before the Panel this time, it appears that the causeway/bridge crossing of the proposed reservoir would cost at least $12 million. The cost of the various alternatives to route traffic around the reservoir are in the range of $4 million to $8 million. All of these alternatives are inferior to the direct crossing of the proposed reservoir and impose a direct social and financial burden on the community residents directly affected by these alternatives. The Panel concludes that the issue comes down to the price of successfully mitigating this major project effect.

In almost all other aspects of the proposed project the Applicant has identified the best mitigative measures available and where equivalent measures were evaluated, lower-cost alternatives were selected. For example, in order to mitigate Diversion Plan impacts on the fishery resource in the Highwood River the Applicant has proposed the expansion of the Squaw Coulee Reservoir at a cost of over $7 million. In selecting this proposed mitigative measure, the Applicant has placed priority on the effectiveness of the mitigative measure, not its cost. The Panel believes that similar reasoning should be applied to the consideration of mitigation alternatives for transportation impacts. The Panel is also aware that a bridge/causeway has been selected in the case of the Pine Coulee Reservoir at considerable extra expense to minimize the social effects in that case. In the Panel's opinion, the circumstances in the current Application are more compelling.

The Panel believes that mitigation of transportation impacts is the sole responsibility of the Alberta government. The Panel believes that the Applicant attempted to control Little Bow River Reservoir construction costs at the direct social and economic expense of the communities affected by providing no direct crossing of the proposed reservoir. Review of alternative routes to provide an east-west connection appeared to show many new routes that placed the burden of cost and inconvenience on local municipalities and area residents and did not meet the transportation needs of the area.

The Panel directs APWSS to compile and present to all stakeholders further comparative information on transportation alternatives including a potential bridge and causeway crossing of the Little Bow River Reservoir.

Furthermore, the Panel recommends that a more comprehensive regional transportation plan be created with all municipal, provincial authorities and area resident stakeholders to meet the needs of all communities impacted by the Little Bow River Reservoir project. Attention should be focused on current community needs and resolving the transportation conflict created by the Little Bow Project. The past APWSS public participation strategies restricted successful resolution of the transportation issue.

Mitigation of construction impacts is required. For example, during construction of the Little Bow River Reservoir, it is required that APWSS implement dust control mechanisms, such as oiling, to reduce dust on gravel roads subject to heavy construction traffic and identify construction traffic routes that do not conflict with school bus routes or playground areas in local towns.

8.8.3 Water Supply and Use

The Panel believes that implementation of the project would benefit the Town of Vulcan in terms of creating a dependable municipal water supply. Having year-round access to water should allow plant operators to pump and treat water as demanded, and should lead to some reduction in operating costs. However, any reduction in water treatment costs will depend on the steps taken to resolve the problem of discharges from Frank Lake and steps taken to control and minimize other potential upstream sources of pollution.

The Panel concludes the project could lead to more secure water supplies for municipal or domestic water users located at or below the proposed Little Bow River Reservoir. Water managers would have more flexibility in how they meet municipal and domestic water demands. The Panel concludes that the reservoir would cause reduced turbidity in the lower reaches of the Little Bow River so that municipal and domestic users could experience some benefits in the form of improved water quality and reduced treatment costs. Since turbidity currently appears to be of greater concern to these communities the Panel concludes that project implementation could have some beneficial impacts on water users in Carmangay and the three water co-operatives.

The Panel believes the project could also benefit existing licensed domestic water users. The Carmangay Hutterian Brethren withdraw their water at a point downstream of the proposed reservoir so they may see reductions in turbidity and lower treatment costs. This Colony could have a more secure water supply as a result of the operating regime for the reservoir. The Little Bow Hutterian Brethren currently withdraw water from the Little Bow River at a location that would be flooded by the reservoir. However, since this Colony would have to be relocated, project impacts on their domestic water supply will depend on the new location of the Colony. The replacement site being offered by APWSS is located on the Little Bow River downstream from the reservoir. Relocation of the Colony to this site may then give them the same domestic water quality benefits that would be experienced by the Carmangay Hutterian Brethren.

The Panel agrees that the general relationship between surface water and groundwater in the upper Little Bow River basin is that groundwater flows toward the Little Bow River. Whether or not implementation of the project would affect groundwater quantity in specific localized and seasonal situations is uncertain but possible. The Panel concludes that monitoring of water levels in groundwater wells is a prudent method for addressing intervener concerns. The Panel requires that APWSS, to the satisfaction of AEP, monitor water levels in groundwater wells and to mitigate any project-related groundwater problems experienced by domestic water users.

The Panel concludes that, at a minimum, implementation of the three-component project would allow irrigation expansion on 8,090 ha (20,000 acres) and that this would help stabilize and expand farm incomes. The project may also provide a more reliable irrigation water supply to existing irrigators at or below the reservoir. Benefits to unsupported irrigators will depend on a revised diversion plan. The Panel expects the plan would ensure that none of the existing irrigators face higher deficits, especially during drought conditions. The Panel recognizes and accepts the common belief among regional residents that increased water storage would support expansion and diversification of the regional agricultural economy.

The Panel concludes that Clear Lake area farmers are committed to conversion from dryland to irrigation farming and appear aware of the risks regarding the need for timely irrigation withdrawals to stabilize water quality in Clear Lake. The farmers have waited a long time and appear ready to assume responsibility to make this component work successfully.

The Panel concludes that the costs incurred by farmers around Clear Lake to assess soil irrigability demonstrates sufficient commitment to proceed with development of this component of the project. AEP needs to identify more clearly the role of Clear Lake water users in any irrigation "sign up" plan. The Panel recommends that a Clear Lake Irrigation Development Plan be prepared involving local farmers, Alberta Agriculture and Rural Development, AEP and APWSS.

The Panel also directs that the north end of Clear Lake be managed for waterfowl and shorebird habitat and that intensive recreational activities in this area should be limited during times when these species are most prone to disturbance.

The Panel has concluded that development of the three-component project would have a positive, long-term impact on recreation in the region, resulting in improvements in the quality of life and providing opportunities for economic diversification. This type of development is consistent with sustainable development.

The Panel believes it is in the public interest for APWSS to develop day-use facilities on the new reservoir. This should allow safe access to the reservoir and could minimize potential impacts on adjacent landowners by concentrating activities at one or two locations on the reservoir.

The Panel recognizes that, at some time in the future, more intensive recreational facilities may be developed on the reservoir and at Clear Lake. However, APWSS has not proposed the development of any such facilities, and the Panel has neither the mandate nor intent of approving any intensive recreational development at this time. The Panel urges the County of Vulcan and the M.D. of Willow Creek to adopt area structure plans for both the reservoir and Clear Lake, and to use this process to determine the types of recreational development that are appropriate to local residents.

The Panel has reviewed the suggestions made by the Recreational Interests Group to modify the construction and operations of the reservoir to maximize the potential for future recreational interests. While these proposals may be technically feasible, the Panel concludes that it would be more appropriate for the private sector to seek approval and pay for any shoreline modifications needed to support future recreational development. Such modifications would of course require all the necessary approvals from regulatory authorities prior to implementation. In terms of modifying the reservoir operating regime to reduce drawdown, the Panel concludes that the primary goal of the reservoir is to store water for consumptive use and that recreational usage would have to accommodate the inevitable fluctuations in water levels that would occur from withdrawing water to meet these needs. The Panel concludes that placing constraints on reservoir operations that might limit water supply from the reservoir during water shortages is not in the broader public interest.

8.8.4 Municipal Wastewater Disposal

Project impacts on municipal sewage treatment and stormwater management practices are directly related to the broader issue of project impacts on water quality. Evidence presented at the hearing suggests that the Little Bow River Reservoir would be hypereutrophic, and the resulting water quality would adversely affect the reservoir's ability to sustain a viable fishery, support recreation, or provide improved municipal drinking water. The Panel is hopeful that various efforts will be taken to reduce nutrient loads in the Little Bow River and Mosquito Creek, including the development of a basin water

quality management strategy to reduce nutrient loads by 60 to 80 per cent. The Panel recommends that costs associated with controlling pollutants be borne by those who are responsible for generating them and not passed on to downstream residents or the public at large.

The Panel notes the concerns of Little Bow and Highwood river residents related to adjacent land use, agriculture cropping and livestock practices, and municipal stormwater and wastewater management impacts on downstream water quality. The Panel believes it is in the public interest to address and mitigate point and non-point source pollution impacting water quality. The Panel believes the implementation of a Little Bow River Reservoir Water Quality Protection Plan could lead to basin-wide water quality solutions.

The Panel is concerned about the water quality in Frank Lake negatively impacting the potential Little Bow River Reservoir and current water quality for upper Little Bow water users. The Panel recommends that AEP create a Frank Lake Water Quality Mitigation Plan, which would control nutrients from Frank Lake to background levels that existed prior to the receipt of wastewater directed to the Lake. It is further suggested that monitoring results from the Frank Lake Water Quality Mitigation Plan be released to the public annually.

In regard to the Town of Nanton, the Panel believes that although existing sewage releases may not appear to significantly add to the elevated nutrient concentrations in Mosquito Creek, they are adding a nutrient load to the lower reaches of the basin. The cumulative impact of all nutrient releases, including those from various non-point sources, may seriously constrain the ability of the project to achieve its stated objectives. Like all other sources within the basin, Nanton may also have to improve the quality of its surface water discharges.

8.8.5 Navigation

With respect to the effects of the project on navigable waters, the Panel notes that the Little Bow and lower Mosquito Creek basins currently receive little use for canoeing primarily due to low flows during most months of the open water season. The proposed project would create the Little Bow River Reservoir, which would be navigable. It would also stabilize Clear Lake and would enable water-based recreation and boating. The diversion structure would continue to create to a barrier to navigation at the diversion works on the Highwood River, and the Little Bow River Reservoir outlet works may have some effects on flows that may present some degree of navigation concern. Due to the limited current and expected use of the Little Bow River and Mosquito Creek for navigation purposes, the Panel does not believe that it would be necessary to develop extensive compensating works to enable passage, but some attention should be given to permit a safe and convenient portage around the diversion works and the dam head-works. The Panel requires that the Applicant, to the satisfaction of the Department of Fisheries and Oceans, establish a safe and convenient portage around the works. The Panel believes that the diversion works and outlet works may present some degree of hazard to canoes or other small craft, but has confidence that relevant federal and provincial authorities would ensure that appropriate steps are taken to mitigate such effects.

In regard to including conditions related to navigation in the operating plans for the dam and diversion works, the Panel believes that it is not in the public interest to place constraints on the project's ability to store and convey water for consumptive uses. The Panel believes that, in times of

drought, water requirements for municipal, domestic and agricultural use should take precedence over navigational and recreational uses, especially since such activities occur so infrequently. The Panel expects that water shortages would tend to occur in late July and August, when normal flows on Mosquito Creek and the upper Little Bow River would preclude boating. Furthermore, including provisions for navigational flows could lead to greater recreational usage and increased risks to public safety unless landowners remove fencing, canal/river crossings and other obstacles. To ensure boating safety on the reservoir, the Panel supports APWSS's proposal to close recreational facilities if water levels drop below a specified elevation.

Overall, the Panel expects that the proposed project would have a minor effect on navigation on the Little Bow River and Mosquito Creek due to the limited use they receive for such purposes.

8.8.6 Land Use and Planning

The Panel believes it is generally appropriate for APWSS to acquire the lands to be flooded or impacted by the new reservoir through purchase in fee simple, with certain exceptions. In this way, APWSS can control and minimize the impacts of any future water fluctuations or bank erosion or slumping and maintain the maximum flexibility in operating the reservoir. This means that landowners surrounding the reservoir would no longer have a riparian right to water. The Panel believes that it is in the public interest for these adjacent landowners to be able to continue to withdraw water from the reservoir for domestic purposes. The Panel therefore directs APWSS to ensure the legal right to domestic water use from the reservoir in the land purchase agreements to be negotiated with landowners around the reservoir, should the project be approved.

The Panel concludes that it is up to APWSS to negotiate compensation and mitigation agreements directly with affected landowners, and recognizes that procedures for resolving disputes are established elsewhere. The Panel urges APWSS together with AEP to provide assistance to landowners who wish to relocate or transfer existing irrigation licences to other diversion points on lands adjacent to the reservoir.

The Panel encourages APWSS and AEP to enter into agreements with landowners to prevent cattle from entering these water bodies, thereby protecting water quality and shoreline habitat. In addition, the Panel encourages landowners to build dugouts on adjacent lands so that livestock would have an alternative source of supply.

In terms of concerns about continued livestock watering in water bodies and the resulting disturbances to riparian habitats and water quality, the Panel requires that APWSS develop a detailed plan to address these issues along the affected water bodies. Such a plan should be developed in consultation with local landowners and stakeholders and should be reviewed and approved by AEP and Alberta Agriculture Food and Rural Development. The Panel recommends that the funds to cover the intermediate and long-term costs of implementing such a plan be included in the capital and operating budget for the project. In addition, responsibility for implementation of the plan should be passed on to AEP when project ownership is transferred over from APWSS. The Panel is aware that there are limitations to what APWSS or AEP may do in some cases.

The Panel believes that to accommodate development of the proposed dam, canals and public recreation sites, it is not necessary to revise the current land-use plans of the Town of High River, the County of Vulcan and the M.D. of Willow Creek. These plans provide for public utilities as

discretionary land uses and the proposed project components are for public-utility like purposes. For more certainty, if the Panel's view of the current land use by-law is not accurate, then the Panel would expect, in the context of Section 619 of the *Municipal Government Act*, that the lands affected by the project be zoned to accommodate the construction and operation of water management facilities as described in the Application.

The Panel believes that the best approach for dealing with land management issues is for APWSS to deal with individual landowners on a case-by-case basis as these issues arise. The Panel directs APWSS to mitigate or compensate landowners for any damages to structures, fences or stream crossings that are in compliance with existing laws and regulations. The Panel also believes that it is appropriate to establish a window of time during which APWSS would be required to address landowner concerns. However, the Panel believes that this window should be for five years after implementation of the revised diversion plan rather than five years after project implementation. The Panel also supports APWSS's proposal to use a third party dispute resolution mechanism.

The Panel also recognizes that many landowners are directly and indirectly affected by the proposed project. Like the Hutterite Colony, these landowners have also experienced disruptions in their lives during the planning of this proposed development, and should the project proceed, will again experience further disruptions. They too may experience a loss of some of their lands to the project and, although compensation is intended to make them whole, they would also feel residual effects for which there can be no compensation.

The Panel received evidence regarding the recreational potential of the proposed Little Bow River Reservoir. The reservoir is intended for multi-purpose use, and the Panel concludes that the water quality expected in the reservoir and the operational regime that will be required to obtain the proposed project benefits would tend to dampen the recreational potential of the reservoir. Nevertheless, the Panel fully expects that the reservoir would receive recreational use that is likely to increase over time due to the relative scarcity of water-based recreation opportunities in the basin. The Panel concludes that it would be prudent to anticipate the need to accommodate various recreational uses in the planning for future land uses adjacent to the reservoir. The Panel agrees with some interveners that the proposed reservoir would create recreational opportunities where none previously existed.

The Panel requires that APWSS, as part of its final planning and design phase, prepare an area structure plan for the lands in the immediate vicinity of the Little Bow River Reservoir. Preparation of the area structure plan should include a public involvement program to involve where applicable, the M.D. of Willow Creek, the County of Vulcan, local communities, interested stakeholders, AEP, Alberta Community Development, and landowners in the vicinity of the proposed reservoir. Matters to be considered should include the following:

- the basic road system adjacent to the reservoir and standards to safely and efficiently service the existing and future land uses adjacent to the reservoir;
- the use of fragmented parcels that would result from the project;
- the need for day use areas, boat launching areas, view points, the aboriginal culture interpretive area, and other similar features which may arise in the preparation of the area structure plan;

- preservation and exhibition of areas of historical and archaeological interest, including the twin hearth teepee ring, in cooperation with Alberta Community Development, Treaty 7 aboriginal people, and other interested parties;

- habitat compensation lands adjacent to the reservoir and the need for environmental reserve lands that might be set aside;

- recreation and country residential development;

- mitigation of the conflicts that may arise between the new land-uses and the existing agricultural community including air and water pollution or other issues for the lands in the vicinity of the reservoir that are to remain under agricultural land uses; and,

- any extra or special administrative infrastructure that may be required and other normal items that need to be considered in an area structure plan of this nature.

The Panel requires that APWSS complete this plan and request amendments to the local land use by-laws from the M.D. of Willow Creek and the County of Vulcan prior to commencement of reservoir operations.

8.8.7 Public Safety and Risk

The Panel believes that planning for and protecting public safety is of high priority in enabling the three-component project to successfully meet its objectives. APWSS provided evidence that the dam and spillway were designed to accommodate the Probable Maximum Flood and that this provides a safety margin such that the probability of a dam failure is extremely small. The Panel concludes that, although the environmental and social impacts of a dam failure would be significant, the potential risk of such a failure would be insignificant. The Panel also concludes that APWSS has considered geotechnical and hydrological factors in the design of the dam and other structures so that the potential impacts of the environment on the dam and other structures would also be insignificant. The Panel requires the Applicant, their contractors, and future project operators to abide by all safety codes, regulations, engineering design standards, and established best management practices relevant to the construction, operation, and maintenance of the project.

The Panel is confident that the public's participation in developing the Emergency Response Plan would produce a practical and reliable plan. The Panel supports the Applicant's position that they would provide compensation for project-caused property damages but not for damages caused by natural flood events.

8.8.8 Aboriginal Interests and Concerns

The Panel was presented with a series of important issues related to First Nation concerns by the Blood Tribe and the Treaty 7 Coalition presentations. A number of the issues raised are beyond the purview or jurisdiction of this Panel. The First Nations raised issues, which can be categorized in three broad areas.

- Water rights, allocation, water management, and the impact of this project on the Oldman River, which flows through the Peigan Reserve and on the border of the Blood Reserve;

- The question of consultation and communication between the Applicant, its consultants and other Alberta government departments with the First Nations and the adequacy of the archaeological research done and the subsequent mitigation proposed; and

- Archaeological sites, their present day meaning to the Treaty 7 aboriginal people, their protection, and the impact on the Blackfoot people of losing any or all of those sites.

The Panel is persuaded that this project would have minimal effect on the flows going into the lower Little Bow River below Travers Reservoir and from there into the Oldman River, or on flows in the lower Highwood River and on into the Bow River. The Panel accepts AEP's evidence that the apportionment agreement with Saskatchewan will not be measurably affected by this Project.

The Panel accepts that should the outcome of the long-standing litigation favour the Peigan and they receive more water allocation and a prior right to that water than almost all present rights holders, sufficient water or an appropriate water management plan can be found or already exists to accommodate that eventuality. The Panel accepts AEP's most recent modeling information and interpretations as reasonable in this regard.

The Highwood/Little Bow Project, in the Panel's view, does not materially affect the allocation of water in the Oldman and Bow basins. The Peigan and other possible water demands from the Blood and Siksika First Nations could be accommodated in a variety of ways including: use of existing allotments of water not as yet taken for irrigation; use of stored water in the Oldman River Dam; reallocation of existing water priorities within the basins in question; or changed or co-operative water management practices regarding the sharing of deficits. The Panel accepts AEP's argument that any shortfalls in water during dry months or years, in either the Bow or Oldman basins, will not be made up from the flows or storage connected with this project.

The Panel does not believe that this project negatively affects the current or future economic well being of either the Peigan or Blood First Nations. Water taken during periods of high flow (the spring freshet) and stored can be managed for release during times of low or lower flow. Storage actually provides the Government of Alberta with additional opportunities and tools to manage water for all purposes. The Panel is of the opinion that existing and possible future aboriginal water needs or claims may actually have a greater possibility of fulfillment if there is increased water storage in the SSRB.

The Panel feels that it is time for all parties involved to engage in a review of communication and consultation requirements relating to all First Nation's and archaeological resources. The *Historical Resources Act* of Alberta presently does not require consultation with Alberta First Nations when archaeological work connected with projects is undertaken. Both groups in the 1995 Pine Coulee Hearing and in this hearing raised similar issues regarding consultation and communication as it relates to archaeological work. In fact the Pine Coulee Panel made a similar recommendation in 1995 and this Panel is surprised that there has been no serious attention to the problem.

