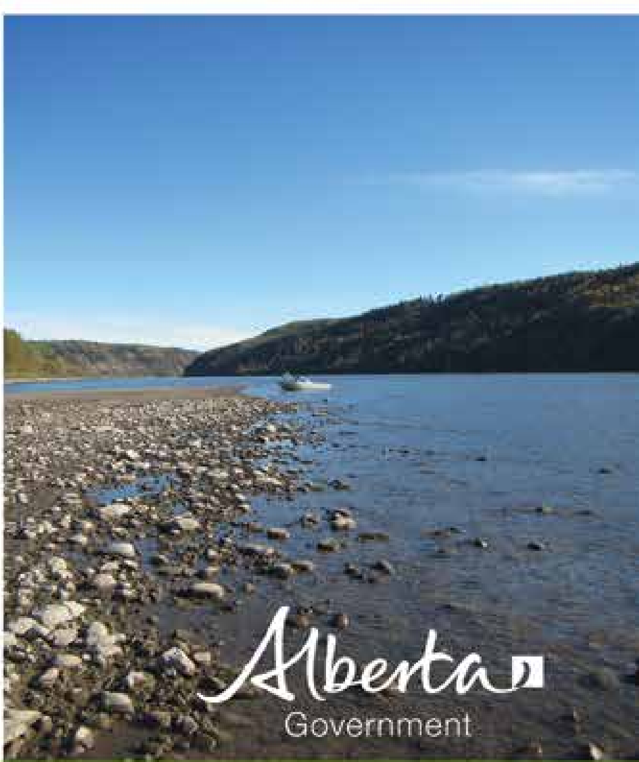
Lower Athabasca Region

Surface Water Quantity Management Framework for the Lower Athabasca River



Alberta Government

Table of Contents

List of Figures

List of Tables

ISBN: 978-1-4601-2173-3 (online version)
February 2015

1.0 Introduction

On August 22, 2012, the Government of Alberta approved the *Lower Athabasca Regional Plan*. The Plan identifies and sets resource and environmental management outcomes for air, land, water, and biodiversity, and will guide future resource decisions, while considering the social and economic impacts of development. Incorporating more than three years of consultation with Albertans and experts on social, economic, and environmental issues, the *Lower Athabasca Regional Plan* sets the stage for strong economic growth in northeastern Alberta, balanced with a comprehensive and informed approach to environmental management.

The Alberta government is committed to managing cumulative effects at the regional level, using management frameworks in a new approach to integrated management. Management frameworks outline monitoring, evaluation, and reporting requirements for resource users, set early warning triggers for government to determine the need for action, and identify what actions may be taken. Three environmental management frameworks have been developed for the *Lower Athabasca Regional Plan*:

- Air Quality Management Framework,
- Surface Water Quality Management Framework, and
- Groundwater Management Framework.

To complement these three new frameworks, the Government of Alberta committed to updating the existing *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River* which was implemented by Alberta Environment and Fisheries and Oceans Canada in 2007. Recognized as Phase 1 of a two-phased approach, the 2007 Water Management Framework provided short-term guidance for the management of cumulative water withdrawals from the lower Athabasca River and included a set of weekly flow triggers and withdrawal limits.

Since 2007, the provincial and federal governments have continued working with stakeholders and Aboriginal communities to clarify issues and discuss interests, to conduct and review detailed technical assessments, and to develop and evaluate alternatives for the next phase of the *Water Management Framework*. Collaboration with the Cumulative Environmental Management Association, the Phase 2 Framework Committee, First Nations, and Métis communities has been instrumental in developing Phase 2 of the Water Management Framework, now called the *Surface Water Quantity Management Framework for the Lower Athabasca River* (the "Framework").The Framework will update and replace the 2007 Water Management Framework. Additional information on First Nations use of the Athabasca River, with particular emphasis on navigation, was derived from *As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change* (Candler *et al.*, 2010).

The Framework focuses on the management of water use by the mineable oil sands sector, based on current and anticipated water demands that contribute to reductions in the flow of the Athabasca River. The mineable oil sands sector is currently the largest consumptive user of water in the lower Athabasca River and is predicted to comprise the largest increase in future water demand. It is anticipated that an integrated, basin-wide water management plan will be developed in the coming years, in cooperation with the greater Athabasca River Basin community.

2.0 Purpose

The *Surface Water Quantity Management Framework for the Lower Athabasca River*, along with other environmental management frameworks, is part of a shift to cumulative effects management. The objective of the Framework is to manage cumulative water withdrawals to support both human and ecosystem needs, while balancing social, environmental, and economic interests. To support achievement of the objective, the Framework identifies indicators of both the condition of the water resource (natural variations in water flow) and of pressure on the water resource (use). The Framework establishes weekly management triggers and water withdrawal limits that will be used to enable proactive management of mineable oil sands water use from the Athabasca River. Weekly water withdrawal limits will reflect seasonal variability and become more restrictive as flows in the river decrease. In addition, adaptive management triggers will indicate when river flow and water use conditions are close to-, or outside of-, the range of predicted future conditions used in modelling and development of the weekly management triggers and withdrawal limits. Adaptive management triggers will direct a management response process, led by Alberta Environment and Sustainable Resource Development.

The framework articulates the Government commitment to ensuring that river flow conditions, oil sands sector water withdrawals, and ecosystem conditions within the lower Athabasca River downstream of the Grand Rapids are monitored, evaluated, and reported to the public. The Government of Alberta will work with oil sands water licence holders to ensure compliance with requirements established through the framework.

2.1 Scope

The *Surface Water Quantity Framework for the Lower Athabasca River* applies to the lower section of the Athabasca River, from just downstream of the Grand Rapids (approximately 135 kilometres upstream of Fort McMurray) to the Athabasca River Delta. It guides the development of conditions for all new, renewed, and amended licences issued to the mineable oil sands sector under the *Water Act* for withdrawals from the lower Athabasca River, or for withdrawals that will have a significant effect on the Athabasca River downstream of Grand Rapids. It also contributes to regional planning through the *Lower Athabasca Regional Plan*, one of seven regional plans being advanced under the *Alberta Land Stewardship Act* and the *Land-use Framework*. Requirements under the framework will be incorporated into regulatory instruments issued under the federal *Fisheries Act*, as part of the environmental regulatory system that continues to apply to oil sands developments, ensuring that appropriate compliance and monitoring requirements are implemented.

2.2 Regional Context

The Lower Athabasca Region is the focus of major industrial development in Northern Alberta. It has extensive natural resource development potential in the oil sands, natural gas, and forestry sectors. With this in mind, increases in human population and industrial expansion are expected to continue for the foreseeable future.

First Nations have indicated that the lower Athabasca River system plays an important role in their ability to pursue Treaty rights. The river helps sustain the livelihoods, cultures, and identities of First Nations and Métis communities in the region. The significant contribution of the river to Aboriginal navigation and the access it provides to hunting, trapping, and fishing locales is directly related to water quantity, particularly during the open-water season. Given the range of uses, opportunities, and potential stressors, residents have expressed concern about development within the region and its potential impact on water quantity, particularly within the Athabasca River, downstream of oil sands developments. These various considerations serve to further emphasize the importance of environmental management frameworks, as part of regional planning.

The Lower Athabasca Region planning boundary incorporates parts of four major river basins: the Athabasca, the Beaver, the Peace/Slave, and the North Saskatchewan (Figure 1). The Athabasca River basin itself is one of the seven major river basins in Alberta, as defined in the provincial *Water Act*. It covers a large geographic area, including parts outside of the Lower Athabasca Region planning boundary. Different portions of the basin contribute differently to flow in the river; additional information on seasonal flow contributions from different parts of the Athabasca River basin is found in Appendix A. The Athabasca River is the main river in the basin, to which all other smaller tributaries contribute flow.

After the Peace River, the Athabasca River is the second-largest river in Alberta (by volume). It is the longest and only major free-flowing river (with no dam structures) in Alberta, and one of the longest free-flowing rivers in North America. Flow of the river is affected by natural weather patterns, as well as by topography and soil cover. Flow in the Athabasca River is naturally variable, both seasonally and inter-annually. Additional information on flow in the Athabasca River is presented in Section 5.

The Athabasca River flows approximately 1,400 kilometres in a north-easterly direction, from the Columbia Icefields in the Rocky Mountains, to Lake Athabasca. The west part of Lake Athabasca, Lake Claire, and the area between them form the Peace-Athabasca Delta. The portion of the Peace-Athabasca Delta located within the Athabasca River basin is referred to as the Athabasca River Delta. From Lake Athabasca, the water flows north, as the Slave River, into Great Slave Lake; it continues in a northwest direction, through the Mackenzie River and into the Beaufort Sea.

Fort McMurray is located at the confluence of the Athabasca and Clearwater rivers. At this point, about 88 per cent of the Athabasca River's flow at Lake Athabasca has already been contributed. The remaining 12 per cent of flow at Lake Athabasca comes from the lower tributaries, most notably the Firebag, Richardson, MacKay, Ells, Muskeg, and Steepbank Rivers.

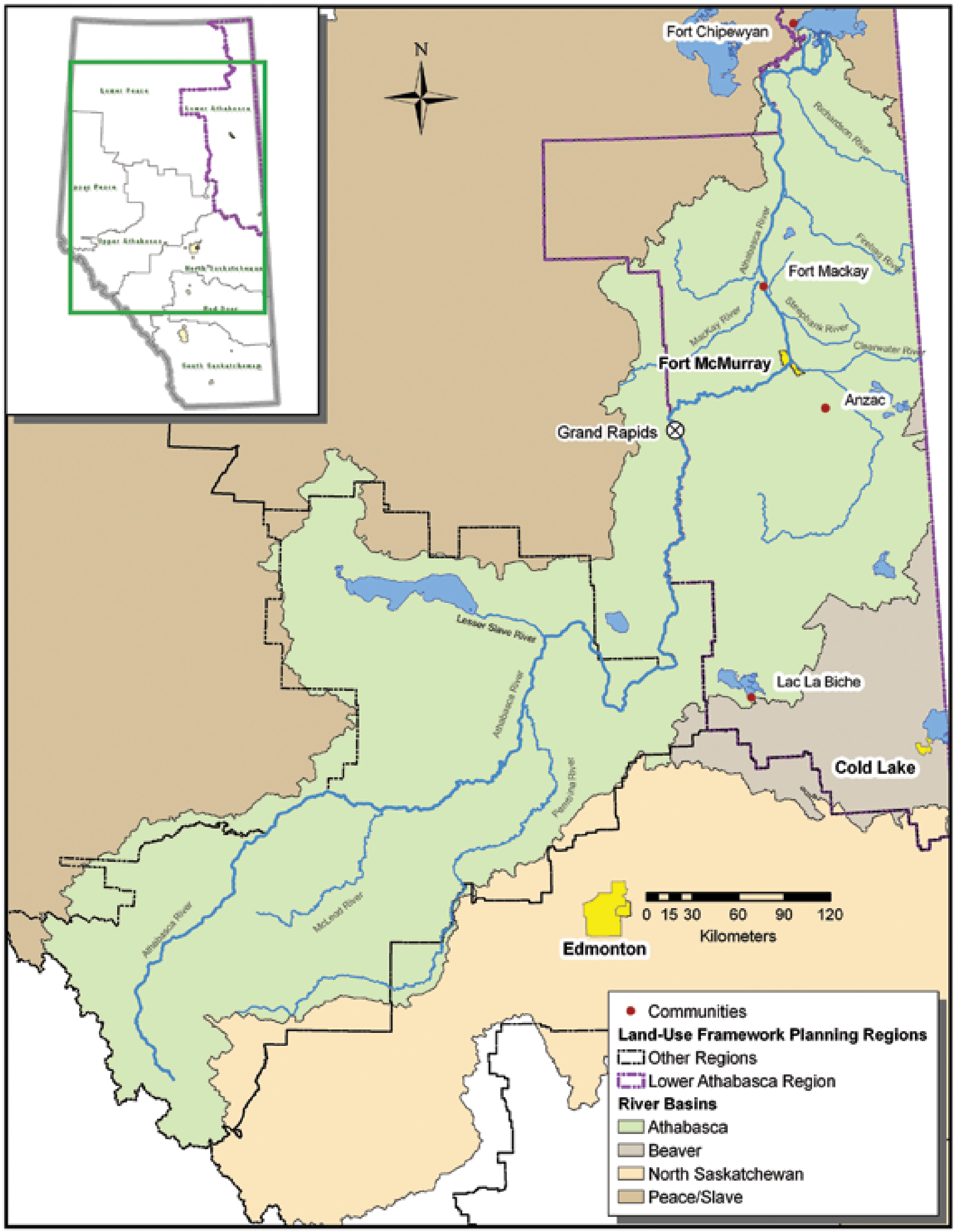


Figure 1.
The Athabasca River Basin and Boundary of the Lower Athabasca Region.

2.3 Framework Development

The framework was prepared by Alberta Environment and Sustainable Resource Development with the support of Fisheries and Oceans Canada. It is the culmination of over 10 years of planning, research, and consultation.

When Alberta Environment and Sustainable Resource Development, and Fisheries and Oceans Canada released the 2007 *Water Management Framework*, both governments expressed a commitment to engagement with stakeholders and Aboriginal communities, as a means of addressing issues identified for further consideration. These issues included socio-economic matters, future oil sands sector growth, climate change science, and consideration of an ecosystem base flow.

In 2008, the Cumulative Environmental Management Association (CEMA) was asked to develop recommendations for an updated *Water Management Framework* ('Phase 2') for the lower Athabasca River. CEMA is a multi-stakeholder organization that addresses community concerns regarding the environmental impact of development in the Lower Athabasca Planning Region. In response to requests from various other organizations to be involved in development of the water quantity management recommendations, CEMA established the Phase 2 Framework Committee, which also helped broaden the interest base in these discussions. The committee used a structured decision-making process to clarify issues and discuss interests, conduct and review detailed technical assessments, and develop and evaluate alternatives. Detailed modelling of river flows and water withdrawal scenarios was undertaken to assess the social, environmental, and economic impacts of different sets of water withdrawal rules. In January 2010, the Phase 2 Framework Committee provided its recommendations to Alberta Environment and Sustainable Resource Development, and Fisheries and Oceans Canada (Cumulative Environmental Management Association 2010). These recommendations formed the basis for subsequent Framework development; additional information on the treatment of these recommendations, as well as the history of Framework development and stakeholder engagement, is presented in Appendix B.

3.0 Key Concepts and Principles

Two main drivers have guided development of the Framework: 1) concerns and interests identified through existing processes, and 2) the need to adopt a cumulative effects management system in the Lower Athabasca Region. The following sections outline Alberta's policy direction, as well as key concepts and principles captured both in this Framework and in other environmental management frameworks that are part of the *Lower Athabasca Regional Plan*.

3.1 Provincial Policy Direction

One of the purposes of regional plans is to translate provincial policy to the regional scale, including specific goals for air, land, water, and biodiversity. The *Surface Water Quantity Framework for the Lower Athabasca River* forms a significant part of the work towards integrated planning for the region, and contributes to the informed management of surface water resources in the broader Athabasca River basin.

By reflecting the ongoing desire to balance environmental, economic, and social outcomes, this framework aligns with the goals of Alberta's *Land-use Framework* and other key policies, including *Water for Life: Alberta's Strategy for Sustainability* (GOA 2003) and the *Regional Sustainable Development Strategy for the Athabasca Oil Sands Area* (Alberta Environment 1999).

Since 2003, *Water for Life* has been the platform for management of Alberta's water resources. In the renewed 2008 strategy, the Government of Alberta accelerated action to safeguard Alberta's water resources and described goals for the sustainable development and management of provincial surface water and groundwater.

3.2 Cumulative Effects Management and Management Frameworks

The Government of Alberta is committed to implementing a cumulative effects management system that focuses on:

- achieving outcomes;
- understanding the effects of multiple development pressures on air, land, and water;
- assessing risk;
- working collaboratively with shared responsibility for action; and,
- improving the integration of economic, environmental, and social considerations.

The Government of Alberta's cumulative effects management system follows an adaptive management model, with decision-makers learning from experience and new information, and adapting to changing social expectations. Performance measurement is an essential element that provides information about environmental conditions and identifies the need for adjustments on an ongoing basis. As more knowledge becomes available, the framework's withdrawal limits can be adapted. The following figure (Figure 2) illustrates the components of a management framework approach.

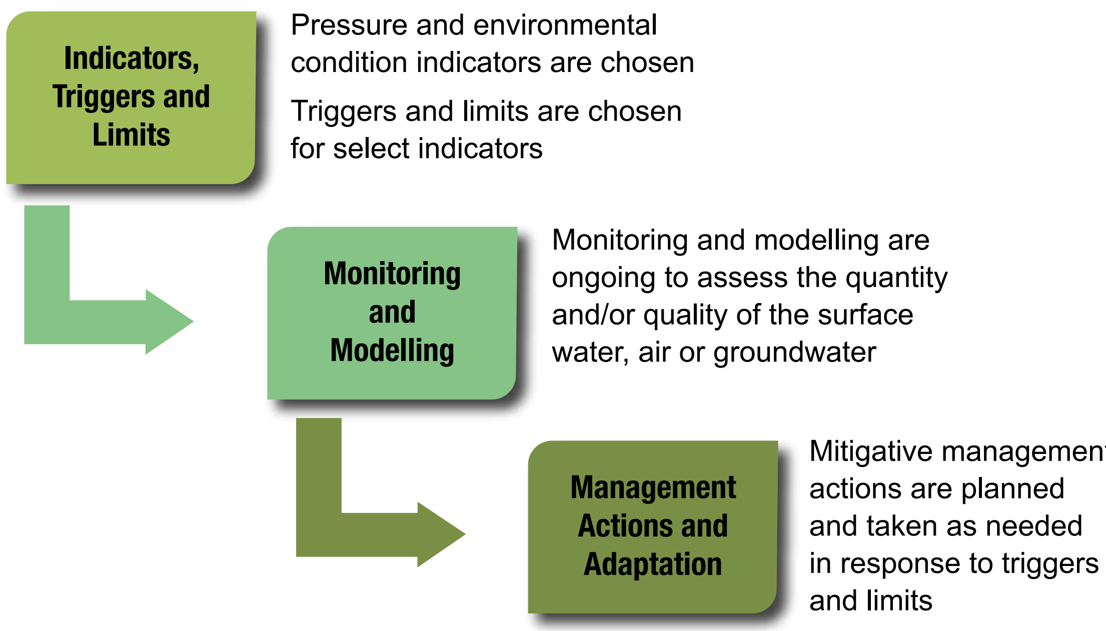


Figure 2.
The Management Framework Approach

3.3 Key Principles

The following key concepts and principles are foundational to the management framework.