The Panel feels that the lack of early, consistent and meaningful consultation with the Blackfoot First Nations is a serious matter and must be addressed. APWSS's archaeological consultant

acknowledged that prior consultation had not taken place, nor was it required, when the Historical Resources Inventory work was completed. However, contact was made with both the Blood and the Peigan First Nations after the EIA was released, some discussions did take place and field visits, involving the proponent, the HRIA consultant, and First Nations' people, took place in 1997. In the Panel's view the Treaty 7 First Nations should be included in direct communication and consultation regarding any project in their traditional territories that touches places that are of historic or sacred importance to them.

The Panel feels that an on-going communication and consultation mechanism should be established with respect to this project. The Panel is aware that this is not an easy task and there are many difficulties involved. Yet all parties at the Hearing expressed a willingness to meet and talk, to learn from each other and to try to reach decisions that would give regard for the legitimate needs of each party. At a minimum, the Panel recommends an all party group be established to oversee any project related activities including monitoring of construction, removal of archaeological material, preparation of explanatory or educational information, protection of sites and guidance for additional studies or protective actions. This group should consist of the proponent, AEP, ACD, First Nations, local governments and local landowners.

The Panel supports the recommendation that the names of the Old Woman's Buffalo Jump and Squaw Coulee be changed as quickly as possible. The proponent and ACD agreed that this should be done and the First Nations requested it be done. The names suggested would be Woman's Buffalo Jump and Woman's Coulee. This matter has been referred to the appropriate agency and the Panel requires that APWSS follow up on that request and inform the NRCB/CEAA about any decisions made.

The Panel has decided to defer consideration of the expansion of the existing reservoir at Squaw Coulee pending the receipt of additional information. The Panel is prepared however to offer the following comments with respect to the Woman's Buffalo Jump and Woman's Coulee. The Panel recommends that the Woman's Buffalo Jump (EcPl 1) (designated as a Provincial Heritage Resource) and associated features should be more thoroughly protected. This site is showing signs of deterioration due to erosion and some illegal excavations. Bison Historical Services Ltd. in their 1997 work indicated that information is "sketchy" on the associated sites and the surrounding geographic areas, some of which have been designated as having "Significant Historic Resource Potential". The proponent, ACD and AEP, First Nations and local governments and local residents should work together to address this issue.

The Panel does not accept that an enlargement of storage on Woman's Coulee (if the Super Expanded Squaw Coulee Reservoir was ever approved) should necessarily be considered as a major negative visual intrusion on the Woman's Buffalo site and therefore exclude the future consideration of the site.

The Panel agrees that there will be significant residual adverse environmental effects leading to social and cultural losses for aboriginal people, particularly the Blackfoot First Nations, if the development of the Little Bow River Reservoir goes ahead. It also agrees that this loss can not be mitigated fully and adds to the loss of other archaeological resources already lost through previous changes to the aboriginal traditional lands off the Reserves.

Agricultural, industrial, recreation and municipal developments in southern Alberta have affected a number of prehistoric sites. The Panel appreciates the arguments advanced by the First Nations that continued development in some geographic areas should not take place because this will destroy the availability of those places for current and future cultural and spiritual use. The Panel observes that under existing legal arrangements and understandings further water management projects are deemed

appropriate and can be in the broader public interest. However, the losses for First Nations people must be acknowledged, resources identified to mitigate and reduce as much of the loss as possible, sites preserved wherever possible, and impacts kept to a minimum.

The Panel believes that it is necessary to provide a broader examination and interpretation of the First Nation's history and occupation in the Little Bow area. An interpretive area and education program needs to be established in that geographic area to document the importance of the area and the losses that have occurred because of changes to it and other adjacent areas such as the Pine Coulee Reservoir, Travers Reservoir and possibly the Oldman River Dam Reservoir.

To assist in the interpretation of the loss to aboriginal people, the Panel would require extra-ordinary research in a number of areas, if the project is approved.

The Panel would require that further archaeological work be done in the vicinity of the Clear Lake canal. This should include more intensive examination of the canal route and the area around the route as well as the junction point of the canal and the region surrounding it at Mosquito Creek. The proponent and the previously identified groups should prepare a research plan for this and it should proceed as soon as possible.

The Panel would also require that more archaeological work be done on the area in and around the confluence of the Little Bow River and Mosquito Creek. This would include some of the area above FSL as well as more intensive examination of the riverine valleys. The two hearth site (EbPi 51-52) should be relocated.

If the project is approved, the Panel would require that a focussed ethnobotanical study be undertaken within and around the proposed Little Bow River Reservoir area with regard to identifying plants used by First Nations people and clarifying their uses where it is permissible. This study should begin as soon as possible and would require the guidance of ACD.

The Panel would also recommend that some research attention be given to the issue of trails in the area and the Old North Trail in particular, if the project is approved. An regional overview needs to be taken on this subject and then a determination made regarding further research. The Panel observes that if trails are not deliberately searched for, those portions that might remain may never be identified. ACD has already indicated that some work on this issue has been requested.

The Panel notes the fiduciary obligations of the Crown and the assertion that such obligations include ensuring that cultural and religious rights of First Nations people are protected. The Panel particularly notes the concern regarding the treatment of culturally significant sites. The Panel notes again the Blood position regarding the need to re-evaluate how aboriginal culture and religion are viewed and treated. The Panel realizes that Alberta legislation regarding historical resources has some relevance to certain aspects of this concern. However, the matter is much more complex and pervasive than the purview of this legislation or the review of this project.

The Panel heard extensive technical and historic evidence on archaeological resources in the area of the confluence of Mosquito Creek and Little Bow River, including detailed questioning and discussion about this research and its implications. The Panel commends APWSS, ACD and their consultants for their careful and thorough research work. It also commends them and the aboriginal participants for the way they sought to address the issues of archaeological and historic resources during the hearing.

The Panel is concerned that the religious, spiritual and cultural significance of the archaeological sites at the proposed Little Bow River Reservoir to the aboriginal people be fully identified, understood and reflected in the planning and development of the project, should it proceed. The Panel accepts that the confluence of the Little Bow River and Mosquito Creek was an important meeting place and camping area that has historical and contemporary significance to the interests of the aboriginal people.

The Panel notes the reluctance of the aboriginal participants to identify and explain the importance and significance of various sites and artifacts for a variety of reasons. The Panel also notes the request to re-evaluate how aboriginal culture and religion are viewed and treated, and the request for a maturing process and a commitment to examine existing views and relationships between aboriginal people and the dominant culture.

The Panel concludes the presentations made by the elders and Band members are an important part of the process. Protection and recognition of cultural and religious freedoms depends upon awareness and understanding. The aboriginal presentations to the Panel have emphasized that the site of the confluence of Mosquito Creek and Little Bow River has special religious, spiritual, and cultural significance to the elders.

The Panel is cognizant that the criteria used to assess the significance of the sites at the proposed Little Bow River Reservoir area from a research perspective may not reflect the criteria used by aboriginal elders. The Panel also notes that the objective of ACD's heritage resources program is to ensure that significant artifacts are protected and preserved, and that ACD has been working more closely with aboriginal people in identifying, assessing, and managing historical impacts associated with proposed developments.

The Panel has considered the issue of the entire complex of sites that were found in and around Little Bow River Reservoir area and their cultural significance. The Panel accepts that many of the archaeological sites, such as teepee rings and campsites, are common in Alberta. However, the Panel notes that further archaeological assessment remains to be completed and that the evidence from the aboriginal presentations indicated that, based on their traditional knowledge, the sites contained more information than was known to the archaeologists. The Panel notes that the researchers may not have recognized some important features of the sites, and that the aboriginal people have a different understanding of the sense of place, the artifacts and their interpretation. The Panel is concerned that the aboriginal people mentioned cultural information not made known to the researchers, and left the Panel with the impression that the sites may have more spiritual and religious significance than known or understood through the research conducted to date. The Panel concludes that in the face of uncertainty, a more prudent and cautious approach should be taken before any final conclusions are drawn regarding the significance of the various camp sites and meeting places found in the vicinity of the confluence of the two rivers. In this case, where it is recognized that relatively undisturbed camping areas and summer meeting places are becoming more significant at provincial and regional levels, conservative assumptions regarding mitigation should be made about them and nearby sites until sufficient evidence has been considered to warrant reaching other conclusions.

The Panel has concluded from the evidence currently available, that there is a need to require that the Applicant, in a manner satisfactory to ACD, undertake additional archeological research and to consult with aboriginal elders. The Panel is not satisfied that the Applicant has made significant progress in developing a new way of working together with aboriginal people. The Panel is prepared to put aboriginal people in a position to provide greater influence over the investigative work to be undertaken, if the project is to be approved.

The Panel heard that, in regard to developments such as the proposed project, all significant aspects of the archaeological, prehistoric and historic resources are safeguarded and managed through the existing regulatory regime in Alberta. The activities include identification, designation, and where appropriate preservation of significant resources; establishing responsibility for mitigation of negative impacts that may be caused by a development; ongoing monitoring; and where required, final disposition of artifacts.

The Panel believes that there should be multi-stakeholder aboriginal input to monitor and manage the Little Bow River Reservoir and area archaeological resources; including monitoring the mitigation process during project construction and subsequent operation, and any future educational or spiritual use of either the sites or artifacts. If the project is approved, the Panel would require the development of an aboriginal interpretive area and program as part of the project. The Panel concludes that the aboriginal people should be given the opportunity to lead the development of such a program. The Panel is confident that they will use this opportunity to give appropriate treatment to their interpretations and sense of loss of an important place at the confluence of Little Bow River and Mosquito Creek. The Panel believes multi-stakeholder aboriginal input should be sought about the interpretive area and program nature, development, and management. Stakeholders would include any Treaty 7 people that wish to participate. Others living in the project area or responsible for it, should play supportive roles in facilitating the aboriginal people in their development of the interpretive area and program. The Panel appreciates that a spirit of cooperation will be required to support such a process from ACD, APWSS, the operator (AEP), the Public Advisory Committee, and representatives from the M.D. of Willow Creek and County of Vulcan, and various communities.

In cases such as the proposed project, the historical resource impact assessment would, in the Panel's opinion, have benefited from a requirement to notify the public, including aboriginal people, of the work involved and the results, with appropriate opportunities for consultation. Therefore, the Panel recommends that ACD establish public participation requirements for historical resource impact assessments for projects that are consistent with, and complimentary to, similar requirements now mandatory for environmental impact assessments in Alberta.

The need to make these changes has been apparent for some time. While legislative authority might ultimately be required, the Panel believes that all parties involved, including the proponent and aboriginal people, would be more than willing to cooperate with ACD in initiating a new approach to public consultation associated with historic resource impact assessments. The time for action is past due, and failure to incorporate public consultation procedures that are now so common place in other aspects of resource development is causing real difficulties in developing trust and respect between aboriginal people and those responsible for initiating resource developments.

The Panel received evidence that the Little Bow River Reservoir area was in the traditional territory of the Blackfoot Confederacy, which included, among others, the Peigan Nation and the Blood Tribe. The Panel believes that discussions should continue to take place between APWSS, ACD and the Treaty 7 aboriginal people about the identification, proper treatment, ownership and use of all Little Bow River Reservoir archaeological and historic sites, and artifacts. The Panel understands that such discussions are already taking place and believes that more discussion would be of value to all parties.

The Panel notes the assertion of the Peigan Nation and Blood Tribe that the Old North Trail was a part of their culture. The Panel believes that further research would be required to establish its location along the Eastern Slopes of the Rocky Mountains and is far beyond the scope of the proposed project. The Panel believes that the testimony before the Panel from both the Peigan Nation and Blood Tribe that the Trail passed through or near the Little Bow River Reservoir should be given further

consideration by ACD and APWSS to decide whether further investigation is appropriate. The Panel believes that should the Trail be identified in Little Bow River Reservoir area, if required, this matter could be properly attended to with appropriate mitigative measures and would not have an effect on the project.

The Panel was asked by the Blood Tribe to consider whether or not the two-hearth teepee ring could be removed from its present location and moved to ground above the Reservoir. As noted, should the project proceed, the Panel would require that the two-hearth teepee ring be moved to the location of the interpretive area to assist in the explanation of the importance of the area to aboriginal people. The Panel believes that with appropriate interpretation the loss associated with flooding this former meeting area and campsites at the confluence of the upper Little Bow River and Mosquito Creek would be recorded and explained by the Blackfoot Confederacy. The Panel believes that this loss must be considered in a regional context along with the other sites that have been lost to the aboriginal culture. The interpretive area and program could include reference to the Pine Coulee Reservoir, Travers Reservoir, the Oldman River Reservoir, and other similar locations that have been disturbed as a result of various forms of development.

The Panel concludes that if the proposed project were to proceed, it should be clearly recognized that it will mean the loss to the aboriginal people of another important feature of the landscape that plays a central role in their culture. Information on the actions and initiatives relating to the conditions and recommendations concerning the aboriginal interests would be included in the Mitigation Progress Report required by the Panel.

The Panel is aware that many serious matters with respect to the relationship between First Nations' people and other Albertans and their government have been brought before it. Though the Panel is not empowered to resolve many of the issues raised in the presentations from the Blood and Peigan First Nations, it would like to offer the following observations.

The effects of development on the traditional territories of the Blackfoot have taken place ever since, if not before, Treaty 7 was signed. Since the earliest days, water projects of various kinds have been proposed and built in southern Alberta. A number of these have been in the Highwood and Little Bow river basins. Most of the lands required for the three-component project are privately held and have already been altered in a variety of ways. For example it was stated in evidence that the lands above the valley of the Little Bow in the vicinity of the proposed reservoir have been largely farmed to the edge. It was also stated by some local people giving evidence at the Hearing that over 40,000 arrowheads and other artifacts have been collected by some 70 individuals across southern Alberta. This group also identified over 800 discovery sites catalogued by the province through a program developed by ACD called the Trace program.

These examples are provided to indicate that the Panel is aware that considerable change has occurred on the lands previously occupied by the Blackfoot. These changes continue.

The Peigan litigation with the Province has as its goal the acquisition of a prior water right and allocations that might enable the Reserve to develop up to 21,045 ha (52,000 acres) of Reserve land. This would make the Peigans one of the largest irrigation operations in the whole SSRB. If more acreage was added for the other Treaty 7 Reserves, this would certainly also be the case. Thus it is clear that the Peigan value the economic importance and benefits that irrigation development brings, particularly if there is a relatively stable supply of water in most years. Such a massive development of irrigation agriculture on the Reserve would have profound effects similar to, but likely greater, than those discussed in this project. Even if the Peigan sold or leased these rights to others or had others develop their own Reserve acreage, it would involve extensive impacts on land. The Panel makes these

observations because in either case water is being sought to provide economic benefits and will involve changes to land and land use.

Treaty 7 First Nations have also dealt with both the loss of many sites and the preservation of a few special sites within southern Alberta. Sites such as Writing-on-Stone, Head-Smashed-In Buffalo Jump and Waterton Park were cited as examples in the Hearing. With proper consultation and more archaeological work, the Panel believes that a way should be found to deal with the identified losses that this project could entail. More attention has been recommended for the Woman's Buffalo Jump and campsite.

8.8.9 Public Consultation

The Panel draws a number of general project-related conclusions about public consultation from the evidence that was presented to it.

There were a number of positive and constructive public consultation aspects to developing parts of this project and it benefited greatly from them. This is demonstrated in the planning and site selection for the Little Bow River Reservoir and dam and the planning to stabilize Clear Lake and develop wetlands.

There were a number of negative effects on the community due to the length of time involved and the uncertainty created by delayed and altered commitments. Some promises were made and were not kept. This lack of consistent follow through in all aspects of the project's development led to some disagreements within the communities involved. Examples include the discussions around transportation routes in the Little Bow River Reservoir area, the agreements with respect to the IFN, and the protracted discussions with the Hutterites.

There were a number of noteworthy consultations that have also left a negative legacy. This includes the type and level of involvement of First Nations with respect to archaeological sites and the involvement of residents around Squaw Coulee and Baker Creek with respect to the proposed enlargement of works there.

Some people felt that they were appropriately consulted and they were still supportive of one or more project components. These interveners did acknowledge that the public consultation included both successful and unsuccessful elements. Others felt that they were not appropriately involved, and while they acknowledged that some excellent consultation had indeed occurred, it was not their experience and they could not support one or more of the project components.

Many interveners acknowledged that their long-term desire was for a win-win solution to the water management issues in the basins and were distressed that all parties had not been consulted to the same degree. There was even some wavering of support by people who still saw many components of the project positively, due to the differences in public consultation and the lack of the fulfillment of certain agreements.

8.8.10 Concluding Comment Regarding Social Effects

With respect to social effects, the Panel finds that the proposed project, should it proceed, would provide significant and positive social benefits to many residents in the Mosquito Creek and Little Bow River basins, with some adverse social effects particularly on Treaty 7 aboriginal people and the Hutterian Brethren. The Panel concludes that the proposed three-component project, through providing a secure and stable water supply, would remove a significant barrier affecting the social stability and well being of the residents in the basin. This positive social effect is compelling, in the opinion of the Panel, and must be given appropriate weight in reaching any overall conclusions regarding the proposed three-component project.

8.9 Economic Effects

Despite concerns about the extent to which some project benefits and costs were adequately quantified in the economic evaluation, the Panel concludes that, on balance, project benefits would exceed costs. The Panel heard abundant evidence from both APWSS and most interveners that the construction of the three-component project would create the water supply conditions necessary to stabilize and expand economic and social development in the region. Construction of the project would provide some employment opportunities for regional residents but, more importantly, project operations and the resulting irrigation expansion would directly and indirectly lead to a significant increase in regional employment and economic activity. The Panel notes that the stabilizing of Clear Lake and creating the new Little Bow River Reservoir would provide new recreational opportunities that would further enhance the quality of life in the region, and become a regional tourist attraction.

The Panel's conclusions concerning the economic effects of the project relate to its responsibility for determining whether the proposed project is in the public interest. A conclusion that the project is in the public interest does not commit the Government of Alberta to actually investing public funds in the project. Should the Panel determine that a project is in the public interest, it remains the responsibility of the Government of Alberta to actually decide whether an investment of public funds is warranted.

The Panel concludes that the proposed project would have significant, positive economic effects on communities and residents near High River, near Clear Lake, and the Little Bow River Reservoir, should it proceed. The Panel specifically notes that while the quantifiable economic effects of the project are favourable, additional non-quantifiable benefits and costs considered by the Panel tend to improve the relative economic effects of the project. The construction and operational effects on the economy of the area surrounding the project will be significant and positive should the project proceed.

8.10 Other Considerations

The Panel notes that adverse effects are predicted to occur in a number of instances, particularly with respect to environmental matters such as the permanent loss of some riverine habitat, the loss of native or near native grasslands, changes to land use affecting some plants and animals, and potentially poor water quality in Clear Lake and the Little Bow River Reservoir. The Panel notes that there are many positive effects for current irrigators, for new irrigators, for consumptive users of water, for recreation, and in terms of creating more stable and viable communities.

In many cases, the avoidance or mitigation of adverse effects depend on the successful implementation of various required or recommended measures with respect to fisheries, wildlife and plants, water quality, habitat enhancement, restoration or preservation, and addressing non-point sources of pollution. A very key factor would be the quick and complete mitigation of Frank Lake as a pollution source.

The Panel concludes that the existing social, economic and environmental situation with respect to water and water uses is not sustainable and that having no project would likely mean further deterioration in water quality and habitat and additional negative effects in the two basins.

The Panel finds that additional storage for the Highwood River basin is required to provide for a healthy river ecology, sustained fisheries, and to deal with projected deficits for irrigators on the Highwood and Little Bow rivers. The Panel concludes that the three-component project is in the public interest, even without the fourth component – additional storage in the Highwood basin, but would be further enhanced by the timely addition of that storage.

On balance, weighing the predicted adverse effects and the positive benefits, the Panel concludes that the three-component project is in the public interest and that the adverse effects are an acceptable cost to gain the benefits.

8.11 Mitigation Progress Report

During the hearing a number of the participants expressed the concern that once the joint NRCB/CEAA review was complete, there would be no process to follow the implementation of the undertakings given by APWSS. There were also a number of items raised where the participants expressed an interest in having the NRCB/CEAA remain a source of information respecting the success of various proposed mitigative measures. The Panel has recommended or required a number of plans or reports to address the ongoing concerns of the community. The purpose of having this information filed with the NRCB/CEAA is so that the information may be maintained in one place and remain accessible to those with an interest. These plans include:

- Frank Lake Water Quality Mitigation Plan (recommended).
- Little Bow River Reservoir Water Quality Protection Plan (recommended).
- Clear Lake Irrigation Development Plan (recommended).
- Clear Lake Wildlife Management Plan (recommended).
- Habitat Compensation Plan (required).
- Report on Hutterite Relocation Process (required).
- Fisheries Mitigation and Enhancement Plan (required).
- Field-Oriented Operations Plan (required).

- Information on Transportation Alternatives (required).
- Regional Transportation Plan (recommended).
- Plan to address livestock effects on riparian habitat and water quality (required).
- Area Structure Plan for lands surrounding Little Bow River Reservoir (required).
- Report on the actions taken with regard to the name change for Old Woman's Buffalo Jump and Squaw Coulee (required).
- Actions and initiatives relating to the conditions and recommendations concerning the aboriginal interests (required).

If the project is approved, the Panel would require APWSS to file information on the progress of these initiatives through a Mitigation Progress Report. The Mitigation Progress Report shall also provide an update of the construction and implementation of the facilities and mitigation initiatives that are referred to in the Approval. APWSS shall prepare and file this report annually with the NRCB until such time as they have fulfilled the conditions of the Approval and have passed authority to AEP for the operation of the project-related facilities. AEP shall prepare and file the report annually with the NRCB for a period of five years from the date it assumes authority for the operations of the project-related facilities. If the project is approved, the Panel would direct that APWSS and AEP shall provide the report directly to the Public Advisory Committee, or its successor, to ensure the exchange of information.

9. NRCB DECISION RESPECTING THE PUBLIC INTEREST AND FEDERAL RECOMMENDATIONS

9.1 NRCB Decision Respecting the Public Interest Regarding the Highwood River Diversion Works, Little Bow River Reservoir and Clear Lake

The Panel began its assessment of the project by making a distinction between diversions during the spring freshet and the diversion of water during the balance of the irrigation season. The project provides for meeting the expansion plans for irrigation, in the lower Little Bow River basin and around Clear Lake, through the diversion and storage of water during the spring freshet and times of high flow. The Panel concluded on a preliminary basis that the Little Bow River Reservoir project component and the Clear Lake project component were examples of projects that could meet the basic characteristics of a sustainable water management project. The proposed expansion of the Highwood River diversion structure to the Little Bow River is a necessary part of the Little Bow River Reservoir. The Panel indicated that it was prepared to consider in a more detailed fashion the social, economic and environmental effects of the construction and operation of the Little Bow River Reservoir and related facilities, and the Clear Lake project.

The Panel is aware that the construction of the Highwood River diversion works at High River and the associated canal enlargement, the construction of the Little Bow River Reservoir, and the construction of the Mosquito Creek diversion works and canal to Clear Lake will take some time to complete. Depending on when construction commences, the availability of funds, the receipt of other necessary approvals and other factors such as weather, the construction may take two or three years to complete before an operations plan would be required.

The Panel's conclusion is that the proposed Diversion Plan fails to remedy the current overallocation of water or meet future needs for water. It does not meet the basic criteria of a sustainable development, since it does not contemplate meeting existing licence commitments; it does not meet IFN requirements; and it does not meet ecosystem and consumptive needs due to the poor water quality associated with low summer flows. The proposed Expanded Diversion Plan does meet the minimum instream flows of the “Preliminary IFN” used in the analysis. However, it also does not meet the other basic criteria of a sustainable development, since it does not propose to satisfy existing licence commitments, and it does not meet ecosystem and consumption needs due to the poor water quality associated with low flows. The Panel finds serious concern with the Diversion Plan and the Expanded Diversion Plan. The Panel concludes that the Applicant’s proposed Diversion Plans are not sustainable and would not remedy the problems that already exist.

In the context of sustainable development, the Panel concludes that there is a need for storage for the Highwood basin. There are very limited alternatives to effectively deal with the demand for consumptive uses of water during low flows. Demand management is one option. Cancelling existing licence commitments and capping future growth and development in the basin would be required. There is no support for these alternatives in the evidence.

The Panel concludes that, on the basis of the information currently available, the Super Expanded Squaw Coulee Reservoir could meet *current* requirements for water in the basin and remedy the currently unsustainable over-allocation of water. The Panel tentatively concludes that the modelling currently available shows that the development of storage equivalent to the Super Expanded Squaw Coulee Reservoir falls short of meeting all *future* water needs while providing sufficient protection to the environment. Taking into consideration the need to provide for winter IFN, unforeseen contingencies, and an updated IFN that is solely science-based leads the Panel to conclude that storage may be needed that exceeds the capacity of the Super Expanded Squaw Coulee Reservoir.

The Panel believes that there is a need to consider a continuum of storage options to meet current and future needs. In the view of the Panel, the question is not whether or not the expanded or the Super Expanded project should be built, but rather whether the development of storage such as or equivalent to the Super Expanded Squaw Coulee plus other storage projects are needed to meet the long term needs in the basin.

In the opinion of the Panel, the Super Expanded Squaw Coulee Reservoir presents a feasible option that appears to meet most project objectives. Further evidence is needed for a Panel to come to a final conclusion regarding the Super Expanded Squaw Coulee Reservoir. The Panel agrees with the Squaw Coulee and Baker Creek area residents that the alternatives to the Super Expanded Squaw Coulee Reservoir require further investigation and consideration. The Panel also agrees that a more in-depth analysis of other water conservation practices also needs to be done.

The Panel directs APWSS to update the comparative analysis of the sites available for meeting the storage needed, including the Super Expanded Squaw Coulee site and the Tongue Creek Site 4, and show comparative data regarding environmental, social and economic effects. The Panel requires additional information sufficient for a Panel to conclude whether or not the Super Expanded Squaw Coulee Project is in the public interest. Therefore, the Panel further directs APWSS to complete the assessment of the environmental, social and economic effects of the Super Expanded Squaw Coulee project. Public consultation is required as an integral part of the further analysis and assessment. Particular attention is to be directed toward finding appropriate routes for return flows to the Highwood using pipelines, since the Panel sees little merit in the further consideration of a large canal through a country residential development when less disruptive equivalent alternatives exist.

The Panel further requires that the Diversion plans for the management of water in the Highwood River basin be revised to meet the basic criteria of a sound water management project. Specifically, the Panel believes that the objectives of the revised diversion plans should be to ensure that the science-based IFN is observed in the Highwood, that existing licence commitments are upheld, that adequate conveyance flows are maintained in both the upper Little Bow River (30-40 cfs) and lower Mosquito Creek (20-30 cfs), that known future demands can be met, and that consideration is given for reserving water, if possible, for future requirements that are unknown at this time. The Panel requires that the diversion plans for the Highwood diversion works be revised on the basis of incorporating the improved flexibility available as a result of developing storage for the Highwood basin. Additional modelling is required to demonstrate the degree to which the above criteria can be met under various low flow scenarios.

The Panel requires that the completed assessment of the environmental, social and economic effects of the Super Expanded Squaw Coulee Reservoir, including the comparative analysis of alternative storage sites and a revised Diversion Plan, be filed with the NRCB/CEAA within 12 months of the release of this decision report.

The Panel requests that the additional information required to complete the review be filed with the Board, CEAA and the Environmental Assessment Division. The Alberta Director of Environmental Assessment will then be in a position to confirm that the supplemental information filed with the Board is, in his opinion, suitable for the purposes of further public review of this component of the Application.

The Panel requires that the detailed process plan for developing the Highwood River Basin Water Management Plan be filed with the NRCB and CEAA in order that these agencies may have regard for the HMP process at a public hearing that will be needed when the additional information is filed. The process plan for the HMP should be developed recognising the need for storage.

The Board has issued an Order regarding supplemental information. A copy of the Order is found in Appendix C.

The Panel defers consideration of the Diversion plans for the Highwood River diversion works, other than diversions proposed for high flows, until it receives additional information. However, the Panel has given consideration to whether or not the construction of the Highwood Diversion works and canal, the Little Bow River Reservoir, and the diversion works and canal to Clear Lake also need to be deferred pending the development of an optimised operating plan for the diversion works.

The Panel concludes that the construction of the 3 component project, based on detailed consideration of the social, economic, and environmental effects, could proceed at the same time as the matter of the diversion plan for low flows is being resolved.

The Panel, pursuant to the *Natural Resources Conservation Board Act,* is required to determine whether in the opinion of the Panel, the proposed Little Bow Water Management Project is in the public interest, having regard for the social and economic effects of the project, and the effect on the environment. The Panel has concluded that the proposed Little Bow and Clear Lake components would result in positive effects on water quality and quantity; near neutral effects on fish and fisheries and soils and land; and adverse effects on vegetation and wildlife. Some of the adverse effects of the proposed project could be mitigated so that the residual project effects on the environment would not be as significant. In the context of cumulative effects, the project represents an overall incremental improvement to the current situation. If the project were to proceed, there would be permanent loss of important grasslands and some riverine areas. The Panel concludes that the proposed project would provide significant and positive social benefits to the residents of Little Bow and Clear Lake basins, with some adverse social effects due to the relocation of the Hutterite colony and the flooding of archeological sites. The proposed project, through providing a secure and stable water supply, would remove a significant barrier affecting the social stability and well-being of the residents of the basin. The Panel concludes with respect to economic impacts and the potential for regional income distribution, that the construction and operational effects on the economy of the area surrounding the project would be significant and positive. The Panel concludes that the benefits of the proposed project tend to improve when non-quantifiable effects, such as an increased security of water supply, enhanced flows below the reservoir, an increased ability to manage water, and the option value of potentially higher valued water in the future are all taken into consideration.

The Panel has weighed the social, economic and environmental effects of the proposed Little Bow and Clear Lake components. The Panel finds that the social benefits of the proposed project are persuasive since the three-component project would substantially remove the lack of a secure and stable water supply as a major factor affecting the social stability and well being of the residents of the basin. These social benefits are offset to some extent by the negative effects associated with relocating the Little Bow Hutterian Brethren and the effects on Aboriginal culture due to the flooding of lands at the

confluence of Mosquito Creek and the Little Bow River. The Panel finds that the economic effects of the three-component project in the local area are significant and positive; however, in relation to the Alberta public interest such effects are not large when compared to all other economic activity undertaken in Alberta. The Panel finds that the environmental effects of the proposed three-component Project are not overly adverse to the public interest. The net environmental effects of the three-component project, in the opinion of the Panel are slightly positive or neutral particularly with respect to water quality, quantity, and fisheries. These environmental effects are combined with the residual project effects on vegetation and wildlife. Overall, the Panel concludes that the proposed three-component project will not have significant adverse environmental effects. The positive social effects of the three-component project, combined with the economic benefits, more than compensate for the negative residual environmental effects of the project, when mitigative measures are taken into consideration.

The Panel has considered the cumulative nature of the effects of the proposed three-component Project on the aquatic ecology of the Little Bow River and Mosquito Creek basins and the other environmental characteristics of the basin. In the opinion of the Panel, the upper Little Bow River and Mosquito Creek aquatic ecosystem is already at risk due to the various water demands that exist within the basin. The proposed project must be considered within the cumulative and regional context of other developments in the basin and their synergistic effects. The Panel has examined the proposed three-component project within the context of the historical development of these basins and the current baseline conditions that characterize the basin. The Panel concludes that the proposed three-component project, including the mitigative measures required should the project proceed, would have little or no effect on the ecological conditions of the Highwood River. In the opinion of the Panel, the storage associated with the proposed Clear Lake and Little Bow River Reservoir project could improve the sustainability of the Little Bow River, Clear Lake, and Mosquito Creek aquatic ecosystem.

On balance, weighing the predicted adverse effects and the positive benefits, the Panel concludes that the three-component project is in the public interest and that the adverse effects are an acceptable cost to gain the benefits.

In the opinion of the Panel, having regard for all the evidence before it, the proposed Little Bow and Clear Lake components, subject to certain conditions, are in the public interest having regard to the social and economic effects of the project, and the effects of the project on the environment.

The Applicant made the following specific request with respect to the Board's public interest determination:

> "The proponent believes that the Little Bow Project is in the public interest and seeks an approval of the Board in relation to same. APWSS does not currently propose to build the enlarged Squaw Coulee component but believes that the Expanded Project which includes the Little Bow Project and the Squaw Coulee component may be in the public interest. Consequently, APWSS seeks further Board approval for the Expanded Project. If the Board finds that the Little Bow Project and the Expanded Project are both in the public interest, the proponent seeks a Board recommendation as to which project is preferable with reasons."

The Panel concludes that the existing social, economic and environmental situation with respect to water and water uses is not sustainable and that having no project would likely mean further deterioration and negative effects in the two basins. The Panel finds that additional storage for the Highwood River basin is required to provide for a healthy river ecology, sustained fisheries, and to deal with projected deficits for irrigators on the Highwood and Little Bow rivers. The Panel concludes that the

three-component project is in the public interest, even without the fourth component – additional storage in the Highwood basin, but would be further enhanced by the timely addition of that storage.

The Panel has also concluded that the development of storage in the Highwood River basin is needed to correct the current over-allocation of water during periods of drought and to provide for future needs. The Panel has requested that the Applicant complete the assessment of the options and alternatives to meet storage requirements within twelve months so that a public interest determination on that aspect of the Application can be made.

The Panel notes the numerous commitments of the Applicant to mitigative measures contained in the Application and the undertakings given at the hearing. All the commitments and undertakings are an integral part of the proposed project and must be discharged by the Applicant. The panel highlights in particular the following commitments and undertakings:

- to operate the reservoir according to the proposed operating plan;
- to mitigate transportation effects at the proposed Little Bow River Reservoir;
- to establish a safe and convenient portage around the facilities;
- to monitor and report on mercury levels in fish;
- to design and operate the Little Bow River Reservoir outlet works to minimize impacts on dissolved oxygen and ammonia levels in the Little Bow River;
- to design and construct the Highwood River diversion works to include fish screening to prevent fish passage;
- to establish wetlands capable of supporting waterfowl and wildlife in the Clear Lake area;
- to prepare and implement a fisheries mitigation and enhancement plan;
- to create walleye habitat associated with the Little Bow River Reservoir;
- to create pike spawning habitat in the Little Bow River Reservoir;
- to prepare and implement a habitat compensation plan;
- to implement the conservation of native grasslands and carry out related studies;
- to monitor and evaluate the programs discussed in the environmental impact assessment as part of the ongoing project mitigation;
- to continue to consult with the affected parties; and
- to protect archaeological resources and mitigate effects where possible, particularly regarding the sites found at the Little Bow and Mosquito Creek confluence and to consult aboriginal people.

The Panel also notes the Applicant's commitment to seek the advice, direction, and approval of appropriate government department and agencies with respect to the mitigation measures contained in the proposed project. The Panel highlights in particular the role and responsibility of Alberta Environmental Protection (Controller of Water Resources, Dam Safety, Fish and Wildlife), Alberta Community Development, Alberta Agriculture, Food & Rural Development, Alberta Transportation and Utilities, Fisheries and Oceans, Environment Canada, the Department of Indian and Northern Affairs Canada, the MD of Willow Creek, MD of Foothills, the Town of High River, the County of Vulcan, and other local authorities.

The Panel acknowledges that many of these commitments and undertakings were proposed by the Applicant and the Panel concludes that they will be fulfilled in a responsible manner.

The Panel, to provide additional certainty regarding these matters, has included a number of specific conditions in the draft form of Approval (Appendix B).

The Panel noted earlier that Alberta Public Works, Supply and Services and Alberta Environmental Protection are involved in the design, construction, and operations of the proposed project and act on behalf of Her Majesty the Queen in Right of Alberta. The Panel adopts the view that the Government of Alberta would be the entity responsible for the design, construction, and operation of the proposed project, and that commitments and undertakings made by Alberta Public Works, Supply and Services were on behalf of the Government of Alberta.

The Panel also realizes that many of the conditions that the Panel would require to be met, should the project be built, would be to the satisfaction of various operating units of AEP such as Fish and Wildlife and Controller of Water Resources. On the surface, there may appear to be the potential for a conflict of interest between the responsibility to operate a water control structure such as the proposed three-component project, and the various regulatory responsibilities of AEP. The Panel has considered this potential concern which was raised by a number of interveners and is satisfied the Panel's requirements that certain conditions be met to the satisfaction of ongoing regulatory authorities is appropriate, since these authorities are entrusted to discharge their regulatory duty in accordance with established legislation and public policy that binds the Crown. Independent monitoring will be required by community members and other groups.

The Panel requires APWSS to prepare an annual progress report with respect to the implementation of its plans for project mitigation. This comprehensive Mitigation Progress Report should be presented to targeted stakeholders for their information, and filed with the NRCB.

The Panel is prepared to make an order granting an approval for the three-component project, with the authorization of the Lieutenant Governor in Council, and subject to the conditions contained in the Draft Form of Approval found in Appendix B.

9.2 Review Panel Recommendations to the Federal Government

The Panel is required to fulfill the Terms of Reference and mandate established by the federal Minister of Environment.

The Panel has concluded that the proposed Little Bow and Clear Lake components would result in positive effects on water quality and quantity; near neutral effects on fish and fisheries and soils and land; and adverse effects on vegetation, wildlife and archaeological sites. Some of the adverse effects of the proposed project could be mitigated so that the residual project effects on the environment would not be as significant. With additional storage for the Highwood basin and a revised diversion plan there could be an improvement. In the context of cumulative effects, the project represents an overall incremental improvement to the current situation. Therefore, the Panel recommends that the Little Bow River Reservoir, Highwood Diversion Works and Clear Lake Projects receive regulatory approval from the Government of Canada.

The Panel notes the primary interests of the Government of Canada with respect to the effects of the proposed Little Bow River Reservoir and Clear Lake projects pertain to navigation; fisheries and fish habitat; migratory birds; vulnerable, threatened or endangered species; and to the concerns and interests of aboriginal people.

The Panel expects that the proposed Little Bow River Reservoir and Clear Lake projects would have a minor effect on navigation on the Little Bow River and Mosquito Creek due to the limited use they receive for such purposes. The Panel recommends that the Department of Fisheries and Oceans, in considering an application for approval for the proposed diversion works and outlet structures, require that the Applicant provide for a convenient means of portage passage around the diversion works and require that the works be designed and operated in a manner so as to minimize the risk of navigation hazards to the small number of canoeists or other small craft users that might utilize the Little Bow River and Mosquito Creek in the vicinity of the proposed works. The Panel notes that that the proposed Little Bow River Reservoir and Clear Lake remain largely unobstructed to boating and that the project includes the establishment of boating access facilities.

With respect to fisheries and fish habitat, the Panel has given detailed consideration to these matters and the NRCB approval would contain a number of conditions upon the Applicant to ensure that fisheries and fish habitat are appropriately integrated into the design and operation of the proposed project. The Panel believes that the detailed fisheries mitigation and enhancement plan, which the NCRB approval would require to be completed, would provide the basis for the Department of Fisheries and Oceans to reach final conclusions confirming the no-net-loss and fisheries habitat policy has been fully met through the mitigation measures required of the Applicant. NRCB Approval requires that the Applicant complete the fisheries habitat compensation plan required by the Department of Fisheries and Oceans, as part of the fisheries mitigation and enhancement plan. In addition, the Panel recommends that the Department of Fisheries and Oceans, along with local residents, take an active role in the development and evaluation of the fisheries mitigation and enhancement plan, contributing its expertise and experience to ensure the protection and enhancement of the fishery resources of the Little Bow basin.

With respect to migratory birds, the Panel notes that the loss of mixed grass habitat will adversely effect songbirds, upland sand-pipers, long billed curlews and ferruginous hawks among other grassland species. The Panel concludes the Clear Lake component of the project could substantially compensate for loss of waterfowl habitat on the Little Bow River, but would do so by converting a substantial contiguous area of mixed grass prairie and shorebird habitat. Among the species that would

be adversely affected, some are rare and endangered. The Panel notes that APWSS proposes that the north end of Clear Lake be managed to provide waterfowl habitat and agrees with Environment Canada's suggestion to manage the wetlands in the area of the Clear Lake canal for shorebird habitat. The Panel recommends that Environment Canada work closely with the Applicant and Ducks Unlimited to provide its expertise and experience.