3.3.1 Identifies and Manages Risk and Adverse Trends

The Framework focuses on managing water withdrawals by the oil sands sector, as the largest current consumptive user of water in the lower Athabasca River. The sector is also forecast to comprise the largest increase in future water demand. The risk to aquatic ecosystems from a constant year-round water demand will generally be highest when flows are lowest. Therefore, weekly water withdrawal limits reflect a hierarchy of protection across seasonal timeframes. The highest levels of withdrawal restrictions are during the periods of lowest flow. The Framework also includes monitoring, evaluation, and reporting on adaptive management triggers to support identification and evaluation of emerging trends that may deviate from predicted future conditions that were used in its development.

3.3.2 Builds on Existing Legislation, Regulations, and Policies

The *Surface Water Quantity Management Framework for the Lower Athabasca River* will replace the *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River* (Alberta Environment & Fisheries and Oceans Canada 2007), which currently applies to the lower Athabasca River. This framework is intended to augment and complement, not replace, existing policies and legislation regarding water allocations, prior allocation and administration of priority, future transboundary commitments, development of water management plans, and emergency water management. The Framework is consistent with other provincial policies, strategies, and frameworks, and with the stated desired outcomes for the region. The Framework is also consistent with the principles and legislative intent of the federal *Fisheries Act*.

3.3.3 Applies a Regional Perspective

The Framework enables the proactive management of cumulative water withdrawals from the lower Athabasca River by the oil sands sector to support both human and ecosystem needs, while balancing social, environmental, and economic interests. The Framework identifies indicators, management triggers, and withdrawal limits that take into consideration the effects of withdrawals on natural flow patterns in the lower Athabasca River. Alberta Environment and Sustainable Resource Development, in cooperation with the greater Athabasca River Basin community, will also consider development of an integrated, basin-wide water management plan.

3.3.4 Incorporates Flexibility and Adaptability

Adaptive management triggers will be used to indicate when river flow or water use conditions are close to, or outside of, the modelled predictions that were used to support the Framework. As more information is derived on ecological and navigation knowledge gaps, further indicators, limits, and triggers may be developed, while existing indicators, limits, and triggers may be updated and refined. A number of existing operational measures could be explored by the oil sands sector as a means of complying with water withdrawal limits/triggers and responding to the development of new or updated limits/triggers. These may include adjusting production, negotiating with other oil sands licence holders, using on-site storage, or applying other innovative solutions.

3.3.5 Communicates Clearly

The *Surface Water Quantity Management Framework for the Lower Athabasca River* supports long-term certainty and predictability in Alberta's policy and regulatory environments. It provides clarity on management requirements for water withdrawals from the lower Athabasca River, in advance of anticipated future growth in the region. The system described in this framework and the expectations for effective water management are clearly defined and transparent. The Framework articulates the Government of Alberta commitment to ensuring that river flow conditions, oil sands sector water withdrawals, and ecosystem conditions within the lower Athabasca River downstream of the Grand Rapids are monitored, evaluated, and reported to the public.

3.3.6 Involves Partnerships

The Government of Alberta recognizes that citizens, communities, industries, and governments must bear a shared responsibility for water management. In keeping with this, decisions executed through this framework were arrived at through a process that was consultative and transparent, and that explicitly considered stakeholder interests in the analysis. Alberta Environment and Sustainable Resource Development will continue to work with a broad range of parties, including Fisheries and Oceans Canada, industry, stakeholders, Aboriginal peoples, municipalities, non-governmental organizations, stewardship groups, academia, and citizens who live and work in the area, toward implementation of the framework.

4.0

The Current Management System

The following section includes an overview of the regulatory and policy context of the *Surface Water Quantity Framework for the Lower Athabasca River*. Additional background information on river flow, water use and monitoring, and the aquatic ecosystem in the lower Athabasca River is provided in Sections 5 through 7, as well as the document appendices.

4.1 Regulatory and Policy Context

Alberta Environment and Sustainable Resource Development uses its water policies and legislation to allocate water and manage activities that can affect the quality and quantity of Alberta's water resources in order to ensure safe, secure drinking water, healthy aquatic ecosystems and reliable water supplies. The *Water Act* guides Alberta Environment and Sustainable Resource Development's work through the use of legislative tools such as approvals and licences, guidelines, and codes of practice. A description of *Water Act* licences is provided in Appendix C.

Alberta's *Water for Life* strategy provides the province's overall water management roadmap. Five key Acts guide management and planning around aquatic ecosystems: the *Water Act*, the *Environmental Protection and Enhancement Act* (EPEA), the federal *Fisheries Act*, the *Canadian Environmental Protection Act*, and the *Species at Risk Act* (Table 1).

A number of major policies also guide surface water quantity management and planning for the lower Athabasca River. These include the 2007 *Water Management Framework* (Alberta Environment & Fisheries and Oceans Canada 2007) and strategic policies such as *Water for Life: Alberta's Strategy for Sustainability* (Government of Alberta 2003, 2008) and *Responsible Actions: A Plan for Alberta's Oil Sands* (Government of Alberta 2009).

Table 1.
Key Legislation, Policies, Strategies, and Agreements for Managing Surface Water Quantity in the Lower Athabasca Region.

Governance	Jurisdiction
Provincial Acts, Regulations and Authorizations	
Alberta Land Stewardship Act	Provincial/Regional
Alberta *Water Act*	Alberta
Licences, approvals, reporting requirements	Alberta (*Water Act*)
Alberta Environmental Protection and Enhancement Act	Alberta
Fisheries (Alberta) Act	Alberta
Wildlife Act	Alberta
Provincial Policies and Strategies	
Framework for Water Management Planning	Alberta
Regional Sustainable Development Strategy for the Athabasca Oil Sands Area	Alberta
Responsible Actions: A Plan for Alberta's Oil Sands	Alberta
Strategy for the Protection of the Aquatic Environment	Alberta
Fish Conservation and Management Strategy for Alberta	Alberta
Water for Life: Alberta's Strategy for Sustainability	Alberta
Land-use Framework	Provincial/Regional
Federal Acts	
Fisheries Act	Canada
Canadian Environmental Protection Act	Canada
Canadian Environmental Assessment Act	Canada
Species at Risk Act	Canada
Transboundary Agreements	
Mackenzie River Basin Transboundary Waters Master Agreement	Federal-Provincial-Territorial

4.2 Transboundary Considerations

When rivers flow from one province or territory to the next, transboundary agreements are in place to ensure that adequate water quality and quantity are maintained. The Athabasca River basin is part of the *Mackenzie River Basin Transboundary Waters Master Agreement* (along with other basins that flow though Alberta — the Peace, Slave, Hay and Liard). This agreement has been in effect since 1997, when it was signed by the governments of Canada, British Columbia, Alberta, Saskatchewan, the Northwest Territories and Yukon.

The agreement established common principles for cooperative water management and the Mackenzie River Basin Board to facilitate application of these principles. The Master Agreement also commits jurisdictions to develop bilateral water management agreements. Alberta is currently negotiating with British Columbia, Saskatchewan, and the Northwest Territories regarding quality, quantity, and flow of water in transboundary streams, lakes and aquifers.

5.0

Characterization of Surface Water Flow Within the Region

The flows in the Athabasca River vary considerably from season to season, and from year to year. The average weekly flow has ranged from 88 to over 3,500 cubic metres per second (m^3/s). The year-to-year variability in Athabasca River flows at Fort McMurray is shown by the "Range of Flow" (shaded area) in Figure 3. The seasonal pattern is shown by the "Average Weekly Flow" line – lowest in winter, a quick increase with spring melt, higher in summer and a slower decline in fall.