With respect to threatened, rare and endangered species, the Panel concludes that the proposed project will not result in any significant adverse environmental effects. Specific species of concern have been identified through the EIA process, and a habitat compensation plan will be prepared to mitigate project effects. The Panel believes that the ferruginous hawk will receive specific attention in the mitigation planning to ensure that the residual effects of the project on this species is minimized. The Panel is also satisfied, subject to certain requirements of the Panel, that the effects on the Baird's sparrow, burrowing owls, and other species of concern are mitigated in a satisfactory manner. The Panel recognizes that the project will result in the loss of some grasslands that cannot be replaced. The Panel again recommends that Environment Canada support the mitigation planning of the Applicant in an advisory capacity, providing expertise and advice that will improve the effectiveness of the mitigation measures required by the Panel of the Applicant. Additional lands may have to be set aside to achieve adequate replacement of lost habitat.

The major project impact on aboriginal concerns involves the loss of special sites and the sense of place due to flooding. The Panel understands the following to also be major concerns and interest of aboriginal peoples about the effects of the project:

- aboriginal sites and artifacts that are or may be affected by the proposed project are located in and around the proposed Little Bow River Reservoir site;

- the proposed Highwood River diversion works would affect flows in the Highwood River and the Bow River, and the Oldman River, and could affect the interests of the Blackfoot First Nations and other Treaty 7 Nations;

- aboriginal interests and concerns have been inadequately reflected in the assessment of the effects and impacts on this culture of the proposed project due to inappropriate consultation.

Water plays a critical role in southern Alberta, and the Indian reserves in the South Saskatchewan basin are associated with water in many ways. Water management considerations in southern Alberta affect, and are influenced by, the Indian reserves that are an integral part of the South Saskatchewan basin. The Panel notes that it received presentations from the Peigan Nation and Blood Tribe, and appreciates that had it received presentations from other aboriginal people within the Treaty 7 coalition from within South Saskatchewan River basin, it would have more complete information regarding the potential effects of the proposed Little Bow River Reservoir and Clear Lake Projects on aboriginal interests and concerns. It also appreciates that the Blood and Peigan do not represent all aboriginal interests within the Blackfoot Confederacy and Treaty 7. The Panel does, however, believe that the submissions are indicative of aboriginal interests and concerns associated with the proposed project, particularly as they relate to the potential effects of the proposed project on their loss of special sites and the loss of the sense of place. The Panel believes that the concerns of aboriginal people regarding the cultural and religious significance of sites in the project area received from the Blood and Peigan would be indicative but not fully representative of those concerns.

With respect to the interests and concerns of aboriginal people in the region, the Panel has a number of observations. The Panel concludes that the primary effect of the project on the interests

and concerns of aboriginal people, particularly the Peigan Nation and the Blood Tribe, pertains to the loss of special sites and the sense of place. The project is seen as a threat to their culture. The Panel has placed specific conditions on the Applicant to ensure that the loss of special sites and the sense of loss of place is recognized in the mitigated actions. Consultation will be undertaken to ensure that the spiritual and cultural significance of these places to the aboriginal people is recognized, and the Panel recognizes that the ability of aboriginal people to obtain the beneficial use of those places has been lost if the project proceeds. Further discussions will take place regarding the meaning and interpretation of these places.

The Panel has concluded that the proposed project would not have significant adverse effects on the environmental interests and concerns of the aboriginal people, including the effects on water.

The Panel believes that the matter of early consultation between the Applicant and aboriginal people in this case can provide guidance for the future. Unfortunately, the experience that the Panel encountered at the Pine Coulee project has been repeated again in this proposed development. There has again been inadequate consultation with aboriginal people. The Panel believes that all parties involved in the current Application, including the Peigan, Blood, and other members of the Blackfoot Confederacy and Treaty 7 would benefit from planning processes that are more inclusive. The responsibility to inform, and be informed, is one that is shared by all. Failure to seek out those who may be affected is unwise. Similarly, failure to seek out and become informed about matters that may affect key interests is also unwise. In the Panel's view, the fiduciary obligations of the Crown in this case may have been fulfilled earlier and in a more efficient manner by the Department of Indian and Northern Affairs Canada and other government agencies that had knowledge of the project.

The Panel particularly notes the concerns of the aboriginal people, expressed regarding the proposed Little Bow Project, pertaining to the treatment of important sites located off Indian reserves on private lands. The Panel encourages all parties to review the *Alberta Historical Resources Act* and begin addressing issues of concern. It also takes note of the assertion of the Blood Tribe that the Crown has a fiduciary obligation to ensure that cultural and religious rights of First Nation people are protected.

The Panel recommends the Little Bow River Reservoir, Highwood River Diversion Works and Clear Lake Projects receive regulatory approval from the Government of Canada. Appendix A contains the Panel Terms of Reference established by the federal Minister of Environment and a summary listing of the Panel's recommendations responding to the mandate.

9.3 Endorsement

Having regard for the Panel's overall conclusions respecting the proposed Little Bow River Reservoir, Highwood River diversion works and Clear Lake water management projects, the NRCB decision with respect to the public interest, and the recommendations to the Government of Canada, now therefore the Joint Natural Resources Conservation Board/Canadian Environmental Assessment Review Panel concludes the review of the Little Bow River Reservoir, the Highwood River diversion works and the Clear Lake project components.

DATED at Edmonton, Alberta on May 29, 1998.

Joint Natural Resources Conservation Board/Canadian Environmental Assessment Review Panel

ORIGINAL SIGNED BY:

Ken Smith	Susan Nelson	George Kupfer
Chairman	Member	Member

APPENDIX A

CANADIAN ENVIRONMENTAL ASSESSMENT ACT

PANEL TERMS OF REFERENCE
JOINT REVIEW PANEL - LITTLE BOW PROJECT/HIGHWOOD DIVERSION PLAN SOUTHWESTERN ALBERTA

CANADIAN ENVIRONMENTAL ASSESSMENT ACT

PANEL TERMS OF REFERENCE
JOINT REVIEW PANEL - LITTLE BOW PROJECT/HIGHWOOD DIVERSION PLAN SOUTHWESTERN ALBERTA

GENERAL

The Panel will review the proposed construction and operation of the Project. In conducting its review the Panel will consider all factors listed in Subsections 16(1) and 16(2) of the *Canadian Environmental Assessment Act*.

SCOPE OF THE REVIEW

The environmental effects of the Project that the Panel will consider include, but are not limited to effects upon, the following: flora and fauna; water quality and quantity; groundwater; fish and fish habitats; migratory birds and migratory bird habitats, and vulnerable, threatened or endangered species; and will include the effects of a change in the environment upon: impacts on navigation both upstream and downstream of the Project; aboriginal and non-aboriginal land use and related interests. Consideration of these factors shall be reflected in the Final Report.

COMPONENTS OF THE REVIEW

The Panel will conduct the review by way of an oral hearing.

The Panel will ensure that all information required for the conduct of its review is obtained and made available to the public, which will include, but is not necessarily limited to:

a) existing technical, environmental or other information relevant to the review, including documents filed in connection with Application No. 9601 to the NRCB;

b) supplementary information including a description of any public consultation program, its nature and scope, issues identified, commitments made, and outstanding issues;

c) the terms of reference for the Environmental Impact Assessment dated September 6, 1991 for the Project and documentation generated by the proponent and other interested parties, in response to these terms of reference; and

d) any other available information that is required to assess the significance of the environmental effects.

The Panel shall be guided by these terms of reference, the Agreement to establish a joint panel review for the Project and the relevant federal and provincial legislation in following its terms of reference.

Summary of Recommendations of the Canadian Environmental Assessment Panel

WHEREAS the federal Minister of the Environment established the Canadian Environmental Assessment /Natural Resources Conservation Board Joint Review Panel to consider the proposal of Alberta Public Works, Supply and Services to construct and operate the Little Bow Project/Highwood Diversion Plan, a water management project to convey and store water diverted from the Highwood River consisting of four interrelated components; and

WHEREAS the Panel had regard for the terms of reference provided the panel by the federal Minister of the Environment in the completion of its public review of the project.

NOW THEREFORE in response to the federal terms of reference, the Joint Review Panel makes the following recommendations to the federal government:

1. The Panel recommends the three-component project consisting of the enlargement of the diversion works and canal at High River, the Little Bow Reservoir, and the Clear Lake Project receive regulatory approval from the Government of Canada.

2. The Panel recommends that Transport Canada require, where appropriate, a convenient means of portage passage around the works and outlet structure and require that the works be designed and operated in a manner so as to minimize the risk of navigation hazards to small craft users in the area.

3. The Panel recommends that the Department of Fisheries and Oceans take an active role in the development and evaluation of the fisheries mitigation and enhancement plan to be prepared by the Applicant, and especially with respect to the approval of the fisheries habitat compensation component of the plan and the design of fish screening devices.

4. The Panel recommends that Environment Canada work closely with the Applicant and appropriate groups, to provide its expertise and experience regarding the establishment of a permanent and managed wetlands in the Clear Lake area.

5. The Panel recommends that Environment Canada support the wildlife and vegetation habitat mitigation planning of the Applicant in an advisory capacity, providing expertise and advice that will improve the effectiveness of the mitigation measures required by the Panel.

6. The Panel recommends that the Department of Indian and Northern Affairs Canada support the Treaty 7 Coalition in developing an appropriate interpretative program to identify and acknowledge the loss of another important place to their culture.

APPENDIX B

FORM OF APPROVAL

THE PROVINCE OF ALBERTA
NATURAL RESOURCES CONSERVATION BOARD ACT
NATURAL RESOURCES CONSERVATION BOARD

IN THE MATTER of a project of
Alberta Public Works, Supply and
Services for approval to construct
a water management project (the Project)
to convey and store water
diverted from the Highwood River

APPROVAL NO. 8

WHEREAS the construction of water management facilities proposed to convey and store water diverted from the Highwood River by Her Majesty the Queen in Right of Alberta as represented by Alberta Public Works, Supply and Services (APWSS), consisting of four interrelated components:

i. A canal and diversion works in the Town of High River and in the Municipal District of Foothills No. 31. This proposed $6.2 million component would triple the capacity of the existing diversion works and canal to allow more water to be diverted from the Highwood River to the Little Bow River during peak flows.

ii. Construction of the Little Bow River dam and reservoir in the Municipal District of Willow Creek No. 26 and in the County of Vulcan No. 2, approximately 20 kilometres (km) west of Champion. The proposed $38.8 million dam would be 25 metres high and create a reservoir that would hold 50,000 acre-feet of water. It would be filled from the natural runoff in the Little Bow River basin and water diverted from the Highwood River.

iii. Construction of the proposed $5.1 million Clear Lake diversion and canal in the Municipal District of Willow Creek, about 15 km east of the Town of Stavely. The 10 km long canal would allow the lake and 12 wetlands along the route to be filled when flows in Mosquito Creek are high; and

iv. The proposed $7.1 million enlargement of the existing Squaw Coulee Reservoir in the Municipal District of Foothills No. 31 from 293 acre-feet to 5,175 acre-feet by constructing upper and lower dams and a return canal to the Highwood River,

is a reviewable project under s.4(d) of the *Natural Resources Conservation Board Act* being chapter N-5.5 of the Statutes of Alberta, 1990; and

WHEREAS the Natural Resources Conservation Board is prepared to grant approval to certain components of the application by Alberta Public Works, Supply and Services for the construction and operation of certain water management facilities on the Highwood River, on the Little Bow River, and on Mosquito Creek leading to Clear Lake, subject to the conditions herein contained, and the Lieutenant Governor in Council has given authorization, hereto attached.

THEREFORE, the Natural Resources Conservation Board hereby orders as follows:

1. The project of Her Majesty the Queen in Right of Alberta, hereinafter called "the Operator", for construction (as represented by Alberta Public Works, Supply and Services) and operation (as represented by Alberta Environmental Protection) of certain water management facilities on the Highwood River, on the Little Bow River, and on Mosquito Creek leading to Clear Lake, as described in Application No. 9601, from APWSS to the Board dated May 7, 1996 and descriptive material supporting the Application marked as exhibits at the joint hearing of the Natural Resources Conservation Board and the federal panel established under the *Canadian Environmental Assessment Act* held from November 12, 1997 to January 9, 1998 including undertakings of the Applicant, is approved, subject to the terms and conditions herein contained.

2. The construction and operation of the Little Bow River Reservoir capable of storing 50,000 ac.-ft. of water is approved, including all associated facilities as described in the Application.

3. The construction and operation of the diversion works on Mosquito Creek and the associated conveyance canal leading to Clear Lake is approved, including all associated facilities as described in the Application.

4. The construction of the works at High River for the diversion of water up to 300 cfs capacity from the Highwood River and the enlargement of the existing canal to the Little Bow River to a capacity of 300 cfs as described in the Application are approved. The consideration of the operating plan for these works pertaining to the operation during the low flow season of late July and August is deferred pending receipt and review of additional information as prescribed in NRCB Board Order 9601-1. The plans for the operation of these facilities during high flows are approved.

5. The consideration of the construction and operation of the expansion of the Squaw Coulee Reservoir and associated diversion works and return works is deferred pending receipt and review of additional information as prescribed in NRCB Board Order 9601-1.

6. The Operator shall, in a manner satisfactory to AEP, monitor and report on mercury levels in fish from the Little Bow River Reservoir and below the reservoir in the Little Bow River.

7. The Operator shall design the reservoir outlet works and shall carry out its operations in a manner, satisfactory to AEP, that minimizes the potential adverse effects of reservoir discharges on dissolved oxygen and ammonia levels in the Little Bow River.

8. The Operator shall incorporate fish screens in the design and construction of the diversion works on the Highwood River, and use the fish screens to minimize adverse effects on the fish during the operation of the diversion works.

9. The Operator shall, to the satisfaction of AEP, prepare and implement a fisheries mitigation and enhancement plan as an integral part of the project. The plan should address, among other relevant factors:

- the feasibility and desirability of managing fisheries upstream of the Little Bow River Reservoir in the Little Bow River for cool-water species, taking into consideration the role of the diversion works on the Highwood River, diversion canal, and implications of flow fluctuations for cool-water species;

- the feasibility and desirability of the establishment of a sustainable cool-water fishery in the reservoir, particularly pike and walleye, taking into consideration creating spawning habitat; the minimum water level and quality that would be required to ensure a sustainable fishery; the effect of mercury contamination; and the effect on reservoir water quality and fisheries of non-point sources of pollution;

- the feasibility and desirability of managing fisheries downstream of the Little Bow River Reservoir, for cool-water species, taking into consideration the flows from the Little Bow River Reservoir works, the design of the outlet channel from the reservoir, the need for pike spawning habitat below the Little Bow River Reservoir, and the water quality discharged to the Little Bow River below the Little Bow River Reservoir;

- plans to monitor salmonid entrainment in the Highwood diversion works, including an assessment of the feasibility of curtailing diversions during the peak of whitefish fry downstream migration;

- the feasibility of maintaining a self-sustaining pike fishery in Clear Lake;

- the fisheries habitat compensation requirement of the Department of Fisheries and Oceans; and

- the ongoing monitoring of the effectiveness of mitigation and enhancement.

10. The Operator shall conduct such further modelling and water quality monitoring as is needed to confirm in a manner satisfactory to AEP that water released from the reservoir is of sufficient quality to meet water quality and fisheries management objectives established for the reach of the Little Bow River above Travers Reservoir.

11. The Operator shall, to the satisfaction of AEP, design and implement a program to establish pike and walleye spawning habitat in or above the Little Bow River Reservoir.

12. The Operator shall report on progress toward a Habitat Compensation Plan one year from the release of the decision report.

13. The Operator shall, to the satisfaction of AEP, prepare a field-oriented operations plan with a goal of ensuring all personnel involved in the construction and operations of the project would be informed of their responsibilities in implementing environmental mitigation measures.

14. The Operator shall, to the satisfaction of AEP:

- mitigate the effects on lands adjacent to the River of the increased flow through the upper Little Bow River to accommodate flows up to 300 cfs; and

- monitor water levels in groundwater wells and mitigate any project-related groundwater problems experienced by domestic users.

15. The Operator shall compile and present to all stakeholders, further comparative information on transportation alternatives, including a potential bridge and causeway crossing the Little Bow River Reservoir.

16. The Operator shall implement mitigation measures to address construction impacts, including dust control measures and identifying construction traffic routes that do not conflict with school bus routes or playground areas in local towns.

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17. The Operator shall, to the satisfaction of AEP, manage the north end of Clear Lake for water fowl and shorebird habitat. Intensive recreational activities in this area shall be limited during times when these species are most prone to disturbance.

18. The Operator shall, to the satisfaction of AEP, manage the wetlands in the area of the Clear Lake canal for shorebird habitat.

19. The Operator shall, to the satisfaction of the Department of Fisheries and Oceans, establish a safe and convenient portage around the Mosquito Creek diversion works and the Little Bow River Reservoir dam head-works.

20. The Operator shall ensure the legal right to domestic water use from the reservoir is included in the land purchase agreements to be negotiated with landowners around the Little Bow River Reservoir.

21. The Operator shall, to the satisfaction of AEP, develop a plan to reduce livestock disturbances to riparian habitats and water quality along project-related water bodies.

22. The Operator shall mitigate or compensate landowners for any damages to structures, fences or stream crossings that are in compliance with existing laws and regulations. The Operator is required to address landowner concerns within five years after implementation of the revised diversion plan.

23. The Operator shall, as part of its final planning and design phase, prepare an Area Structure Plan for the lands in the immediate vicinity of the Little Bow River Reservoir. The Operator shall complete this plan and request amendments to the local land use by-laws from the M.D. of Willow Creek and the County of Vulcan prior to commencement of reservoir operations. Matters to be considered should include the following:

- the basic road system adjacent to the reservoir and standards to safely and efficiently service the existing and future land uses adjacent to the reservoir;

- the use of fragmented parcels that would result from the project;

- the need for day use areas, boat launching areas, view points, the aboriginal culture interpretive area, and other similar features which may arise in the preparation of the area structure plan;

- preservation and exhibition of areas of historical and archaeological interest, including the twin hearth teepee ring, in cooperation with Alberta Community Development, Treaty 7 aboriginal people, and other interested parties;

- habitat compensation lands adjacent to the reservoir and the need for environmental reserve lands that might be set aside;

- recreation and country residential development;

- mitigation of the conflicts that may arise between the new land-uses and the existing agricultural community including air and water pollution or other conflicts for the lands in the vicinity of the reservoir that are to remain under agricultural land uses; and,

- any extra or special administrative infrastructure that may be required and other normal items that need to be considered in an area structure plan of this nature.

24. The Operator and its contractors shall abide by all safety codes, regulations, engineering design standards, and established best management practices relevant to the construction, operation, and maintenance of the project.

25. The Operator shall:

- follow up on the processing of the request to change the names of the Old Woman's Buffalo Jump and Squaw Coulee and inform the NRCB about any decisions made.

- to the satisfaction of Alberta Community Development, conduct further archaeological work in the vicinity of the Clear Lake canal.

- to the satisfaction of Alberta Community Development, conduct further archaeological work in and around the confluence of the Little Bow River and Mosquito Creek.

- undertake a focussed ethnobotanical study within and around the proposed Little Bow River Reservoir to identify plants used by First Nations people and clarifying their use where it is possible.

- develop an aboriginal interpretive area and program as part of the project. Aboriginal people should be given an opportunity to lead the development of this program.

- move the two-hearth teepee ring to the location of the interpretive area to assist in the explanation of the importance of the area to aboriginal people.

26. The Operator shall, within one year from the release of the decision report, file a Mitigation Progress Report with the NRCB and CEAA that will include an update of the progress of various initiatives, including:

- Negotiations with the Little Bow Hutterian Brethren (required)
- Frank Lake Water Quality Mitigation Plan (recommended).
- Process plan for completing the Highwood River Basin Water Management Plan (required).
- Little Bow River Reservoir Water Quality Protection Plan (recommended).
- Clear Lake Irrigation Development Plan (recommended).
- Clear Lake Wildlife Management Plan (recommended).
- Habitat Compensation Plan (required).
- Fisheries Mitigation and Enhancement Plan (required).
- Field-Oriented Operations Plan (required).
- Information on Transportation Alternatives (required).
- Regional Transportation Plan (recommended).
- Plan to address livestock effects on riparian habitat and water quality (required).
- Area Structure Plan for lands surrounding Little Bow River Reservoir (required).
- Report on the actions taken with regard to the name change for Old Woman's Buffalo Jump and Squaw Coulee (required).
- Actions and initiatives relating to the conditions and recommendations concerning the aboriginal interests (required).