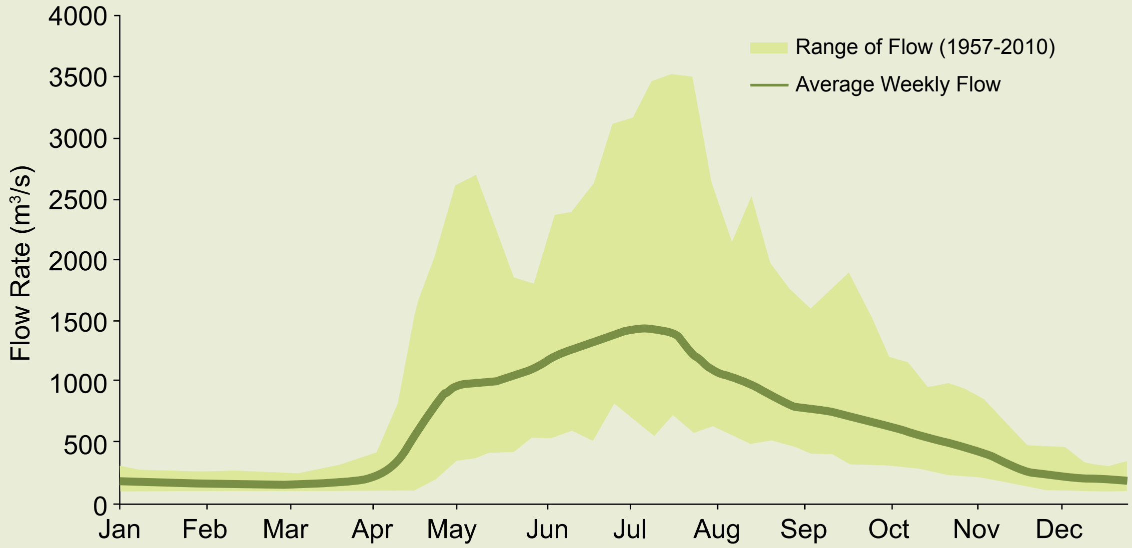


Figure 3.
Variability in Flows in the Athabasca River

In general, flows in the Athabasca River at Fort McMurray are seasonally lowest in the months of January to March – they have ranged from 90 to 250 m^3/s. The onset of spring snowmelt and break-up makes April the most variable month. If the melt comes late, flows in early April can be as low as 100 m^3/s, but can reach over 2,000 m^3/s by late April in high melt years. From May to July, flows are high, averaging 1,000 m^3/s or more. The highest weekly flows can reach over 3,500 m^3/s, while summer flows can fall as low as 500 m^3/s between rain events. By October, flows average 500 m^3/s, reaching as high as 900 m^3/s in the wettest years and falling below 250 m^3/s in dry years. Flows continue to decline into November, when sub-freezing temperatures result in the river becoming covered in ice, and there is a return to low winter flows.

5.1 Current Surface Water Flow Monitoring in the Region

In Alberta, Environment Canada's Water Survey of Canada agency conducts most stream flow and water level monitoring on a cost-share basis with Alberta and publishes the final data in its national database. Flow monitoring in the Lower Athabasca Region is conducted in tributaries of the Athabasca River in addition to the mainstem. Tributary monitoring contributes to the understanding of water supply and flow patterns in the area.

Additional flow stations on the mainstem and tributaries are being operated in the Lower Athabasca Region by the *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring* (JOSM). Many of these stations were previously under the Regional Aquatics Monitoring Program (RAMP; established 1997) and were transferred to JOSM in 2012.

Figure 4 shows all flow monitoring stations – both Water Survey of Canada and JOSM stations – within the Lower Athabasca Region. Additional monitoring occurs on smaller tributaries to the Athabasca.

In total, there are 57 distinct flow monitoring stations in the Lower Athabasca Region. These comprise:

- 3 mainstem stations (1 Water Survey of Canada, 2 JOSM)
- 14 stations on the six major tributaries (6 Water Survey of Canada, 8 JOSM)
- 40 stations on 36 other tributaries in the region (4 Water Survey of Canada, 36 JOSM)

For the purposes of this framework, the "McMurray station" will be used as the principal flow measurement site. The McMurray station is the Water Survey of Canada gauge 07DA001 "Athabasca River below McMurray". This location has been monitored since 1957. It is located at Fort McMurray, downstream of the confluence with the Clearwater River, and upstream of all water withdrawals by the oil sands sector. This station is situated on a stable substrate and has historically demonstrated a consistent relationship between water level and flow, providing a high degree of confidence in the monitoring data under varying flow conditions.

JOSM operates two mainstem Athabasca River flow stations downstream of the McMurray station. One is located just upstream of the Firebag River confluence, while the other is upstream of the Embarras River. Both of these sites have a shorter period of record than other Water Survey of Canada sites.

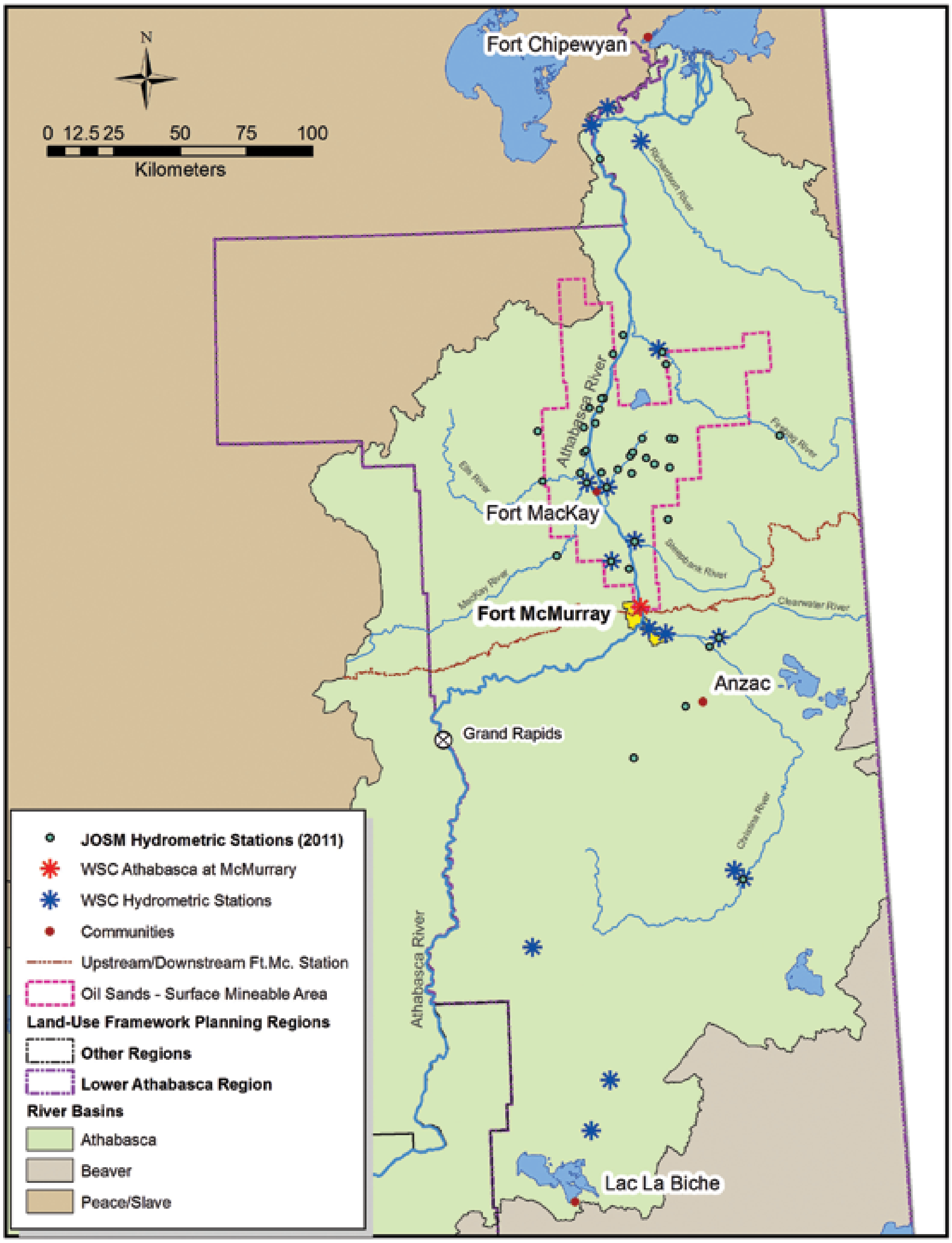


Figure 4.
Flow Monitoring Stations in the Lower Athabasca Region

6.0

Current Water Use in the Athabasca River Basin

Current water allocations and use, as a proportion of the historical flows for the Athabasca River, are relatively small, especially when compared to other basins in Alberta. Current total water allocation, net water allocation and estimated net water use in the Athabasca River basin are summarized in Table 2. 'Net water allocation' is the licensed total volume permitted to be withdrawn, minus water flows returned to the river. Licence holders do not usually withdraw their maximum permitted volumes, therefore we refer to 'net water use' as the actual annual volume withdrawn, minus the actual water flows returned to the river.

In 2011, the total water allocation for the Athabasca Basin was 848,055,739 m^3, the net water allocation was 645,547,643 m^3, and the estimated net water use was 143,483,558 m^3. Withdrawals from the Athabasca River by the oil sands sector represented the majority of the total water allocation (51 per cent), the net water allocation (61 per cent), and the total estimated water use (72 per cent) for the basin.

Upstream of the McMurray station, relatively small volumes of water are licenced for use, compared to historically occurring flows. These uses are primarily for industrial purposes (mainly pulp and paper mills), followed by municipal purposes (drinking water, household and commercial use). These types of uses tend to require water at a consistent rate throughout the year. Water used for industrial and municipal purposes involves a high percentage of volume returned to the river. Future water allocations and water use upstream of the McMurray station are not anticipated to change significantly, especially relative to projected water demand from the oils sands sector.

Downstream of the McMurray station, relatively small volumes of water are currently licensed for use, compared to historical flows. Mineable oil sands withdrawals from the Athabasca River represent the majority of the total water allocation (73 per cent), the net water allocation (71 per cent), and the total estimated water use (91 per cent) downstream of the McMurray station. To date, this water has been needed at a consistent rate throughout the year. Water used for oil sands mining operations is generally not returned or released back to the river. If this changes, and the release of treated water becomes more common in mining operations, the Framework will be revisited.

Both water allocation and water use for the oil sands sector are projected to increase within the next decade. The projected cumulative water use requirement for the oil sands sector from the Athabasca River is expected to peak at about 505 million m^3/year (16 m^3/s) within the next decade (CEMA 2010).

Table 2.
Water Allocations and Water Use in the Athabasca Basin.

	Licences in Downstream Basin	**Licences in Upstream Basin**			**Total Licences in Athabasca River Basin Boundary**
		Oil Sands Licences from Athabasca River	**Other Licences in Downstream Basin**	**Total**	
Licenced Allocation Volume (m^3/year)	259,547,418	**430,689,101**	157,819,220	588,508,321	848,055,739
Average Rate (m^3/s)	8.2	**13.7**	5.0	18.7	26.9
Net Allocation (m^3/year)	95,718,992	**392,043,101**	157,794,550	549,828,651	645,547,643
Average Rate (m^3/s)	3.0	**12.4**	5.0	17.4	20.4
Estimated Net Use (m^3/year)	30,600,000	**102,686,300**	10,197,258	112,883,558	143,483,558
Average Rate (m^3/s)	1.0	**3.3**	0.3	3.6	4.6

- “Upstream Basin” refers to upstream of the McMurray station, downstream the Grand Rapids. “Downstream Basin” refers to downstream of the McMurray station.
- “Allocation” refers to the maximum annual amount of water permitted to be withdrawn.
- “Average Rate” is the allocation, if it were withdrawn at a constant pump rate throughout the year, and is the allocation volume divided by the number of seconds in a year. The same process is used to calculate the average rate for net allocation and estimated net use.
- “Net Allocation” is the licensed allocation minus return flows specified on the licence.
- “Estimated Net Use” is calculated slightly differently upstream and downstream on the Athabasca River. Upstream of the McMurray station, Estimated Net Use is based on the largest water licence withdrawal and returns data, plus an estimate for the remaining smaller licences. Downstream of the McMurray station, Estimated Net Use is calculated using monitoring data from the major licences, which are oil sands licences.

6.1 Current Water Use Monitoring and Reporting

The historical data collected on water withdrawals and returns has been less consistent over time and less standardized than the data collected on flow. Where historical data on water use is available, it is often available as a total monthly quantity diverted, especially for larger licences. Historically, reports containing monthly quantity diverted were required to be submitted annually in paper format.

Alberta Environment and Sustainable Resource Development currently requires all water users to measure water use, but does not prescribe how measurement should be done. Water use is generally measured directly by meters (with an expected accuracy of about +/- 2 per cent), or it is estimated based on a combination of pumping start and stop times and pump capacity (with less accuracy, but usually overestimated). Because water withdrawals occur through engineered systems (i.e., pipes with a consistent shape), while river channels are a less consistent and evolving shape, estimating water use is easier and usually more accurate than measuring streamflow. For oil sands operations, three of the four current operators have meters installed, and all new projects require meters.

Recent changes to the water use and returns data collection system require mandatory submission of data to a new on-line system (http://esrd.alberta.ca/water/reports-data/water-use-reporting-system/default.aspx).

The data required to be measured is specified on the water licence and varies according to the use, as does the reporting frequency. Currently, water use data is required to be submitted monthly, and is generally required to be reported as the total monthly quantity withdrawn. The large licences also require daily withdrawal volumes to be reported. Licensees are also required to indicate peak pumping rates for each reporting period in their licence. Under recent licence amendments, more frequent reporting is required for oil sands licensees withdrawing from the Athabasca River. All of these licensees must report monthly to the electronic system; reporting must include daily withdrawal volumes, as well as the peak daily rate for the previous month.

7.0

Characterization of the Aquatic Ecosystem in the Region

The Athabasca River is part of a rich ecosystem and provides habitat for many plants and animals. Fish are integrators of impacts on the entire aquatic ecosystem and are of concern for local residents. For this reason, fish habitat and populations have been chosen as key indicators of ecosystem health. To date, 31 species of cool- and cold-water fish have been documented in the lower Athabasca River between Fort McMurray and Lake Athabasca (Appendix D).

The distribution of fish species in the lower Athabasca River, like all rivers, is strongly influenced by the physical characteristics of the riverine environment, including channel morphology, substrate, water depth and velocity. The section of the Athabasca River downstream of the Grand Rapids to the mouth of the Clearwater River is dominated by coarse substrates and erosional habitat, including several sets of rapids. In contrast, the lower Athabasca River downstream of the confluence of the Clearwater River to Lake Athabasca is a relatively straight channel, consisting largely of depositional habitat dominated by sand and silt substrate. The channel has numerous sandbars, with sections consisting of pools and backwaters at mouths of tributaries. This portion of the river has many tributaries that provide important fish habitat, including the Steepbank, Muskeg, MacKay, Ells, Tar, Pierre, Firebag and Richardson rivers.

The lower Athabasca River provides year-round spawning, rearing and feeding habitat for a variety of fish species. There are several spawning areas in the lower Athabasca River, including the Cascade and Mountain Rapids on the mainstem river upstream of Fort McMurray, where the substrate consists of boulder, cobble or gravel suitable for lake whitefish, walleye and longnose sucker, and slower-moving, vegetated areas where habitat is suitable for flathead chub, northern pike and burbot. Spawning habitat also exists on major tributaries, with gravel bars and slower moving waters suitable for northern pike, walleye, longnose sucker, and white sucker. During winter, burbot use the river to feed, grow and spawn, while other species select habitat to minimize energy loss, avoid predation and ultimately survive the winter. A number of primary factors, such as sufficient water depth below ice and adequate dissolved oxygen concentrations, are important in determining the suitability of overwintering habitat for fish.

The fish community in the lower Athabasca River is influenced by complex and varied seasonal movements to and from the Peace-Athabasca Delta, Lake Athabasca, tributaries or, to a lesser extent, by the restriction of upstream movement due to the presence of rapids upstream of Fort McMurray. For example, many thousands of lake whitefish migrate upstream from the lower river, delta and lake during fall to spawn; burbot migrate throughout the river for spawning during winter; and walleye and northern pike can migrate downstream to the Peace-Athabasca Delta in spring to spawn, returning to the river for winter. A similar migration pattern to walleye and pike has been observed for goldeye that spawn in delta lakes but migrate to the Peace River to overwinter.

7.1 Key Environmental Stressors

Fish stressors are factors that directly or indirectly influence fish health, including the availability and quality of fish habitat. Stressors can be natural environmental factors or they may result from the activities of humans. Some environmental stressors exert a local influence, while others are regional in scope. Examples of important natural fish stressors in the Lower Athabasca Region include climate, low flows, temperature, low winter dissolved oxygen, and parasitism. Examples of human activities that could influence fish health include fishing pressure, increased land access, land disturbances and barriers affecting fish habitat, and changes in water quality and quantity. As is the case in many of Alberta's riverine ecosystems, the cumulative effects of natural and human stressors on fish communities within the lower Athabasca River are not well understood.

7.2 Aquatic Ecosystem Monitoring

Alberta Environment and Sustainable Resource Development works with local organizations, the Alberta Biodiversity Monitoring Institute, academia, industry, and other partners in monitoring and studying the physical and biological resources within the Lower Athabasca Region, including the Athabasca River mainstem. These programs support understanding of the local ecosystem, help establish reference conditions, and provide information on the cumulative effects of natural and human stressors. To date, this work has not focused solely on the effects of water withdrawals.

Alberta Environment and Sustainable Resource Development conducts fish sampling and monitoring across the province. Existing monitoring efforts (water quality and quantity, sediments, benthic invertebrates and fish) are currently being enhanced through the *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring*.

The following is an overview of the monitoring and research work conducted in the lower Athabasca River Basin:

- The Cumulative Environmental Management Association has completed numerous studies that support water management for the lower Athabasca River. These studies explore hydrology, biology, geomorphology, water quality, and connectivity. Copies of the *Cumulative Environmental Management Association* reports are available through their website (http://cemaonline.ca).
- The *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring* devotes effort over a broad geographic scale that includes the mainstem Athabasca River and tributaries, the Peace-Athabasca Delta and small lakes throughout the oil sands region. The program includes long-term monitoring of the physical and

biological environment including: hydrology and climate, sediment and water quality, benthic invertebrates, fish community and health, and acid sensitive lakes.

- The Alberta Biodiversity Monitoring Institute and Alberta Environment and Sustainable Resource Development have jointly designed fish community monitoring protocols that continue to increase the understanding of lake and river ecosystems, focusing on fish and aquatic habitats, as well as physical and aquatic characteristics. Sampling is stratified across the province and within tertiary watersheds to capture provincial trends and evaluate whether or not aquatic biodiversity targets set through land-use planning are being met. The program is not designed to continually monitor trends at specific sites on the Athabasca River mainstem. The standard sampling within the Athabasca River sub-watersheds will include portions of the Athabasca River mainstem. The standard sampling within the Athabasca River sub-watersheds will include portions of the Athabasca River mainstem. Fish sampling standards from the Alberta Biodiversity Monitoring Institute program are available through their website, at http://www.abmi.ca.

A number of industry-led environmental monitoring programs are also conducted as a condition of, – or in preparing applications for, – their *Environmental Protection and Enhancement Act* approvals, *Water Act* licenses, and/or federal *Fisheries Act* authorizations. These programs have provided useful information such as habitat use and migration patterns of certain fish species. Most project-specific monitoring occurs onsite in tributaries, small creeks, and lakes.