The Mitigation Progress Report shall also provide an update of the construction and implementation of the facilities and mitigation initiatives that are referred to in the Approval. APWSS shall prepare and file this report annually with the NRCB until such time as APWSS have fulfilled the conditions of the Approval and have passed authority to AEP for the operation of the project-related facilities. AEP shall prepare and file the report annually with the NRCB for a period of five years from the date AEP assumes authority for the operations of the project-related facilities. The Panel directs that APWSS and AEP shall provide the report directly to the Public Advisory Committee, or its successor, to ensure the exchange of information.

Made at the City of Edmonton, in the Province of Alberta, this _____ day of _____, 1998.

NATURAL RESOURCES CONSERVATION BOARD

APPENDIX C

BOARD ORDER

THE PROVINCE OF ALBERTA
NATURAL RESOURCES CONSERVATION BOARD ACT
NATURAL RESOURCES CONSERVATION BOARD

IN THE MATTER of a project of
Alberta Public Works, Supply and
Services for approval to construct
a water management project (the Project)
to convey and store water
diverted from the Highwood River

BOARD ORDER NO. 9601-1

WHEREAS the construction of water management facilities proposed to convey and store water diverted from the Highwood River by Her Majesty the Queen in Right of Alberta as represented by Alberta Public Works, Supply and Services (APWSS), consisting of four interrelated components:

1) A canal and diversion works in the Town of High River and in the Municipal District of Foothills No. 31. This proposed $6.2 million component would triple the capacity of the existing diversion works and canal to allow more water to be diverted from the Highwood River to the Little Bow River during peak flows.

2) Construction of the Little Bow River dam and reservoir in the Municipal District of Willow Creek No. 26 and in the County of Vulcan No. 2, approximately 20 kilometres (km) west of Champion. The proposed $38.8 million dam would be 25 metres high and create a reservoir that would hold 50,000 acre-feet of water. It would be filled from the natural runoff in the Little Bow River basin and water diverted from the Highwood River.

3) Construction of the proposed $5.1 million Clear Lake diversion and canal in the Municipal District of Willow Creek, about 15 km east of the Town of Stavely. The 10 km long canal would allow the lake and 12 wetlands along the route to be filled when flows in Mosquito Creek are high; and

4) The proposed $7.1 million enlargement of the existing Squaw Coulee Reservoir in the Municipal District of Foothills No. 31 from 293 acre-feet to 5,175 acre-feet by constructing upper and lower dams and a return canal to the Highwood River,

is a reviewable project under s.4(d) of the Natural Resources Conservation Board Act being chapter N-5.5 of the Statutes of Alberta, 1990; and

WHEREAS the Natural Resources Conservation Board may defer consideration of an application on any terms and conditions that the Board may prescribe or make any other disposition of an application that the Board considers to be appropriate.

WHEREAS the Natural Resources Conservation Board has deferred a decision respecting the Expanded Squaw Coulee component of the application by Alberta Public Works, Supply and Services for the construction and operation of certain water management facilities on the Highwood River and in Squaw Coulee including the Diversion Plans pertaining to proposed diversion works leading to Squaw Coulee and from Squaw Coulee to the Highwood River and to Mosquito Creek; and the Diversion Plans pertaining to the operation during the low flow season of late July and August of certain expanded diversion works in the Town of High River leading to the Little Bow River, subject to the filing and review of certain supplemental information herein specified.

THEREFORE, the Natural Resources Conservation Board hereby orders as follows:

1. The consideration of the operating plan for the expanded works for the diversion of water at High River from the Highwood River to the Little Bow River during the low flow season is deferred pending receipt and review of additional information as described herein.

2. The consideration of the expansion of the Squaw Coulee Reservoir and associated diversion works and return works is deferred.

3. The Operator shall complete its economic, social, and environmental assessment of the effects of the Super Expanded Squaw Coulee project component within twelve months of the date of issuance of this Order.

4. The Operator shall file with the Board for its approval the plans for the completion of the assessment of the economic, social and environmental effects of the Super Expanded Squaw Coulee project component, including a specific plan for public involvement, within three months of the date of issuance of this Order.

5. The Operator shall update the comparative analysis of potential storage sites within the Highwood River Basin. The comparative analysis shall include among other sites, the Super Expanded Squaw Coulee site, Stimson Creek Site 8 and the Tongue Creek Site 4, and shall include comparative data regarding environmental, social and economic effects for each site identified. The comparative analysis should form part of the completed assessment of the Super Expanded Squaw Coulee Reservoir.

6. The Operator shall, to the satisfaction of Alberta Environmental Protection, revise the IFN analysis used in the Application to reflect current fisheries management objectives for the Highwood River and to include instream flow needs based on the most recent information regarding the River, and current scientific assessment procedures and file the results thereof in the updated assessment of the economic, social and environmental effects of the Super Expanded Squaw Coulee project component.

7. The Operator shall file with the completed assessment of the economic, social and environmental effects of the Super Expanded Squaw Coulee project component an updated plan for the completion of the Highwood River Basin Water Management Plan based on the advice and consent of Alberta Environmental Protection. This update shall include: the design of an independent mediated/facilitated process; the process to identify all stakeholders and their respective community representation; detailed timelines providing for the completion of the HMP planning process within a period of two years; and cost estimates for consulting services and studies related to both parts (design and implementation) of the HMP.

8. The Panel requires that the completed assessment of the Super Expanded Squaw Coulee Reservoir project component include a revised Diversion Plan for works leading to and from Squaw Coulee and for diversion works downstream at High River leading to the Little Bow River.

Made at the City of Edmonton, in the Province of Alberta, this day of , 1998.

NATURAL RESOURCES CONSERVATION BOARD

APPENDIX D

HEARING PARTICIPANTS

Hearing Participants

Alberta Public Works Supply and Services
(PWSS or the Applicant)

Stan Rutwind, Counsel	Ron Middleton	Russ Lewis
Gilbert Van Nes, Counsel	John Englert	Tom Head
Joanne Esbaugh, Counsel	Mark Digel	Bryan Leach
Dave Fernet	Norm Weimer	Doug Clark
Allan Locke	Ron Pitt	Dave McGee
Jim Barlishen	Doug Skinner	

Alberta Environmental Protection

Everett Bunnell, Counsel	Dave Trew	Gregg Dill
Al Sosiak	Denis Magowan	Sandy Larsen
Alan Pentney	Dick Hart	Simon Knight
Dave McGee	Doug Clark	Vance Buchwald

Alberta Environmental Protection
Controller of Water Resources

Ronald Kruhlak, Counsel	Cindy Robinson	David Ardell

Little Bow River Project – Public Advisory Committee

Gary Flitton	Hannah McDonald	Paul DeClerq
Glen Roemmele	Neil Ohler	

The Fisheries Coalition

Alan Harvie, Counsel	David Andres	Kerry Brewin
Bill Mackay	Gord Kennedy	Peter Boxall

Upper Little Bow Basin Water Users Association

Cameron MacLennan, Counsel	Chip Andrus	Peter Niemans
Bruce Akitt	Glenn Jordan	Shirley Pickering
Bruce Tait	Jack Top	Tim Hardin
Charles Andrus	Joseph Eilers	

Hearing Participants

Little Bow River Basin Water Users Association

Cameron MacLennan, Counsel	David Yates	Alfred Little
Gary Flitton	Adrian Dykstra	
Gerald Alder	Diana Andrews	

Citizens of Baker Creek

Lil Rehak	Stephen Evans	Gary Hoffart
Bob Rehak	Norman Smith	
Chris Wilson	Chris Linnington	

Federation of Alberta Naturalists

Maryhelen Posey

Blood Tribe

Annabel Crop Eared Wolf	Brian Reeves	Louise Crop Eared Wolf
Wilton Goodstriker	Rosie Day Rider	

Clear Lake Water Users

Bob Christie	Neil Ohler	Glen Roemmele

Treaty 7 Coalition

Louise Mandell, Counsel	Mike Watson	Celeste Strikes With a Gun
Allan Pard		

Vulcan Economic Development

Georgie Popovitch

Hearing Participants

Alberta Community Development

Everett Bunnell, Counsel
Les Hurt
Rod Vickers
Jack Brink

Town of Vulcan/Village of Carmangay/Village of Champion

Dave Mitchell
Wally Sholdice

Town of Nanton

Lillian McLellan, Counsel
Karen Harty
Scott Chant
Herb Johnson
Bryan Scott

Alston Community Group

Nick Finn
Hannah McDonald
Jerry Strauss
Bob Dion
Barry Johnson
Ron Mueller (Also, Town of Stavely)

M.D. of Willow Creek

Earl Hemmaway
Ian Sundquist
Cindy Zabolotney
Brian Nelson
Mike Burla
Sharon Shearer

County of Vulcan

Wayne Davey
Robert Strauss
Mike Burla

Alberta Land Compensation Board

Cecil Purves

Hearing Participants

Little Bow Hutterian Brethren

Brian O'Ferrall, Counsel	Logan Tait	Paul Hofer
Joe Hofer	Bruce Tait	Darius Hofer
Mike Hofer	John Hofer	

Giles Family and Edna Moncreif

Shawn Munro, Counsel	Murray Giles	Helen Giles
Dawn Giles	Ross Giles	Jim Evans

Lower Highwood River Water Users Group

Tom MacLachlan	Gerry Porter	Gordon Walder
Bob Berrien		

Recreational Interests Group

John Taylor	Ed Sparrow	Gerald Lyon
Michael Dockman		

Federal Panel
Fisheries and Oceans (Coast Guard)
Fisheries and Oceans (Fish Habitat Management)
Environment Canada:

Stephen Faulknor, Counsel	Rick Courtney	John Wood
Ursula Tauscher, Counsel	Trevor M. Swerdfager	John Woodward
Ken Brant	Ursula Banasch	Paul Goossen
Garry Linsey	Dorthy Majewski	

Individuals

Tom Alcock	Roy Eggar	Ralph Nelson
Claire MacKay	Bea Eggar	Bob Baker
Warren Fisher	Bob Christie	Karen Snodgrass
David Pope	Don Coreman	Hugh MacKenzie
James Perrott	Pam Brooks	

Hearing Participants

Joint Panel Secretariat

William Y. Kennedy, Counsel
John Thompson

Jane Currie
Robert Powell

Jacinta Rodrigues
Ghislaine Kerry, CEAA

APPENDIX E

ACRONYMS, UNITS OF MEASUREMENT, GLOSSARY

ACRONYMS	
AADT	Average Annual Daily Traffic
ACD	Alberta Community Development
AE	Alberta Environment was a governmental department with the mandate of protecting Alberta's environment up until 1993.
AEP	Alberta Environmental Protection has the same mandate as AE and replaced AE as of 1993.
AEPEA	Alberta Environmental Protection and Enhancement Act
AAFRD	Alberta Agriculture Food and Rural Development
AFSL	Above Full Supply Level
APWSS	Alberta Public Works, Supply and Services
ASA	Archaeological Survey of Alberta
AWRC	Alberta Water Resources Commission
BATHTUB	A mass-balance computer simulation model for reservoir water quality
BETTER	Box Exchange Transport Temperature Ecology Reservoir (a computer model)
B.O.D.	Biochemical Oxygen Demand
BRID	Bow River Irrigation District
BRWQTF	Bow River Water Quality Task Force
BRWG	Bow River Working Group
CCREM	Canadian Council of Resource and Environment Ministers
CEAA	Canadian Environmental Assessment Act
CFU/100 ml	Colony Forming Units per 100 millilitres
CLC	Clear Lake Committee
CLI	Canada Land Inventory
CRPC	Calgary Regional Planning Commission
DFO	Department of Fisheries and Oceans
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DP	Dissolved Phosphorous
EC	Electrical conductivity
EEM	Environmental Effects Monitoring
EIA	Environmental Impact Assessment
EMP	Environmental Mitigation Plan
EPP	Environmental Protection Plan
FRC	Fish Rule Curve
FSL	Full Supply Level
GCA	Grassland Conservation Area

GDP	Gross Domestic Product
HEP	Habitat Evaluation Procedure
HMP	Highwood River Basin Water Management Plan
HRPAC	Highwood River Public Advisory Committee
HRA	Historical Resources Act
HRIA	Historical Resources Impact Assessment
HSI	Habitat Suitability Index
HU	Habitat Unit
IFA	Instream Flow Allocation
IFIM	Instream Flow Incremental Methodology
IFN	Instream Flow Needs
IFO	Instream Flow Objective
IRR	Internal Rate of Return
LAC	Local Advisory Committee
LBLAC	Little Bow Local Advisory Committee
LBPAC	Little Bow Public Advisory Committee
LBR	Little Bow River
LBRID	Little Bow River Irrigation District
LBWUA	Little Bow Water Users Association
LHRA	Lower Highwood Residents Association
M.D.	Municipal District
MLA	Member of Legislative Assembly
MOL	Minimum Operating Level
NAQUADAT	AEP's water quality database
NPV	Net Present Value
NRCB	Natural Resources Conservation Board
NRCBA	Natural Resources Conservation Board Act
NTU	Nephelometric Turbidity Units
ORRPC	Oldman River Regional Planning Commission
PAC	Public Advisory Committee
PPM	Parts per million
PFRA	Prairie Farm Rehabilitation Administration
PHABSIM	Physical Habitat Simulation System
PMF	Probable Maximum Flood
SAR	Sodium Adsorption Ratio
SH	Secondary Highway
SSRB	South Saskatchewan River Basin

SSRBPP	South Saskatchewan River Basin Planning Program
TAC	Technical Advisory Committee
TDS	Total Dissolved Solids
TP	Total Phosphorous
TSC	Technical Subcommittee
USFWS	United States Fish & Wildlife Service
VEC	Valued Ecosystem Component
WASP	Water-quality Analysis Simulation Program
WQRRS	Water Quality for River and Reservoir Systems
WRA	Water Resources Act
WRMM	Water Resources Management Model
WSC	Water Survey of Canada
WUA	Weighted Useable Area

UNITS OF MEASUREMENT

This report uses metric units of measure followed by the imperial conversion presented in parenthesis where deemed necessary. The information presented below represents both imperial and metric units of measure used in this report, conversion factors, and abbreviated forms used throughout the text of this EIA.

Area:			
1	acre (acre)s	0.405	hectares (ha)
1	hectares (ha)	2.47	acres (acres)
1	square kilometre (km^2)	0.3861	square miles (mi^2)
1	square foot (ft^2)	0.09290	square metres (m^2)
1	square metres (m^2)	10.76	square feet (ft^2)
Volume:			
1	acre-foot (ac-ft)	1.2335 1233.5 271,322	cubic decameters (dam^3) cubic metres (m^3) gallons
1	cubic decameter (dam^3)	0.811 1000	acre feet (ac ft) cubic metres (m^3)
1	cubic metre (m^3)	220.17	gallons (gal)
1	gallon (gal)	.00454	cubic metres (m^3)
1	milligram per litre (mg/L)	1.0	parts per million (ppm)
Length:			

1	foot (ft)	0.3048	metres (m)
1	kilometre (km)	0.6214	miles (mi)
1	metre (m)	3.281	feet (ft)
1	millimetre (mm)	0.03937	inches (in)
Discharge rates:			
1	cubic foot/second (cfs)	0.0283	cubic metres/second m^3/s)
1	cubic metre/second (cms)	35.315	cubic feet/second (cfs)

GLOSSARY	
Aerobic	When used to describe living organisms, aerobic means "requiring oxygen". When used to describe a physical environment, it means "oxygen is present".
Anaerobic	When used to describe living organisms, anaerobic means "without oxygen"; such organisms do not require oxygen to live and are inhibited by oxygen. When used to describe a physical environment, anaerobic means "without oxygen"; oxygen is not present or only at very low concentrations.
Anoxic	Without oxygen; conditions where oxygen concentrations are very low so that oxygen requiring (aerobic) organisms cannot live.
Aquifer	A saturated permeable geologic unit capable of transmitting significant quantities of groundwater
Coliform	Type of bacteria present in the digestive tracts of animals and present in other sources such as soil. Faecal coliform bacteria are present in the intestine of warm-blooded animals including humans.
Confluence	The meeting points of two rivers
Cumulative impacts	Impacts arising from the interaction of project components or activities with other activities of the past, or those occurring simultaneously or sequentially.
Discharge area	That portion of the drainage basin where the predominant direction of groundwater flow is upward towards the water table; in a discharge area the water table is usually located at or very near the surface.
Dissolved oxygen (DO)	The amount of oxygen dissolved in water, reported in milligrams per litre. Levels of 5 mg/l or above indicate a relatively healthy stream. The maximum level of DO is ordinarily 8-9 mg/l, depending on water temperature and salinity.
Domestic water use	The use of water for households, especially at the farm level, as opposed to municipal use, which includes industrial water supplies as well as households
Drawdown	The depth a reservoir is lowered below full supply level during operations
Ecoregion	An area characterized by a distinctive regional climate as expressed by vegetation

Ecosystem	A community of interdependent plants, animals and other living organisms (including humans) together with the environment which supports them and with which they interact
Effluent	Wastewater, treated or untreated, flowing from a sewage treatment plant, sewer or industrial outfall.
Emergent macrophyte	An aquatic plant that extends above the water surface, e.g., cattail
Epilimnetic	Referring to the upper region of warmer water in a water body
Eutrophic	Nutrient rich water bodies often characterized by excessive growth of algae and other plants and decreased aquatic species diversity
Eutrophication	The process of nutrient enrichment of surface water leading to increased biological productivity
Exceedence level	A measure of how frequently an event is equalled or exceeded
Evapotranspiration	Combined water loss to the atmosphere by evaporation from the soil and transpiration from plants
Fecal coliforms	A group of bacteria used as an indicator of sanitary quality in water. The total coliform group is an indicator of sanitary significance because the organisms are usually present in digestive tracts of humans and other warm-blooded animals, and exposure to them in drinking water causes diseases such as cholera
Fish entrainment	Drawing in of fish into water withdrawn from a natural water body (e.g., into a canal, intake pipe)
Floodplain	Belt of low, flat ground present on both sides of a graded stream channel or river, subject to inundation by a flood about once annually
Fluvial	Of a river or river flow
Freeboard:	The vertical distance between the full supply level and the top of a dam or dyke
Full supply level (FSL)	The maximum level at which a reservoir is generally operated (i.e., the reservoir is full at FSL)
Geohydrology	Study of the groundwater of a region (also referred to as hydrogeology)
Groundwater	The fresh water found beneath the earth's surface, usually in aquifers, that supplies wells and springs
Headworks	The portion of the irrigation systems that include on-stream storage facilities, diversions from the mainstem rivers and tributaries, and the conveyance systems to the junction with the Irrigation Districts' facilities
Hydrograph	Graphic presentation of the variation in stream discharge over time
Hydrology	The study of the distribution and properties of water within the atmosphere and at the earth's surface
Hydrogeology	The science of groundwater and its distribution and movements
Hypereutrophic	Pertaining to an aquatic habitat with very high biological productivity; rich in mineral nutrients required by green plants
Hypolimnetic	Referring to the lower region of colder water in a water body
Irrigation efficiency	A measure of the hypothetical water requirements to maximize crop production compared to actual amounts of water withdrawn for irrigation

Limnological	Pertaining to the study of freshwater habitats and communities, particularly lakes, ponds and other standing waters; includes biological, physical and chemical components
Macrophyte	Aquatic plant that is larger than algae
Mesotrophic	A water quality in between oligotrophic and eutrophic characterized by the abundance and diversity of aquatic life forms.
Minimum irrigation level	The reservoir level below which releases of water for irrigation needs would not be allowed
Minimum operating level (MOL)	The minimum level to which the reservoir would be lowered
Mitigation	An activity aimed at reducing the severity, avoiding or controlling environmental impacts of a project, through design alternatives, scheduling, or other means
Model	A mathematical description of some process or situation that is created and used to assist in forecasting the effects of possible changes. Complex models are able to describe interrelated physical, biological, and chemical effects in three dimensions over time, and are usually run on computers.
Morphometry	Pertaining to specific form, shape or structure; e.g. river channel morphometry
Nutrients	Elements and compounds that feed bacteria, plants, and animals. The major crop nutrients that often require amendment are nitrogen (N) and phosphorus (P). They are present in organic wastes such as municipal sewage, feedlot runoff, meat-processing wastes, and in commercial inorganic fertilizers such as anhydrous ammonia, ammonium nitrate, ammonium sulphate, and ammonium phosphate.
Oligotrophic	Pertaining to an aquatic habitat with very low biological productivity and low numbers of aquatic life forms; poor in mineral nutrients required by green plants
PH	A physical measure of the acid/base characteristics of a material
Probable maximum flood (PMF)	The flood that may be expected from the most severe combination of meteorological and hydrological conditions reasonably possible in a particular drainage basin
Recharge areas	A land area in which water reaches the zone of saturation from surface infiltration (e.g., where rain water soaks through the earth to reach an aquifer)
Riparian	Pertaining to the banks of a river or waterbody; vegetation growing naturally along the sides or banks of a waterbody
River stage	Water surface elevation of a river
Runoff	Portion of precipitation landing on an area that flows into surface lakes and streams
Salinization	The accumulation of salts in soil. Eventually the salt buildup prevents plant growth

Salmonid	Any fish of the salmon family (Salmonidae); includes subfamilies Salmoninae (salmon, trout, char), Coregoninae (whitefish) and Thymallinae (grayling)
Setback	The area above the reservoir full supply level reserved to accommodate potential bank sloughing and to provide access for maintenance
Spillway	A channel to release water from the surface or near surface of a reservoir
Spring freshet	Flow within a water course associated with runoff from melting snow
Standing crop	Weight of plant or animal matter of a particular species in a given area
Submergent macrophyte	Aquatic plant which grows below the water surface, e.g. Richardson's pondweed, Canada waterweed
Tailwaters	The river or creek immediately downstream of a dam
Takeline	The boundary between project lands and non-project lands, which reflects the recommended setback for a reservoir
Total dissolved solids (TDS)	Inorganic and organic material dissolved in water, as determined from dried residue
Total suspended solids (TSS)	Small particles of solid material that are suspended in or floating on the water
Trophic	Relating to the processes of energy and nutrient transfer from one or more organisms to others in an ecosystem; pertaining to food or nutrition
Trophic status	Degree of biological productivity, e.g. eutrophic, mesotrophic, oligotrophic.
Turbidity	Water cloudiness cause by the presence of suspended particles
Withdrawal	Man-induced removal of water from a natural source

APPENDIX F

WATER QUANTITY MODELLING:
THE WATER RESOURCES MANAGEMENT MODEL

F. Water Quantity Modelling: The Water Resources Management Model

As noted in Section 4, APWSS used the Water Resources Management Model (WRMM) to develop their proposed diversion plan. The purpose of this appendix is to provide a more detailed overview of the model and the assumptions that were used to develop the proposed Diversion Plan.