8.0

Regional Objective

In support of the outcomes of the *Lower Athabasca Regional Plan*, this management framework establishes the following regional objective for surface water quantity:

> *Cumulative water withdrawals will be managed to support human and ecosystem needs, considering an acceptable balance between social, environmental, and economic interests.*

The Framework focuses on managing water withdrawals by the mineable oil sands sector and is based on current and anticipated future water demands. The mineable oil sands sector is currently the largest consumptive user of water in the lower Athabasca River and is also forecast to comprise the largest increase in future water demand.

Alberta Environment and Sustainable Resource Development, in cooperation with the greater Athabasca River Basin Community, will consider developing an integrated, basin-wide water management plan in the future.

9.0

Indicators, Weekly Triggers, and Adaptive Management Triggers

The *Surface Water Quantity Management Framework for the Lower Athabasca River* relies on three types of tools in establishing the need for- and nature of a management response. Each type is designed for a specific and unique purpose (Table 3).

The Framework incorporates weekly management triggers and water withdrawal limits that will be used to enable proactive management of mineable oil sands water withdrawals from the Athabasca River. Weekly water withdrawal limits reflect seasonal variability and become more restrictive as flows in the river decrease. They are established as specific regulatory conditions through individual *Water Act* licenses, and must be adhered to by mineable oil sands operators on a day-to-day basis.

Adaptive management triggers are included in the Framework as a means of establishing when river flow and water use conditions are close to- or outside of the range of predicted future conditions that were used in modelling and development of the weekly management triggers and withdrawal limits. Exceedance of adaptive management triggers will direct a management response process, led by Alberta Environment and Sustainable Resource Development.

9.1 Indicators

Indicators provide information about whether or not the regional objective is being met.

With respect to surface water quantity, measurement and tracking of indicator trends for both environmental conditions and pressures will help to ensure that water withdrawals are managed in consideration of social, environmental, and economic outcomes, now and into the future.

Five indicators have been identified for monitoring purposes under this framework:

1. **Upstream Water Use:** The upstream water use indicator is the cumulative water withdrawals from- and returns to the Athabasca River by all water licensees upstream of Fort McMurray (Section 9.3.1).
2. **River Flow:** The river flow indicator is measured at the Water Survey of Canada gauge 07DA001 “Athabasca River below McMurray” (Section 5.1).
3. **Oil Sands Water Use:** The oil sands water use indicator is the cumulative weekly water withdrawals from the Athabasca River by all oil sands licensees (mineable and in situ; Section 9.3.4).

Table 3.
Tools applied in the *Surface Water Quantity Management Framework for the Lower Athabasca River*.

Tools	Purpose	Management Response
Indicators	• Indicators of environmental conditions and human pressure. • Track for changes over time (natural or anthropogenic). • Indicators provide information about whether or not objectives are being met.	Indicators are designed to provide information only; they do not have management responses associated with them. Data and trends will be interpreted in relation to triggers and limits.
Weekly Management Triggers and Water Withdrawal Limits	• Limits restrict weekly water withdrawals by mineable oil sands operators, in response to exceedance of weekly flow triggers. • Developed on the basis of stream flow tracking (1957 – 2007), climate change scenarios, forecast water use, and predicted changes to the aquatic environment. • In general, limits become more restrictive as stream flow decreases; they are seasonally dependent.	Regulatory response established within Water Act licenses and enforced by the Alberta Energy Regulator.
Adaptive Management Triggers	• Indicates when river flow and/or water use conditions are outside the range of predicted future conditions used in development of the framework. • Designed to detect departures from expected change.	Trigger an investigative response led by AESRD and designed to determine causal factors for unexpected change. Depending on results, further management actions could be taken, including revision of weekly management triggers and withdrawal limits.

4. **Seasonal Flow Exceedance Indicators (Table 6):** The seasonal flow exceedance indicators assess departures from modelled climate change scenarios used during development of the Framework (Section 9.3.2).
5. **Aboriginal Navigation:** The Aboriginal Navigation Index (ANI) rates the quality of Lower Athabasca River navigability, expressed as a percentage change from pre-withdrawal flow conditions (Section 9.3.7; Appendix G).

Further research is required before ecological indicators can be established. The Fish Sustainability Index and the Index of Native Fish Integrity are being considered as ecological indicators. Additional information on future planning indicators and triggers can be found in Section 11.2.

9.2 Weekly Management Triggers and Water Withdrawal Limits

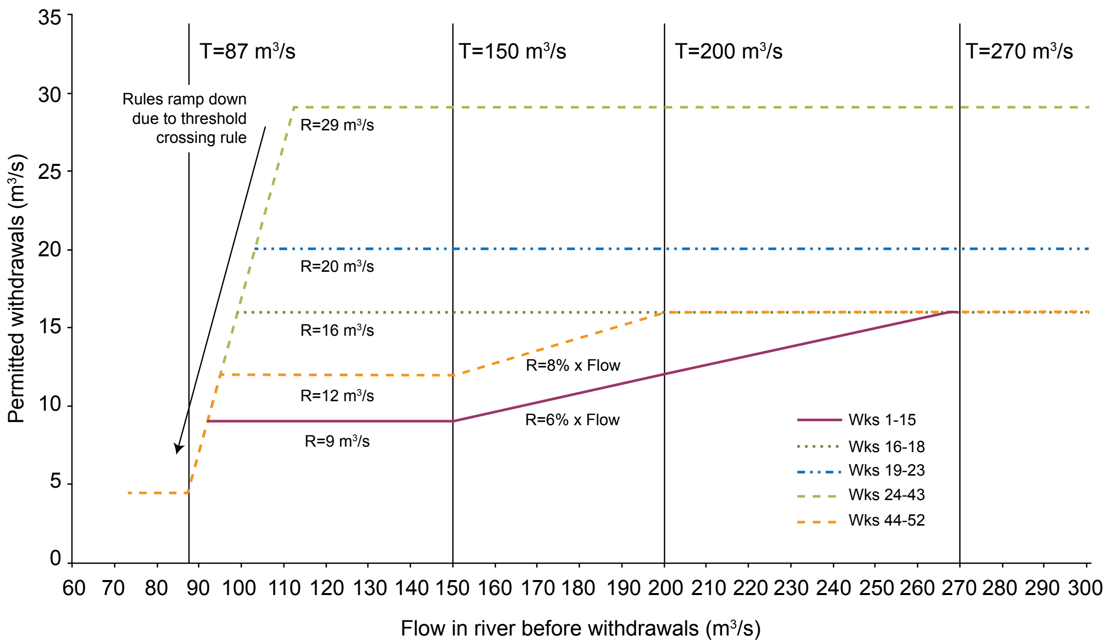
The weekly management triggers and cumulative water withdrawal limits have been adopted from the recommendations of the P2FC process. Input from other processes was also taken into consideration (Appendix B). The water withdrawal limits consider the results of detailed field work and modelled river flow and water withdrawal scenarios, and are intended to establish a balance between social, environmental and economic interests.

Table 4 stipulates the weekly management triggers and water withdrawal limits, while Figure 5 is a visual illustration of the limits. These management triggers and associated water withdrawal limits reflect seasonal variability in river flows and become more restrictive as flows decrease, in order to minimize impacts on the aquatic ecosystem.

Weekly flows measured at the McMurray station will be compared to the management triggers to determine the applicable limits on how much water is available for cumulative mineable oil sands water withdrawal for each week of the year. The weekly cumulative withdrawal limits presented in Table 4 must not be exceeded. Communication and reporting processes for the triggers and limits are outlined in Section 12.

The weekly management triggers and withdrawal limits are divided into five seasons: Mid Winter, Early Spring, Late Spring, Summer/Fall, and Early Winter. Each of these seasons has distinct weekly flow triggers and corresponding cumulative water withdrawal limits. If weekly flows are less than the lowest management trigger of 87 m^3/s in any of the five seasons, the cumulative oil sands water withdrawal limit will be reduced to 4.4 m^3/s. This flow condition is statistically estimated to occur rarely, having about a 1-in-100 chance of persisting from January to March in any given year.

As an approved management framework under the *Lower Athabasca Regional Plan*, the *Surface Water Quantity Management Framework for the Lower Athabasca River* establishes operator requirements for mineable oil sands that will be incorporated into *Water Act* licenses and help ensure that appropriate compliance and monitoring requirements are implemented.



T = Weekly Flow Trigger; R= Cumulative Water Withdrawal Limit
Source: Cumulative Environmental Management Association 2010

Figure 5.
Graph of weekly Flow Triggers and Cumulative Water Withdrawal Limits

When flow conditions are close to the lowest management trigger of 87 m^3/s, a transition rule applies (Figure 5; "threshold crossing rule"). This rule ensures that permitted withdrawals for a higher management trigger do not cause the flow in the river to be less than that at the lowest management trigger.[1]

Existing oil sands projects currently have a licensed pumping capacity of approximately 20 m^3/s. An additional 7 m^3/s of pumping capacity has been approved but is not yet built, resulting in a total licensed pumping capacity of 27 m^3/s. The oil sands sector's cumulative maximum licensed pumping capacity is expected to

[1] For example, if the flow in the river were 89 m^3/s, a full withdrawal of 9 m^3/s could result in the remaining flow in the river being 80 m^3/s, whereas at the lowest management trigger the remaining flow in the river is 87 minus 4.4, or 82.6 m^3/s. The transition rule therefore limits the withdrawal at 89 to 6.4 m^3/s, so that the remaining flow would still be 82.6 m^3/s.

increase as more projects are approved and built. In the current system, individual oil sands licence holders can only pump at a cumulative maximum withdrawal rate that is the lesser of either:

- The sum of the maximum rate listed on each of their licences, or
- The sum of the maximum as-built capacity of each operator.

The Framework identifies an additional cumulative withdrawal limit of 29 m^3/s; under normal operating conditions, the total pumping capacity cannot be used simultaneously, such that this limit is exceeded. Under rare circumstances (e.g., filling of a newly-constructed reservoir during high flow conditions), some flexibility around this limit may be entertained. It is expected, however, that operators will work to ensure that these rare circumstances are adequately considered through water sharing agreements. They will be further addressed through Framework reviews and assessment of adaptive management triggers.[2]

Implementation of the weekly water withdrawal limits will include reducing water withdrawals for surface mining operations during low flow seasons (winter), in order to protect the aquatic ecosystem. The oil sands sector will have the flexibility to adopt appropriate operational measures in order to comply with the weekly water withdrawal limits. These operational measures could include adjusting oil sands production, negotiations with other oil sands licence holders, using on-site storage, or other innovative solutions. Storage would enable the withdrawal of water during high flow periods (summer) so that it can be stored and used during low flow periods (winter).

At this time, weekly management triggers and withdrawal limits are applicable to mineable oil sands operations only, as these currently represent the largest volumes of water withdrawn from the Athabasca River. In the future, depending on the evolution of the oil sands industry, and based on information derived from framework indicators and adaptive management triggers, consideration may be given to the application of short term limits and triggers to in situ operations.

[2] To date, cumulative daily average pumping rates have remained quite low; between January 2011 and December 2012, for example, they ranged from 1.9 m^3/s to 6.7 m^3/s.

Table 4.
Weekly Flow Triggers and Cumulative Water Use Limits on the Lower Athabasca River for Oil Sands Operations.

Mid Winter (January 1 to April 15) Weeks 1-15	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 270 m^3/s	16 m^3/s
150 to 270 m^3/s	6% of Weekly Flow
91.6 to 150 m^3/s	9 m^3/s
87 to 91.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4 m^3/s

Early Spring (April 16 to May 6) Weeks 16-18	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 98.6 m^3/s	16 m^3/s
87 to 98.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4 m^3/s

Late Spring (May 7 to June 10) Weeks 19-23	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 102.6 m^3/s	20 m^3/s
87 to 102.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4 m^3/s

Summer/Fall (June 11 to October 28) Weeks 24-43	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 111.6 m^3/s	29 m^3/s*
87 to 111.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4 m^3/s

Early Winter (October 29 to December 31) Weeks 44-52	
Weekly Flow Triggers (m^3/s)	Cumulative Water Withdrawal Limits
more than 200 m^3/s	16 m^3/s
150 to 200 m^3/s	8% of Weekly Flow
94.6 to 150 m^3/s	12 m^3/s
87 to 94.6 m^3/s	Weekly Flow minus 82.6 m^3/s
less than 87 m^3/s	4.4 m^3/s

* Cumulatively, licensed pumping capacity for mineable oil sands projects may eventually exceed this limit. Water sharing agreements will identify how water management decisions will help ensure maintenance of the limit.

Note: Table 4 has been reformatted from the version presented in *Cumulative Environmental Management Association 2010*, and incorporates the transition rule.

9.3 Adaptive Management Triggers

As described in Section 2.3, development of weekly management triggers and withdrawal limits was supported through modelling of multiple water management alternatives and climate change scenarios. Adaptive management triggers are designed to indicate when river flow or water use conditions are close to or outside of the modelled predictions that were used to develop the Framework. Seven adaptive management triggers are included in the Framework; they are based on a review of long-term monitoring data for river flow and water use. These adaptive management triggers may indicate that predictions and outcomes associated with river flow and water use models need to be reviewed. Significant changes in river flow or water use conditions would initiate a management response, as described in Section 10.2.

Unlike the weekly management triggers and withdrawal limits, the management response for adaptive management triggers is non-regulatory. Associated management actions are designed to review the data and determine if further investigation is required. If further investigation is required, efforts will be made to identify the natural and/or anthropogenic factors that may be responsible for a given deviation and to assess potential implications for the aquatic environment. Based on this analysis, options will be developed and the most appropriate option will be implemented. Management action options may be regulatory or non-regulatory and could include support for additional evaluation criteria, revision of water withdrawal limits, additional long term monitoring requirement, or improving water use monitoring. Due to the high variably around each unique circumstance, it is difficult to provide specific details around management actions pre-emptively.

The seven adaptive management triggers are:

1. Upstream Water Use
2. Changes to Long-Term Seasonal Flows in the Athabasca River
3. Changes to Oil Sands Water Use
4. Cumulative Oil Sands Water Use, Relative to Weekly Flow
5. High Oil Sands Water Use During Low Summer/Fall Flows
6. Development of Ecological Indicators and Triggers
7. Preliminary Aboriginal Navigation Index

The following sections describe the adaptive management triggers in more detail.

9.3.1 Upstream Water Use

A significant change in upstream water use related to existing allocations, or changes to water allocations upstream, will indicate that conditions are outside of the modelled predictions used to develop the water withdrawal limits (Table 4). These predictions assumed that upstream water use would not change significantly during the timeframe under consideration.

The current net water allocation in the basin upstream of the McMurray station is 95,718,992 m^3. For the purpose of developing the weekly water withdrawal limits, future water allocations and water use upstream of the McMurray Station were not anticipated to change significantly, especially relative to projected oil sands water demand. The Upstream Water Use trigger is intended to indicate if and when upstream water use begins to affect the degree to which flow measurements in the Athabasca River below McMurray approximate natural flows. Net withdrawals (volume of water withdrawn from the river, minus the volume of water returned to the river; vs. gross or total withdrawals) are used for this trigger, because it is the net withdrawal that influences downstream flows.

Adaptive management triggers for upstream water allocation and use are:

- **Net water allocation upstream of Fort McMurray reaches or exceeds 160 million m^3/year (approximately 5 m^3/s).**
- **Actual reported net water use upstream of Fort McMurray reaches or exceeds 60 million m^3/year (approximately 2 m^3/s).**

Arrival at- or exceedance of- these triggers would indicate that upstream licenced water use has almost doubled from the historic range. This would result in a management response, as described in Section 10.2.

9.3.2 Changes to Long-Term Seasonal Low Flows in the Athabasca River

Low Flow Adaptive Management Triggers have been identified for six seasons (Table 5). These triggers represent conditions that are outside of the modelled climate change scenarios that were used to develop the weekly management triggers and withdrawal limits. The model used an analysis of historical flows (1957-2007) extrapolated on the basis of future climate change, which resulted in a flow reduction of 10.8 per cent in winter and 12.1 per cent in the open-water season by 2039 (Appendix F).

The Low Flow Adaptive Management Triggers in Table 5 were calculated in two steps, by first calculating the low flow for that season (i.e., the point where the flow is greater than that number 97.5 per cent of the time), and then applying the appropriate reduction for that season (10.8 per cent in the winter seasons and 12.1 per cent in the other three seasons).

If the median seasonal flow for a given season drops below the specified Low Flow Threshold value three or more times within any 10 consecutive year period, the adaptive management triggers for changes to long-term seasonal flows in the Athabasca River will have been exceeded.

The frequency of three or more low flow events in a 10 consecutive year period was chosen to distinguish between short-term weather variation and climate change (Hurst, 1951; Koscielny-Bunde *et al*., 2006).

Table 5.
Long-Term Seasonal Low Flow Adaptive Management Thresholds.

Weeks	Season	Low Flow Threshold (m^3/s)
1 to 15 (January 1 – April 15)	Mid-Winter	91.3
16 to 18 (April 16 – May 6)	Early Spring	173
19 to 23 (May 7 – June 10)	Late Spring	442
24 to 33 (June 11 – August 19)	Summer	636
34 to 43 (August 20 – October 28)	Fall	298
44 to 52 (October 29 – December 31)	Early Winter	105

River flow data for this indicator will be reviewed annually. As an example, if the median mid-winter flow drops below the low flow threshold value three times in a 10-year period, then the trigger will be reached. However, if the flow drops below 91.3 m^3/s once in mid-winter and below 442 m^3/s twice in late spring, the trigger would not be exceeded. Three similar extreme events in the same season in a 10-year period would initiate a management response.

The above thresholds focus on the lowest flows that could occur with a moderate degree of climate change in the Athabasca River Basin. However, changes to the low flow regime of the Athabasca River are not the only potential concern. To evaluate the full range of flows, Long-Term Seasonal Flow Exceedance Indicators were developed from the moderate climate change hydrographs. Table 6 shows the number of weeks during which flows drop below various key rates in the driest 10 years of the moderate climate change scenario (10.8 per cent flow reduction in the winter season and 12.1 per cent reduction in the open water season).