WRMM is a computer model that allocates naturally available water among a set of competing demands for water. It incorporates the physical and operational components of the water management system being evaluated. In this case, the water management system being evaluated is the Highwood River basin and the Little Bow River basin upstream of Travers Reservoir. The physical components include the river channels and the existing and proposed diversion canals and reservoirs. The model simulates all significant demands for water and allocates natural flow among these demands on a priority basis. The model user sets the priorities to represent alternative operating plans for the system being evaluated.

A number of types of data and assumptions are necessary to use the WRMM to simulate the allocation of water among competing demands. These include:

- Estimates of natural flow, which are calculated by adjusting recorded flows to account for the effects of significant water diversions, inflows and impoundments.
- Estimates of current and future consumptive demands. For this project, estimates of consumptive demands were provided by AEP based on historical records, projections and various other assumptions.
- Conveyance flows, which are flows that ensure that consumptive users can actually withdraw water and that provide for contingencies.
- Instream flow requirements. These requirements were developed as a result of the Highwood River IFN study and describe the flows necessary to provide habitat and water quality conditions necessary to support fish populations.
- Water use priorities, which provide WRMM with the rules necessary to allocate water among the various competing consumptive and non-consumptive uses.

The balance of this appendix summarizes the data and assumptions used for each of these five inputs to the WRMM model.

F.1 Natural Flows

A first step in using the WRMM to model water demand and supply in the Little Bow and Highwood River basins was to establish the natural flows in each river basin. Natural flows are not measured but can be estimated using a variety of methods. In the case of the Highwood River, natural flows were estimated by combining recorded river flows with estimates of major water diversions. This method was selected because there were fairly complete flow records for four Water Survey of Canada

gauging stations in the basin for much of the period from 1912 to 1989. There were also fairly complete water use records for the Little Bow Canal and the Squaw Coulee diversions, which represent the two major water diversions on the Highwood River. The resulting natural flow estimates, as prepared by Alberta Environment, were then used as the basis for most of the hydrologic analysis contained in the EIA. These estimates are known to be conservative. They do not account for minor diversions in the Stimson-Pekisko sub-basins or consumptive withdrawals in the Highwood basin. These omissions were judged by the Applicant to be insignificant in terms of total flow volume and would overestimate the frequency of low flow events.

A second method was used to estimate natural flows in the Little Bow River basin. This was necessitated because there was only one gauging station in the basin, there are very limited records of actual consumption, and flows in the Little Bow River and Mosquito Creek have been heavily augmented by diversions from the Highwood River. To construct natural flow estimates for the Little Bow River, Alberta Environment developed a natural flow data set for one water gauging station in the Basin (Mosquito Creek at Nanton) and then extrapolated this for the rest of the Basin using data on stream flows in nearby basins. The one natural flow data set was developed statistically using regression analysis and assuming uniformity of run-off for various elevation zones in the Basins. Although this method was judged to provide a useful tool for assessing water use options in the Basin, AEP suggested that caution be exercised in using the data beyond their intended purpose.

F.2 Consumptive Uses

The second step in developing a WRMM simulation for the Little Bow and Highwood river basins was to determine current and predicted consumptive water uses in each Basin on a weekly basis. Although existing licences can be used to establish total water requirements and maximum diversion rates, various methods were used to determine weekly diversions for the various types of consumptive uses. For purposes of modelling, consumptive water uses were grouped into two major categories. Irrigation demands were treated as one broad category of demand. All other licensed uses, including municipal, industrial, agricultural and domestic uses, were grouped together as a second demand category.

F.2.1 Municipal, Domestic and Industrial Water Requirements Used in WRMM

There are currently nine licences authorizing withdrawals of water from the Highwood River for municipal, industrial, agricultural, domestic and "other" purposes. This includes the groundwater licence for the Town of High River. These nine licences allow a maximum of 6,953 dam^3 (5637 ac-ft) of water to be withdrawn each year, with a combined maximum diversion rate of 0.51 cms (17.9 cfs).

To determine current and future water demands on a weekly basis, AEP undertook a consumptive demand study. A primary source of information for this study was the annual water use returns submitted by large municipal and industrial water users. Water use returns are annual reports that are required from licencees. Theses reports provide a detailed record of the actual amounts of water pumped on a monthly basis. In the case of municipal and industrial demands, the water use returns were judged to provide an accurate seasonal pattern and rate of water withdrawals, and this information was used to determine weekly flows. For the Town of High River, diversion rates were increased to account

for an assumed 91 per cent increase in population by the year 2011.

Licence information was used to determine the pattern of withdrawals for "other" purposes, namely the licence to divert water to Frank Lake. This licence actually contains a monthly withdrawal rate that starts with 0.03 cms (1.0 cfs) during January and February and then increases to a maximum of 0.20 cms (7.0 cfs) during June. The licence requires that these diversions cease during July and August and then can resume in September at a rate of 0.11 cms (4.0 cfs), then dropping to (0.03 cms) 1.0 cfs by December.

For the smaller municipal, domestic and agricultural licences it was assumed that the total demand, as specified in the licence, would be distributed evenly throughout the year.

The resulting estimates of municipal, industrial, agricultural, domestic and "other" water uses in the Highwood River Basin are shown in Figure F-1, along with the demand assumptions used in the model. The figure shows that the maximum rate of diversion ranges between 0.23 cms (8 cfs) and 0.42 cms (15 cfs), with the higher diversion rate occurring during May and June. These estimates of average weekly diversion rates are below the maximum licensed diversion rate of 0.51 cms (17.9 cfs).

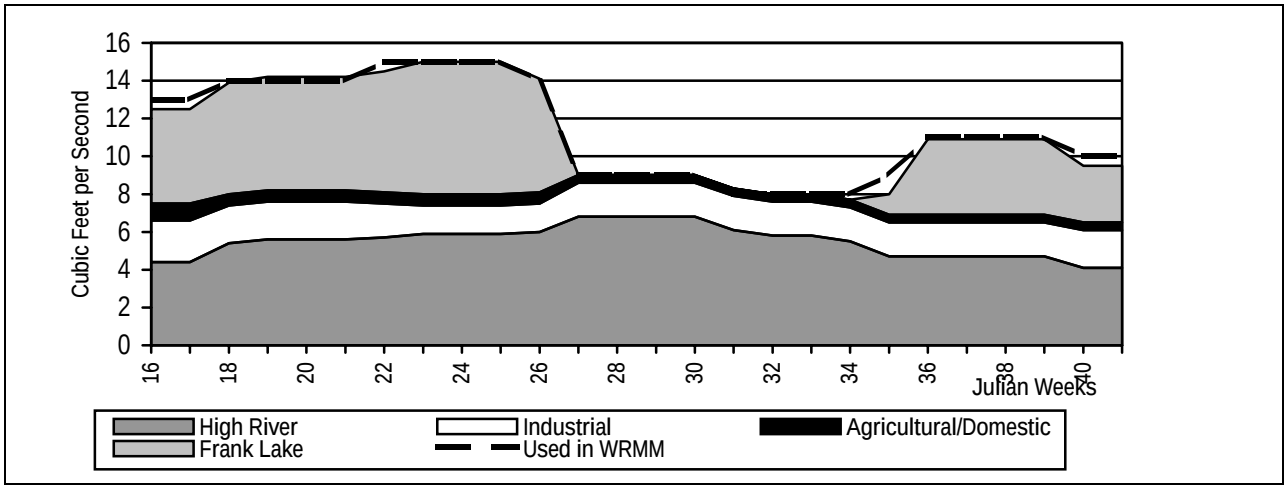

Figure F-1: Weekly Municipal, Domestic and Industrial Demands in the Highwood River Basin

A similar approach was taken to determine weekly municipal and industrial water demands in the Little Bow River Basin. Water use returns were used to determine weekly use patterns for all the major municipalities, and potential water use by the town of Vulcan was determined on the basis of their current licence application for an additional 259 dam^3 of water (210 ac-ft). However, there are few water use records for the small municipal users like the water co-operatives and the Hutterite colonies since they were only recently licensed. Consequently, weekly demands for these users were estimated by assuming that their pattern of weekly demand would be similar to that of the Village of Carmangay. The resulting estimates of weekly water municipal, domestic and industrial water demands in the Little Bow River Basin and the corresponding demand estimates used in WRMM are shown in Figure F-2.

Figure F-2 indicates negative water consumption for the Town of Nanton during the early spring and late fall months. This unusual situation occurs because the Town of Nanton draws their water supplies from wells and springs during the winter months. After being used and treated, this water is then returned to Mosquito Creek where it represents an addition to natural flows.

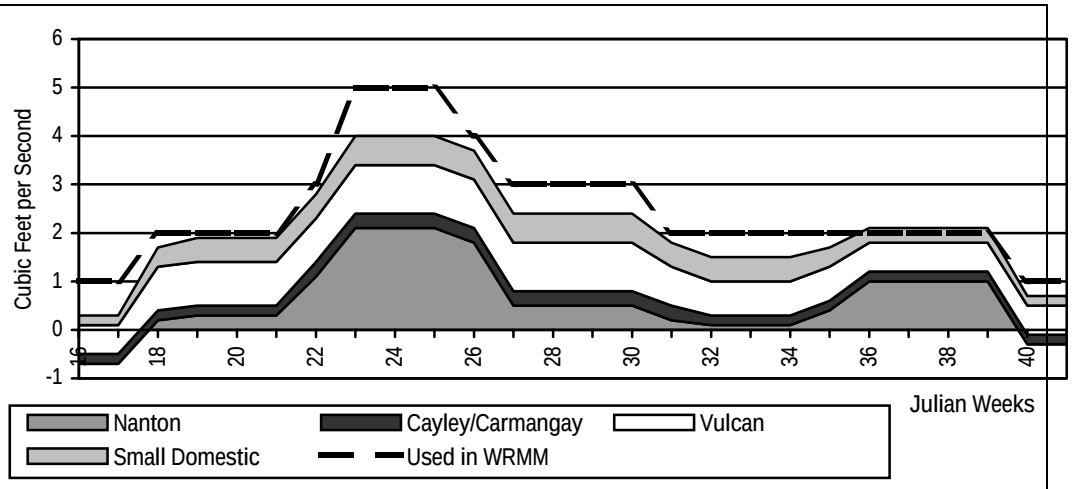

Figure F-2: Weekly Municipal, Domestic and Industrial Demands in the Little Bow River Basin

F.2.2 Irrigation Water Requirements Used in WRMM

Modelling of current and future irrigation demands in the Highwood and Little Bow river basins first involved dividing total demands into eight separate irrigation blocks. Irrigators in each of these blocks have slightly different irrigation requirements and would be affected differently by project implementation. The eight irrigation blocks used in the model are described in Table F.1.

TABLE F.1
IRRIGATION REQUIREMENTS USED IN WRMM

Irrigation Block	Existing Irrigation (acres)	Irrigation Expansion (acres)	Water Demand (acre-feet)	Irrigation Target (ft/acre)
Highwood River				
9. Upstream of the Little Bow Diversion	1,552		1,268	0.82
10. Little Bow Diversion to Aldersyde	1,021		841	0.82
11. Aldersyde to Sheep River	739		776	1.05
12. Downstream from Sheep River[+]	1,688		1,229	0.73
Little Bow River Basin				
13. Upstream of Little Bow Reservoir	1,688		1,623	0.96
14. Downstream of Little Bow Reservoir	11,512		15,334	1.33
		16,500	21,979	1.33
15. Mosquito Creek	1,893		2,087	1.10
16. Clear Lake		3,500	4,662	1.33

[+] This includes 13 licences for 1,125 acre-feet of water from the Sheep River on 1513 acres of land.

The second step in modelling irrigation demand was to determine weekly water diversion patterns for existing irrigation on each of the eight blocks. The process for determining weekly irrigation demand is set out in the *Consumptive Demand Analysis* undertaken by AEP in 1993. It involved examination of water use returns provided by a sample of irrigators in the Little Bow River Basin for the period from 1983 to 1988. Although not entirely representative of all irrigators, the water use information was judged by the Applicant to be a reasonable description of the weekly pattern of irrigation water use.

In interpreting the water use return information, it was noted that actual water use, based on monitoring conducted in 1986 to 1988, is often different from the amounts of water irrigators reported in their water use returns and is also different from licensed amounts. For example, actual monitoring of withdrawals showed that irrigators tend to overstate the amount of water used during June and September, but understated the amount they used in July and August. The reported water use information was then adjusted to account for these differences. The water use data also show that irrigators sometimes report using more than their licences would allow. Reported use exceeded the licensed allocation by an average of 10 per cent between 1983 and 1988. However, since monitoring studies showed that the accuracy of reported water use was within the range of ± 10 per cent, it was concluded that using the licensed allocation, as the basis for modelling, was appropriate.

The *Consumptive Demand Analysis* also concluded that future weekly irrigation demands will probably differ from current practices. Current diversions are tied to the availability of water from the Highwood River and the diversion canals. But with a more assured water supply as a result of the proposed project, irrigators are more likely to irrigate according to crop requirements. Switching from a supply-based operating regime to a demand-based approach would reduce irrigation water demands in late July and early August, but would increase usage in late August and early September. Thus, weekly irrigation demand for irrigated acres located adjacent to or below the proposed reservoir was based on crop water requirements rather than historical use patterns. Crop water requirements were also used to estimate irrigation demand along the Highwood River because there were insufficient water use returns to determine current patterns of water usage.

The weekly irrigation water requirements for the Highwood River Basin, as used in the WRMM, are shown in Figure F-3. Irrigation water requirements increase gradually during the irrigation season, reach a peak in early July (Week 27), and then decline for the remainder of the period. At the peak, irrigation diversions from the Highwood River above the Sheep River are estimated to be about 0.54 cms (19 cfs). This amount represents only about 35 per cent of the total maximum diversion rate of nearly 1.53 cms (54 cfs) authorized under existing irrigation licences.

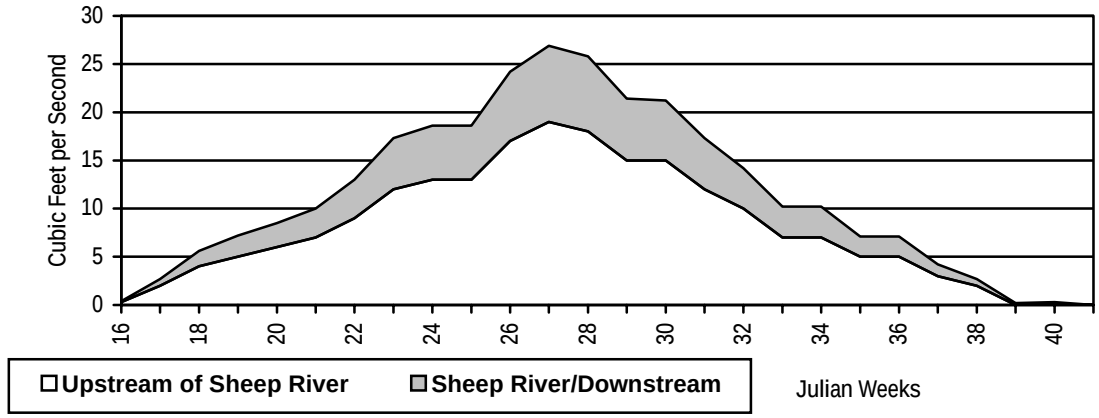

Figure F-3: Weekly Irrigation Requirements in the Highwood River Basin

The historical distribution of demand was used in the WRMM to simulate weekly irrigation requirements for irrigation demand for Squaw Coulee and along the Little Bow River and Mosquito Creek above the proposed reservoir. The weekly distribution of irrigation demand from Mosquito Creek is provided in Figure F-4 and the corresponding information for the Upper Little Bow River is provided in Figure F-5. Figure F-4 shows that high levels of irrigation occur along Mosquito Creek in early June (Weeks 22 to 24) and peak in late July (Week 29). The maximum irrigation demand is estimated to be slightly less than 0.42 cms (15 cfs). However, maximum irrigation diversions allowed under existing licences total over 0.93 cms (33 cfs).

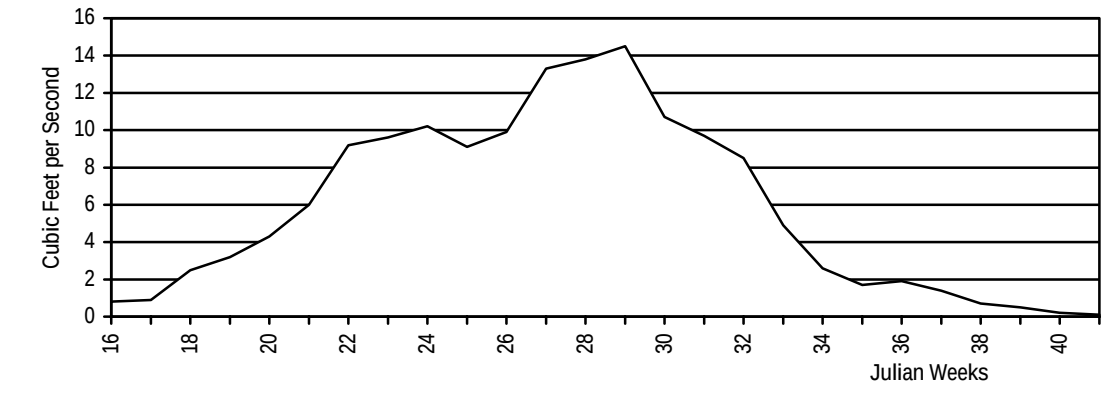

Figure F-4: Weekly Irrigation Requirements from the Mosquito Creek

Figure F-5 shows that the irrigation demands used in the WRMM for the upper Little Bow River are different from the demand projections offered by the *Consumptive Demand Analysis*. Although the general pattern of diversions and the maximum rate of diversions are about the same, the WRMM assumes that irrigation demand in this part of the Basin commence and peak about two weeks earlier than suggested by historical records. Peak irrigation demand is estimated to be about 0.35 cms (12 cfs) in early July (Weeks 26 and 27). However, existing irrigation licences authorize up to nearly 0.71 cms (25 cfs).

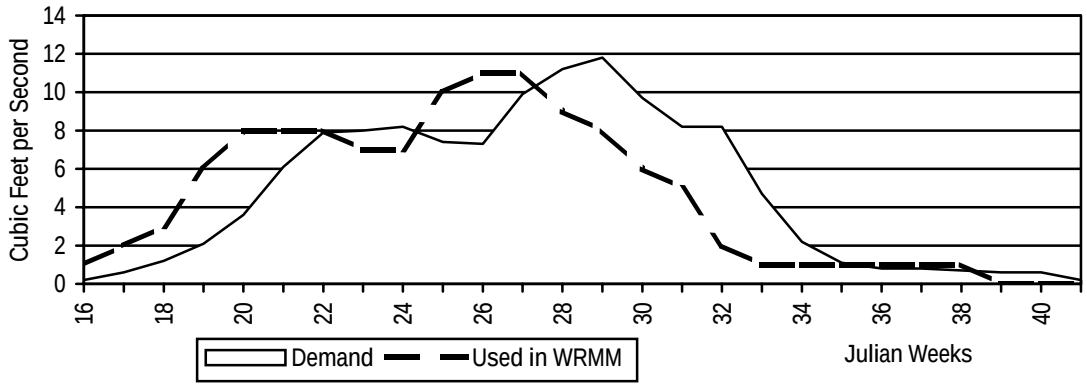

Figure F-5: Weekly Irrigation Requirements in the Upper Little Bow River Basin

Existing weekly water requirements for irrigation from the Little Bow River and Mosquito Creek adjacent to and downstream from the proposed reservoir are shown in Figure F-6. This figure shows some differences between crop water requirements in the Basin and the pattern of diversion used in WRMM. Peak water demand currently occurs in early July (Week 27) with average diversion being about 2.83 cms (100 cfs). Current licences in this reach currently authorize maximum withdrawals of up to 4.47 cms (158 cfs) for irrigation.

Figure F-6 also shows future irrigation water requirements assuming 6,680 ha (16,500 acres) of irrigation expansion adjacent to and downstream from the proposed reservoir. For the irrigation expansion, crop water requirements were based on assumptions about the types of crops that would be grown, target crop yields, and the acceptable level of risk of crop failure due to moisture deficits. Maximum irrigation water requirements would increase to about 7.79 cms (275 cfs), based on crop water requirements as per the *Consumptive Demand Analysis*. In the WRMM, irrigation water requirements are assumed to peak at about 6.80 cms (240 cfs), and would exceed water demands based on crop water requirements in the spring and fall.

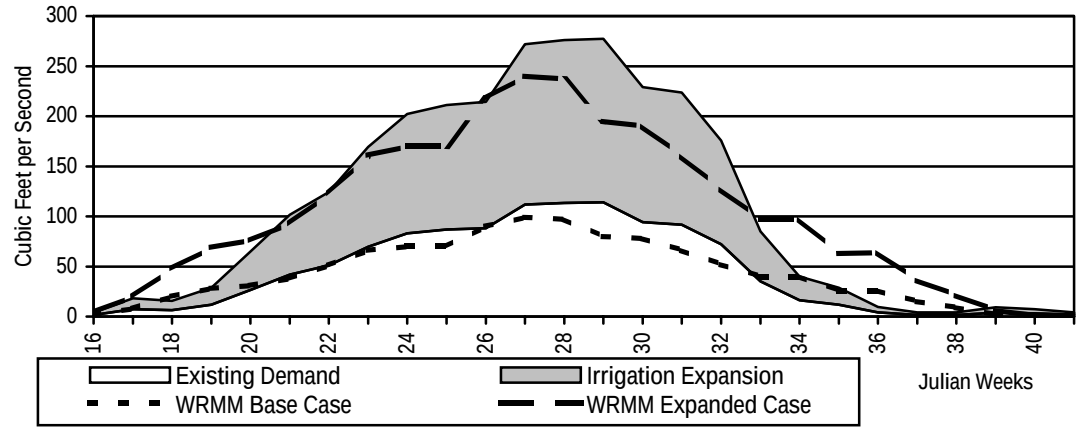

Figure F-6: Weekly Irrigation Requirements in the Lower Little Bow River Basin, Including Irrigation Expansion

With implementation of the project, water will be diverted out of Mosquito Creek and into Clear Lake where water can then be withdrawn for irrigation. The modelling assumed that 1,415 ha (3,500 acres) of new irrigation could be supported from Clear Lake. Water demands were predicted based on crop types, target yields, weekly requirements and acceptable levels of irrigation risk. Figure F-7 shows that irrigation requirements, as assumed in the WRMM, would gradually increase throughout the season, peaking at about 0.85 cms (30 cfs). For most of the summer, the irrigation water requirements for Clear Lake included in the WRMM are slightly higher than those estimated as part of the *Consumptive Demand Analysis*.

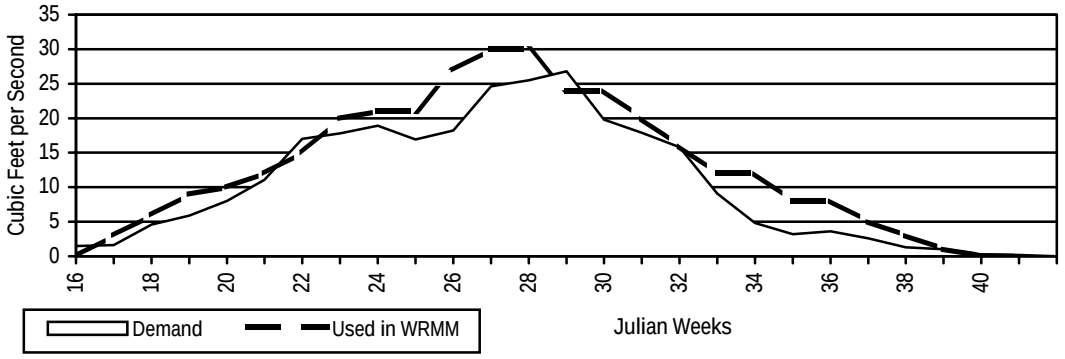

Figure F-7: Weekly Irrigation Water Requirements for Clear Lake

F.3 Conveyance Flows Used in WRMM

Another water demand in the Little Bow River basin is termed "conveyance flow". Technically this is defined as the amount of water that must be diverted from the Highwood River to maintain the ability to withdraw water from the Little Bow River and Mosquito Creek during water-short periods. Conveyance flow is required to ensure that consumptive users can physically withdraw water (i.e. pump intakes are covered) and to provide for contingencies (i.e. emergencies, unauthorized withdrawals, miscommunication in the timing of supply and demand).

This means providing some water so that there is still some flow in the streams after consumptive users have withdrawn their water. The amounts of water required for conveyance flows is not a fixed or specified number. However, AEP indicated that the current practice was to release between 0.14 cms (5 cfs) and 0.42 cms (15 cfs) down each of the Little Bow Canal and through Squaw Coulee into Mosquito Creek for conveyance flow. For purposes of the WRMM simulations, a flow of 0.28 cms (10 cfs) was adopted as the conveyance flow for each stream. However, it was further assumed that, during the winter months, 0.57 cms (20 cfs) of conveyance is required for the Little Bow River, while supplementary flows into Mosquito Creek could be shut off. Estimates of weekly conveyance flow were provided in the *Consumptive Demand Analysis* and are summarized in Figure F-8.

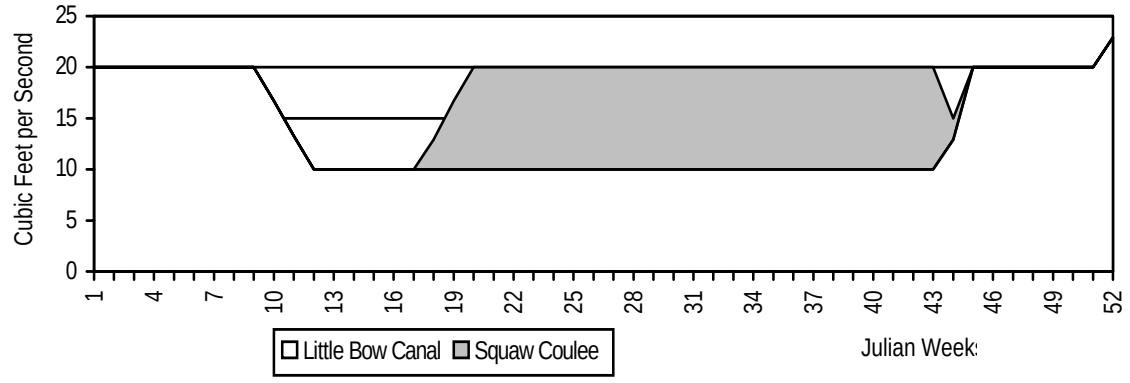

Figure F-8: Total Conveyance Flows

F.4 Instream Flow Needs

The third step in developing the WRMM simulations was to determine instream flow needs. The benefits of meeting demands for consumptive uses of water such as those just described must be balanced against the benefits of keeping water in the stream. Instream flows protect aquatic and riparian communities, which in turn support fisheries and recreation in the Highwood and Bow Rivers. Instream flows also ensure conveyance of water to downstream users and maintain water quality by diluting or assimilating pollutants. Although instream needs are sometimes mistakenly characterized as solely environmental needs, the benefits of protecting instream flow needs are clearly economic and social as well. The economic welfare of downstream irrigators, campground operators and angling guides all depend on adequate instream flows. The value of a family picnic in a poplar forest by a clear Highwood River is no less real because it cannot be easily quantified. With these observations in mind it is clear that it would be a distortion of the real issue to paint the allocation of water to instream and consumptive demands as an 'environment vs. economy' matter. There are environmental, social and economic reasons to leave water in the stream and these must be weighed against the benefits of diversions and withdrawals.

The assessment of instream flow needs differs from the problem of estimating consumptive demands in some important respects. Consumptive demands and diversions do not overlap in the sense that water used for one purpose is not generally available to supply another demand. The effect of withdrawals and diversions from the Highwood can therefore be estimated by adding up the demands and subtracting the total from the natural flow. Instream flows are the opposite; an instream flow that provides habitat for fish near High River also maintains shallow groundwater and conveyance for downstream irrigation users. The problem of defining instream flow needs is therefore one of defining flows that simultaneously serve many purposes.

Although the state of many instream and riparian values depend on stream flows, the IFN assessment the applicant used to develop the Diversion Plan focused solely on the instream needs of salmonid fishes.

F.4.1 The Scientific Assessment of Instream Flow Needs

The scientific assessment of instream flow needs included three components: an assessment of the need for flushing flows, an assessment of water quality impacts on fish, and an

assessment of fish habitat in relation to flows. The IFN was defined as being either the maximum of the flows defined by the three requirements or the natural flow of the stream whichever was less.

Freshet flushing flows alter the shape of the rivers (channel morphology) and remove fine sediments that may accumulate during lower flow conditions. Alberta Environmental Protection reviewed the requirements for habitat maintenance flushing flows, that is, those that remove sediments. They concluded that a discharge of 28.32 cms (1000 cfs) for three consecutive days would remove fine sediment from reach four of the Highwood River. Freshet discharges in the Highwood are commonly much greater. Therefore the flushing flow is readily accommodated.

The relationship between stream flow and fish habitat was studied according to the procedures of Instream Flow Incremental Methodology (IFIM). Hydraulic data collected at five study sites during various flow conditions were used to simulate the hydraulic characteristics of the river downstream of the diversions. Microhabitat frequency and use data for rainbow trout and mountain whitefish were used to develop microhabitat preference curves. PHABSIM (Physical Habitat Simulation) models were used to combine these data to develop relationships between flow and Weighted Usable Area (WUA), an index of habitat for each fish species and life stage.

The relationship between fish habitat and flow (i.e. the WUA curves) differs from species to species and with life stage. Consequently, a flow that is beneficial to one stage and species may be detrimental to another. The seasonal periodicity of spawning, incubation and rearing of fry make certain periods critical to the survival and reproduction of fish. In order to provide water management planners with the best estimate of flow requirements for fish, the open water season was divided into "biologically significant periods". A flow was selected to provide optimal habitat for the most critical life stages present based on the WUA curves for that species and stage. The optimum habitat value was adjusted to accommodate the habitat requirements of the other species and stages where these conflicted. Since optimum habitat is only intermittently available, the optimum habitat was requested only for the 20 per cent wettest conditions (i.e. the 0 to 20 per cent exceedance flows). Average and habitat-limiting conditions were also defined. Average habitat conditions based on the WUA curves for the critical species and life stages were requested for average flow conditions (i.e. the 50 per cent exceedance flows). Habitat-limiting conditions, operationally defined as flow conditions that reduce habitat by 80 per cent, were requested for the driest 20 per cent of conditions (i.e. the 80 to 100 per cent exceedance flows). A Fish Rule Curve (FRC), also described as a Variable Flow Request was defined by joining the wet, average and dry year points and superimposing this on the naturalized flow exceedance curve. When the FRC exceeded the naturalized flow, the naturalized flow was taken to be the FRC. Thirty curves corresponding to Julian weeks 14 through 43 were generated in this manner. The Fish Rule Curves are 'variable flow requests' in the sense that flows requested for instream needs are assessed in relation to natural flows. Optimal conditions are requested in wet years, average conditions in average years and habitat-limiting conditions in dry years.

The Fish Rule Curve in Figure F-9 for Julian week 30, the end of July, illustrates the variable flow request concept. The weekly average flows requested for instream needs may be as high as 500 cfs in wet years, declining to 150 cfs in dry years. The FRC is less than the natural flow in wet, average and dry years. Figure F-10 shows that only three weeks later, the natural discharge of the Highwood is lower than the FRC curve during average years. The FRC is adjusted downward to the natural flow. Later in the summer natural flows decline further so that the FRC is the natural flow under average and dry conditions.

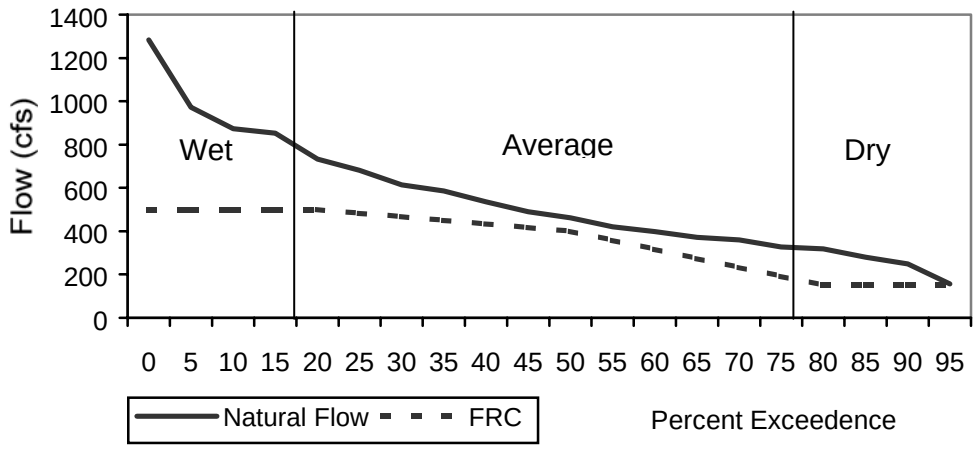

Figure F-9: Natural Flow and Fish Rule Curve for Week 30

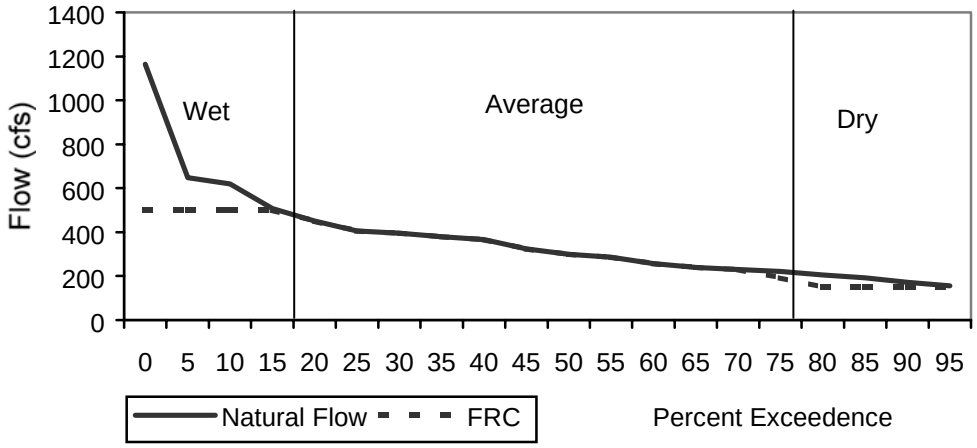

Figure F-10: Natural Flow and Fish Rule Curve for Week 33

The third component of the IFN was water quality. As Highwood River fish are frequently exposed to poor dissolved oxygen (DO) and high temperatures even under natural conditions, it would not be reasonable to establish a management goal of strictly avoiding water quality criteria under developed conditions. Instead, a more pragmatic goal was adopted. The management goal is to ensure that the frequencies of exceedences for both acute and chronic criteria for temperature and dissolved oxygen must be less than or equal to the frequency under natural conditions. The rationale for this approach is that the species are clearly capable of surviving the frequency of poor water quality conditions found under natural conditions, but may not be able to survive a greater frequency of poor conditions. Both acute and chronic criteria for dissolved oxygen and temperature were obtained from the literature for mountain whitefish and rainbow trout fry and adults.

F.4.2 Minimum and Preferred Flows and the Preliminary (Interim) IFN

The FRC Variable Flow Request specifies both an amount and a frequency because it is related to the distribution of natural flows (i.e. the exceedence values). This is in contrast to the standard setting approach implemented in the Water Management Policy for the South Saskatchewan River Basin. That policy required that two levels of instream flow requirements be defined: a 'minimum' to protect basic water quality and instream flow needs; and a 'preferred' level to protect desirable instream needs. The management target was to achieve the preferred flows most of the time.

The standard-setting approach benefits from its simplicity relative to the variable flow request, but is a very blunt instrument to protect biological instream resources. It fails to take account of the biological fact that the responses of, for example fish populations, depend on the severity, duration and frequency of stress conditions. "The ability of fish populations to compensate for a one-in-ten-year low flow event may give the false impression that the fish population will remain healthy and viable if this minimum flow (drought) condition were imposed year after year "(Trihey and Stalnaker 1985). To comply with the policy's demand for minimum and preferred flows without forfeiting the benefits of the FRC approach, the author of the IFN report defined an envelop around the FRC. The preferred flow, or upper envelope, was defined as either the optimum flow of 14.16 cms (500 cfs) or the natural flow whichever is less. The lower envelope was defined both by fish habitat and by water quality conditions. The habitat component was defined as:

- the FRC during wet conditions (0 to 20 per cent natural flow exceedence);
- the FRC during dry conditions (70 to 100 per cent natural flow exceedence); and
- 80 per cent of the habitat prescribed by the FRC for average flow conditions.

This lower envelope, adopted as a trade-off during the development of operations scenarios (see section 4.1.3.5), came to be called the 80 per cent Fish Rule Curve.

The third component of the Preliminary IFN was water quality. In the modelling, the FRC could be supplemented up to the natural flow to prevent water temperature from exceeding 21^{o}C or dissolved oxygen from falling below 5 mg/l.

F.5 Water Use Priorities Used in WRMM

Having established natural flows and the various water demands in the basin, it is then necessary to specify the rules by which the WRMM would distribute the water available during any given week among the competing demands. These rules are built into the model as a series of penalty points, such that the larger the penalty, the greater influence that demand will have upon how the model allocates water. WRMM attempts to allocate water by minimizing total penalty points.

While the actual penalty points used in WRMM will vary according to the diversion plan being evaluated, the general priorities assigned to describe baseline conditions are provided below:

1. Municipal, industrial and domestic demands in the Highwood and Little Bow Basins

2. Conveyance flow to deliver above demands in the Little Bow Basin

3. Minimum instream flows including then 80% FRC plus water quality and flushing flow requirements.

4. Irrigation from the Highwood River

5. Unsupported irrigation from the Little Bow River, first 85 percent of demand.

6. Supported irrigation from the Little Bow River, first 85 per cent of demand.

7. Main reservoir storage.

8. Little Bow irrigation, remaining 15 per cent of demand.

9. Preferred instream flow, lesser of 14.16 cms (500 cfs) or natural flow.

10. Top reservoir storage zones.

It should be noted that the general priorities used in the model do not correspond to the priorities established through water licences. Under the *Water Resources Act*, water licences have priority among themselves according to the date the licence was created, such that older or senior water licences have priority over more recent or junior licences. Modelling based on the legal priorities associated with water licences would be much more complicated. In addition, an assessment based on licence priorities would have required resolution of a number of legal issues related to the relative priorities of licences between the two river basins.

F.6 Use of WRMM

Conditions in the Little Bow and Highwood river basins for the period from 1950 to 1988 were used as the simulation period for the WRMM. This simulation period covers the low flow years of the 1980s and captures a range of natural flow and weather conditions. Extending the period to cover the extreme drought of the 1930s could result in higher irrigation deficits than reported for the dry years of the 1980s. For each week in the simulation period, the WRMM was used to calculate the flow in all channels, the water level in all reservoirs and the water delivered to each demand, including the Preliminary IFN. The flows delivered to each demand were then compared to its ideal demand to assess the frequency and magnitude of water shortages. The resulting pattern of shortages was then compared to selected assessment criteria to judge the performance of the scenario being evaluated. The model results were then used to assess how a particular operating plan for the Highwood and Little Bow river basins would perform, given the natural flows and weather conditions that occurred in the recent past.

F.7 Model Limitations and Cautions

The WRMM does provide some useful insight into how the complex water management system of the Highwood and Little Bow basins might respond to various management decisions over time with varying climatic and hydrologic conditions. The model does have some serious limitations. Perhaps the most serious is the reliance on the period of record as the basis to represent future conditions. There is no way to be sure that the 39 year period chosen for the simulations is representative of long-

term conditions. The model depends on our limited ability to forecast future demands, and changes in social values and scientific knowledge. The model did not reserve water explicitly for unspecified future needs. Droughts may become more frequent than in the past.

A key point is whether the priorities assumed in the model are consistent with legal priorities inherent in licenced water rights. The model focuses on irrigation blocks and does not differentiate between individual water rights holders who may have different legal priorities. No differentiation of priorities was made between new irrigation and existing irrigation in those areas supported by new water storage in the reservoir. Average deficits may not be a good indicator of success, since they tend to mask the serious effects of deficit events on water users with junior licences. Deficit estimates are based on licenced volumes and may overstate deficits in many years when full licenced amounts of water are not required.

The Panel has previously indicated its concern regarding the Preliminary IFN used in the Application as a basis for determining environmental acceptability of proposed diversion plans.

Irrigation demands have been tied to certain seasonal and crop requirements and irrigation efficiencies that could change in future with crop market demands. Estimates of future industrial and municipal demands are limited to assumptions in the *Consumptive Demand Analysis* which is dated and provides only limited suggestions for future water requirements. There is no allowance for unlicensed but legal withdrawals such as domestic and stock-watering, which may grow considerably in the near future. A science-based IFN could require more water.

APPENDIX G

RULES FOR THE OPERATION OF THE EXISTING AND PROPOSED WATER MANAGEMENT STRUCTURES

G. Rules for the Operation of the Existing and Proposed Water Management Structures [4]

Various rules for the operation of the existing and proposed water management structures in the study area were tested with the Water Resources Management Model (WRMM). As noted in Appendix F, the WRMM was used to develop a diversion plan that would allocate available water among competing uses, according to some specified management priorities. The Diversion Plan being proposed by APWSS assumes that the water management structures being proposed are operated in a specific way. A description of how existing and proposed water management structures in the basins would be operated under the proposed Diversion Plan is provided below. APWSS noted that the assumptions employed in the Diversion Plan would form the basis of the operating plans that AEP would develop for these structures, if the Project/Plan were to be implemented.

G.1 Little Bow Canal

Figure G-1 summarizes the operation of the proposed enlarged Little Bow Canal. A flow of 0.57 cubic metres per second (cms)(20 cubic feet per second [cfs]) would be diverted throughout the winter months, as is the current situation (i.e. the Base Case). Throughout the rest of the year, the minimum diversion would be reduced to 0.28 cms (10 cfs) with a maximum of 8.5 cms (300 cfs) subject to meeting the instream flow requirements of the Highwood River. Diversions greater than 0.28 cms (10 cfs) would commence with spring runoff on the Highwood River, normally in early May, and cease by late July.

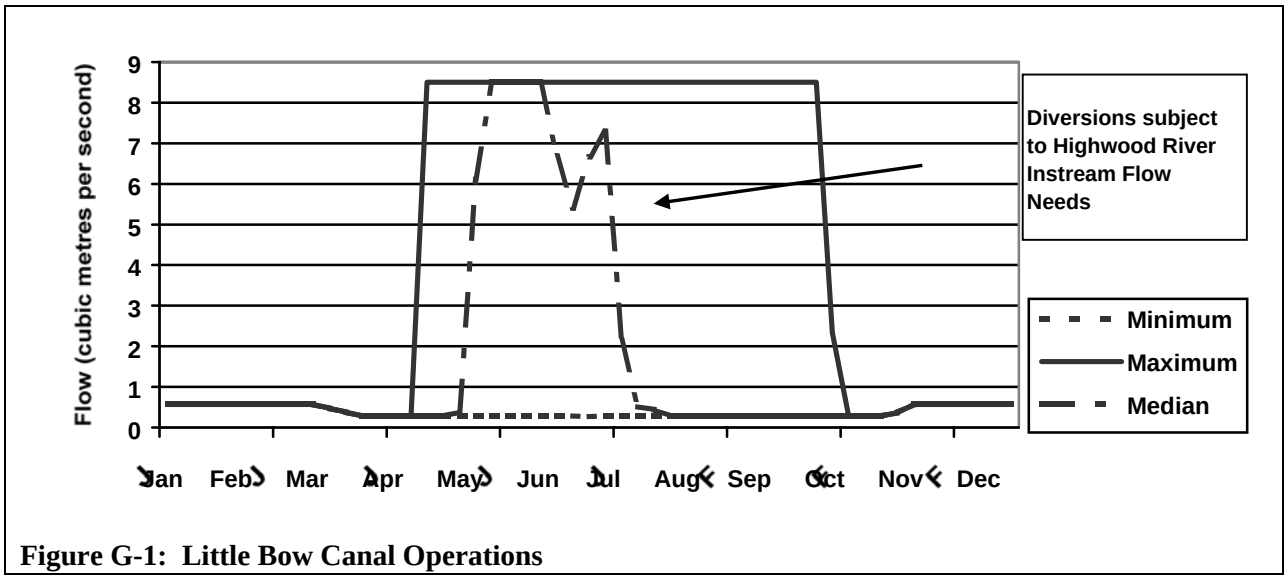

Figure G-1: Little Bow Canal Operations

4 This information is taken from Section 5.4.2 of Volume 1 of the Environmental Impact Assessment submitted by Alberta Public Works, Supply and Services.

G.2 Squaw Coulee Diversion

Figure G-2 outlines the operation of the Squaw Coulee Diversion on the Highwood River under the proposed Diversion Plan. There would be no diversions from the Highwood River from early October to the end of April. The minimum diversion throughout the summer would be 0.28 cms (10 cfs). The maximum would be 1.70 cms (60 cfs) and would be subject to meeting the Highwood River Instream Flow Needs (IFN). The pattern of diversion at Squaw Coulee would be similar to that of the Little Bow Canal. Diversion would start in early May and, apart from maintenance of minimum diversions, would generally end in late July.

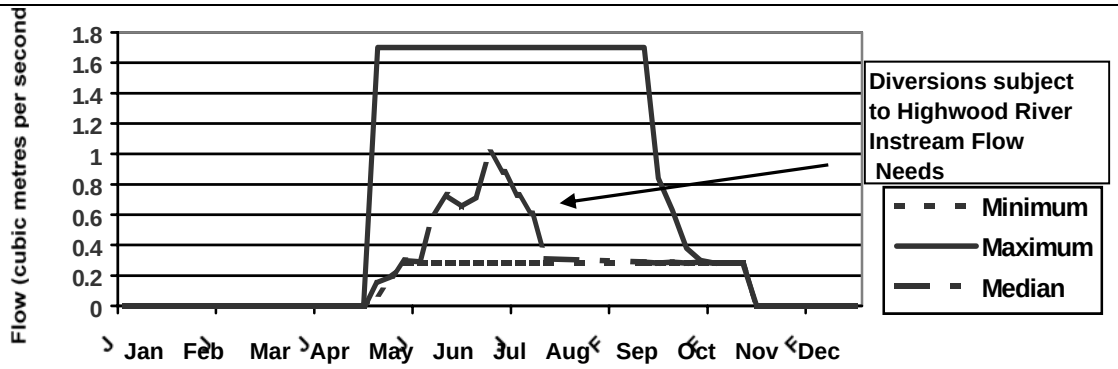

Figure G-2: Squaw Coulee Diversion Operations

G.3 Little Bow River Reservoir

The proposed operation of the Little Bow River reservoir would vary significantly year to year, in response to flow conditions and water demands. In most years, the reservoir would fill by mid-May. It would remain full throughout June and levels would gradually start to drop until late September. In about half of the years drawdown would be less than 3 metres (m)(10 feet[ft]), and in over 80 per cent of the years it would be less than 5 m (16 ft). Figure G-3 illustrates the normal range of water level variation that would be expected for the proposed reservoir. A succession of dry years, such as occurred in the 1980s, would result in drawdowns of as much as 14 m (45.5 ft) and there would be years when the reservoir would not completely fill.

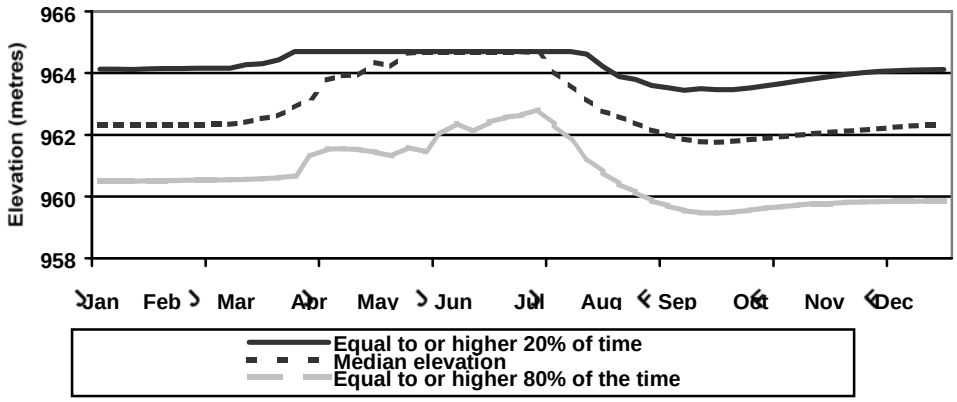

Figure G-3: Little Bow River Reservoir Elevations

G.4 Clear Lake Diversion

The Clear Lake Diversion would be operated from mid-April to mid-September when water would be diverted, if available, to bring Clear Lake to its full supply level and offset withdrawals and evaporation. Maximum diversion from Mosquito Creek would be 1.7 cms (60 cfs), but rates would normally be much lower. Figure G-4 illustrates the operation of the proposed Clear Lake Diversion.

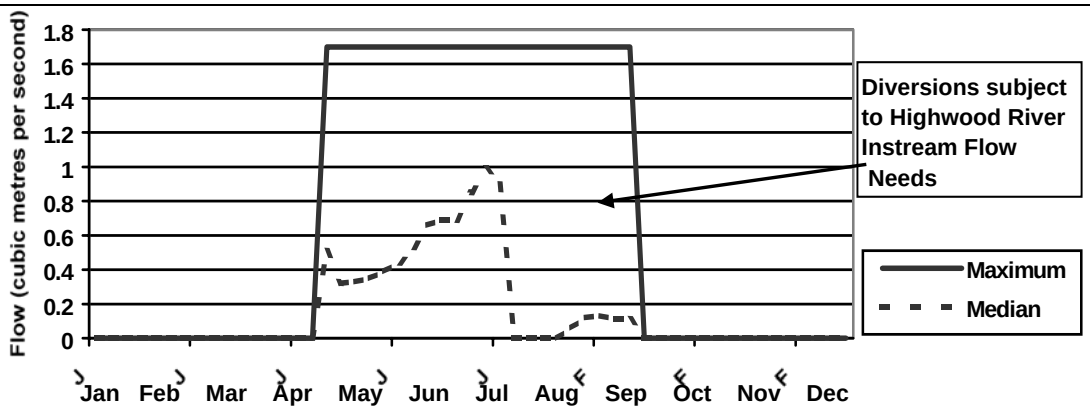

Figure G-4: Clear Lake Diversion Canal Flows

Figure G-5 illustrates anticipated Clear Lake water level fluctuations if the proposed Project/Plan is implemented. Clear Lake would normally fill by late May and remain full through June and into July. Levels would then generally drop gradually until mid-September. In approximately 75 per cent of the years, the drawdown would be less than 1 m (3.3 ft), and would never exceed 2 m (6.6 ft).

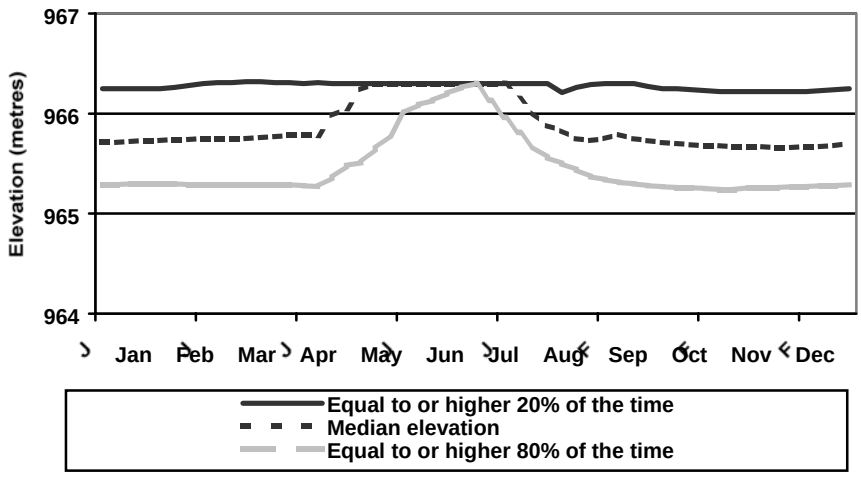

Figure G-5: Clear Lake Elevations

The Diversion Plan provides guidelines under which the Little Bow Project facilities would be operated. The Diversion Plan assumes the construction of the Little Bow Project and the adoption of different operating procedures for the existing Squaw Coulee and the enlarged Little Bow diversion works.

G.5 Reservoirs and Canals

The physical characteristics of the reservoirs and canals required in the Diversion Plan were discussed earlier. Squaw Coulee Reservoir remains in its current state in the Diversion Plan. Conveyance flows remain the same as in the Base Case.

G.6 Squaw Coulee Expansion

Enlarging Squaw Coulee Reservoir would permit storage of additional Highwood River water during high flow periods. With this additional storage, the resulting Expanded Diversion Plan would eliminate the need to divert into Squaw Coulee during low flow periods and would allow water to be returned to the Highwood River to offset diversions into the Little Bow Canal. The operations of the Squaw Coulee Reservoir would vary considerably from year to year depending on river flows and water demands. As shown in Figure G-6, filling would start in mid-April with water being diverted from the Highwood River up to the maximum 1.7 cms (60 cfs), depending on the Highwood River Instream Flow Needs.

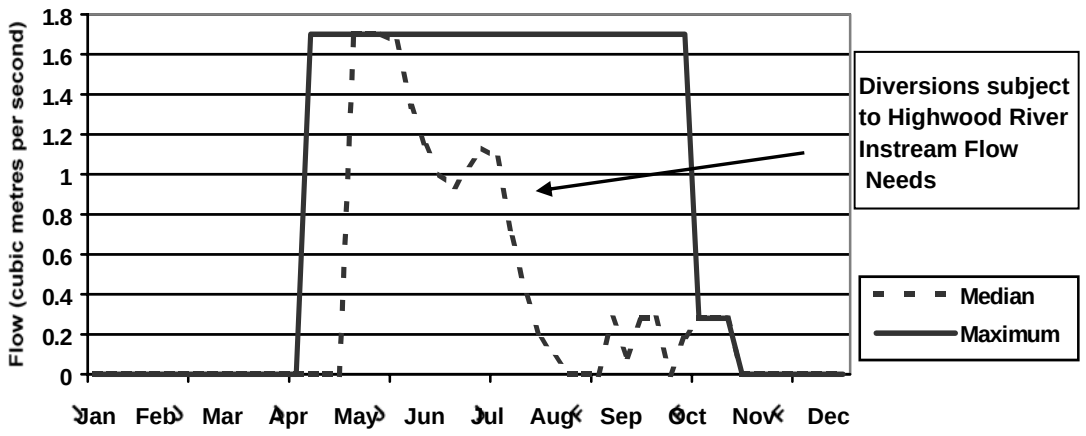

Figure G-6: Squaw Coulee Diversion Canal Flows: Expanded Project

The reservoir would reach full supply level by early June (Figure G-7). Reservoir levels would remain constant until late July or early August when releases would be required to meet licensed demands on Mosquito Creek or the Highwood River IFN. Reservoir levels would normally drop until late September or early October. Some refilling of the reservoir would often occur in the autumn when consumptive water demands decrease. Reservoir levels would remain relatively constant throughout the winter. Average drawdown of reservoir levels over the summer would be less than 2 m (6.6 feet), but on occasion would exceed 10 m (33 feet).

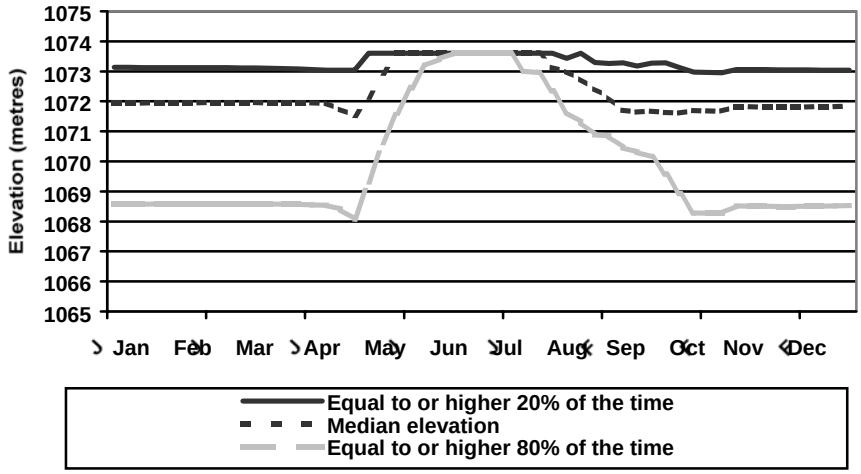

Figure G-7: Elevations of Squaw Coulee Reservoir: Expanded Project

The return canal from the Squaw Coulee reservoir would be used to replace water withdrawn from the Highwood River at the Little Bow Canal during low flows to ensure that the Highwood River IFN criteria would be met. As shown in Figure G-8, releases to the Highwood River would commence in late July and continue to mid-October. There would occasionally be releases earlier in the spring before spring runoff. Most of the time releases would be 0.28 cms (10 cfs) balancing the diversion into the Little Bow Canal. Releases would occasionally be as high as 0.66 cms (23 cfs).

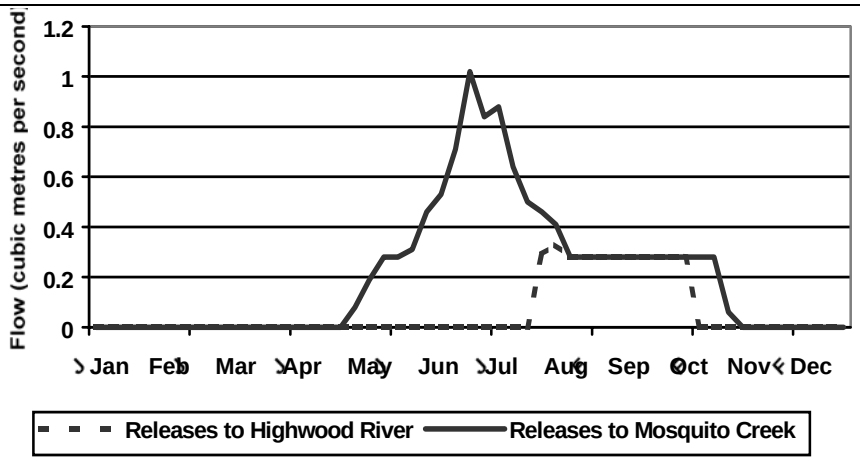

Figure G-8: Squaw Coulee Reservoir Return Canal: Expanded Project