Seasonal Flow Exceedance Indicators (Table 6) were derived by determining the number of times over 10 consecutive years that modelled weekly average flows would drop below a series of key flows, given a moderate climate change scenario. In comparison, from 1998 to 2007 (the lowest 10 year period on record) weekly flows were less than 100 m^3/s 13 times in the winter (weeks 44 to 52 and 1 to 15) and less than 400 m^3/s 46 times in the open water season (weeks 16 to 43). Any counts higher than the values shown in Table 5 would indicate that some aspect of the selected 10-year flow period is outside the range anticipated by the recommendation process.

Table 6.
Long-Term Seasonal Flow Exceedance Indicators (based on a moderate climate change scenario)

Flow Rate (m^3/s)	# of Weeks Below Flow Over 10-Year Period	
	Winter (week 44 to 15)	Open Water (week 16 to 43)
87	9	0
100	37	1
125	96	1
150	131	1
200	184	4
270	221	13
400	237	60
600	240	133
1000	240	241
1600	240	275

9.3.3 Changes to Oil Sands Water Use

Adaptive management triggers have been identified to track water use and detect whether it is close to the modelled predictions that were used to develop the weekly management triggers and withdrawal limits (Table 4). Attainment or exceedance of the trigger would initiate the management response.

In the Framework analysis, maximum cumulative annual water withdrawals by the oil sands sector were assumed to be 505 million m^3/year (16 m^3/s). The adaptive management trigger will be reached if cumulative annual water withdrawals by the oil sands sector exceed 441 million m^3/year (14 m^3/s). This trigger was established at a lower level than that used in the analysis, in order to allow time for implementation of a management response.

Unlike the Upstream Water Use trigger, the Changes to Oil Sands Water Withdrawals trigger is currently based on gross withdrawals; it does not consider the volume of water returned to the Athabasca River. Due to the fact that water returns are currently minimal, modelling work assumed that water withdrawn from the Athabasca River for use in oil sands processes would not be returned to the Athabasca River. This may change in the future; as fluid tailings are reclaimed, process-affected water may be liberated from the tailings matrix. Over time, the onsite storage of this water may constrain site management options for some mine operators, which may eventually require the consideration of alternative water management practices. Should this be the case, operators will be required to provide a detailed assessment of water management alternatives that address the end fate of process-affected water and optimize the following water management approaches:

- Reducing water consumption and water intake
- Reusing water, wherever feasible
- Re-using water, wherever possible
- Leveraging opportunities to share water regionally

As the Changes to Oil Sands Water Withdrawals trigger will evaluate the level of oil sands water demand, relative to what was anticipated by the Framework process, it is not comparable to the Upstream Water Use trigger. The latter is designed to evaluate departures from natural flow conditions in the Athabasca River upstream of Fort McMurray.

In support of their water use sharing agreements, oil sands companies forecast their annual water demand for the next several years (further detail is provided in Sections 10.1 and 13.4). Annual reporting of the Changes to Oil Sands Water Withdrawals trigger should include any available industry forecasts of water demand from the Athabasca River.

9.3.4 Cumulative Oil Sands Water Use, Relative to Weekly Flow

Three adaptive management triggers are designed to detect whether water use (mineable and in situ), relative to flow, is outside of the modelled predictions applied in the development of weekly management triggers and withdrawal limits (Table 4).

1. **The first trigger will be reached if cumulative (mineable and in situ) oil sands water use is equal to or greater than 10 per cent of the flow measured at the McMurray station for six or more weeks during the winter period of any given year (weeks 1 to 15 and 44 to 52).**
    - A winter exceedance of 10 per cent water use, relative to flow, is expected to be relatively rare, assuming that withdrawals and flows remain within the modelled range. Under water use and flow modelling for the full build-out scenario, withdrawals in the winter did not exceed 10 per cent of flow more than five weeks in any given year.

2. **The second trigger will be reached if cumulative (mineable and in situ) oil sands water use is equal to or greater than 6 per cent of the flow measured at the McMurray station for six or more weeks during the open water period of any given year (weeks 16 to 43).**
    - An exceedance of 6 per cent water use during the open water period is expected to be relatively rare, if withdrawals and flows remain within the modelled range.
3. **The third trigger will be reached if cumulative (mineable and in situ) oil sands water use is equal to or greater than 15 per cent of the flow measured at the McMurray station for a single week at any time of the year. The value of 15 per cent is used in the 2007 water management framework.**
    - An exceedance of 15 per cent water use is expected to occur only under rare extreme conditions, such as a late winter break-up or a severe freeze-up.

The intent of these three adaptive management triggers is to track weekly water use, relative to weekly finalized Water Survey of Canada flow data, such that the level of week-to-week protection can be verified for the year. This will support the intent of the Framework to develop water withdrawal limits that are generally more restrictive as river flows decrease:

- The primary management action associated with these triggers will be a reassessment of water withdrawal rules, to better reflect changing flow conditions.

9.3.5 High Water Use During Low Summer/Fall Flows

The Framework currently allows for up to 29 m^3/s to be withdrawn from the Athabasca River during the Summer/Fall season (weeks 24 to 43). During late summer and fall of dry years, however, stream flows can drop substantially and a protracted withdrawal of 29 m^3/s may not follow the general Framework principle of reduced withdrawals with declining flows. According to Candler *et al.* (2010), First Nations use of the river for navigation may be limited if flow drops below 400 m^3/s during this period, restricting access to traditional activities.

A management response will be triggered if cumulative oil sands water use exceeds the predicted full build-out scenario (16 m^3/s) during any week in the Summer/Fall season (weeks 24 to 43) in which the average weekly flow is less than 400 m^3/s.

9.3.6 Development of Ecological Indicators and Triggers

At the end of the P2FC process (December 2009), various knowledge gaps were still outstanding and could not be filled, due to limited time and data. Participants agreed to move forward with recommendations to the regulators, on the understanding that these knowledge gaps would be filled in a reasonable time frame to support the framework. The *Surface Water Quantity Framework for the Lower Athabasca River* acknowledges these knowledge gaps and the need to address them over time.

The *Surface Water Quantity Management Framework for the Lower Athabasca River* identifies a process for developing ecological indicators and triggers, based on additional monitoring and research. Key areas include ecosystem status monitoring (indicators) and ecological knowledge gap research. Additional monitoring and research is required in order to build a baseline for detecting changes in the aquatic ecosystem in the lower Athabasca River. Ecosystem status monitoring will require a long-term commitment for successful implementation.

If the maximum allowable water withdrawals under the *Surface Water Quantity Management Framework for the Lower Athabasca River* are taken, modeling predicts that measurable but reversible declines in some fish populations would occur, but that biodiversity would be maintained (Cumulative Environmental Management Associatioin 2010). Refer to Appendix E for a synoptic analysis of *Environmental Assessment of Climate Change and Proposed Water Management on the Lower Athabasca River*, or CEMA (2010) for the complete analysis.

Two long-term ecosystem status indicators are under consideration:

1. **The Fish Sustainability Index:** This population-level metric has been developed to track the regional and provincial status of fish stocks with important management or conservation concern (Coombs and MacPherson, 2013).
2. **The Index of Native Fish Integrity:** This community-level metric has been used on the Battle River to spatially monitor the effect of land use on fishes (Stevens *et al*., 2010).

These indicators are discussed further in Section 11.2. They reflect cumulative effects from multiple stressors and are not solely influenced by water withdrawals. Triggers and limits for these indicators have not yet been established.

The Framework also acknowledges a number of ecological knowledge gaps (Cumulative Environmental Management Association, 2011). These are:

- Winter ecology in the delta (mesohabitat, hydrology, hydraulics and dissolved oxygen);
- Riparian vegetation and aquatic mammals in the delta;
- Access to tributaries;
- Richardson Lake connectivity;

- Big Egg Lake connectivity (perched basins);
- Walleye recruitment in the delta; and,
- Dissolved oxygen in river segments 2-5.

Alberta Environment and Sustainable Resource Development (ESRD) is working with the Cumulative Environmental Management Association (CEMA) to address these knowledge gaps. CEMA will report the results of knowledge gap studies to ESRD. It is anticipated that these studies will be completed within a reasonable timeframe, following implementation of the Framework. If the analysis of study results identifies significant ecological risk, the appropriate management response will be undertaken. For more information on the knowledge gaps and associated work of CEMA, refer to Appendix G.

In May of 2014, CEMA completed work on two knowledge gaps and provided the following recommendations:

- Walleye recruitment: Results of knowledge gap studies (Paul 2012; Paul 2013) indicate that P2FC recommendations would not have been altered or affected. Therefore, no further work is deemed necessary under this knowledge gap.
- Winter ecology in the delta (mesohabitat): Water withdrawal recommendations of the Phase 2 Framework Committee are not expected to have an irreversible impact on benthic invertebrates or fish communities in the delta through changes in winter availability of mesohabitat (medium velocity, deep habitat), which would be most sensitive to water withdrawals. Therefore, no further work is necessary under this knowledge gap.

9.3.7 Preliminary Aboriginal Navigation Index (ANI)

The Athabasca River is an important navigational route that provides access to traditional activities for First Nations and Métis communities. Open water navigability of the river for small craft is a consideration for the *Surface Water Quantity Management Framework for the Lower Athabasca River*. Navigation can be challenging in low flow years, during early spring, late summer, and fall. Conditions in the fall are of additional interest, because low flows can persist for weeks or months before winter freeze up makes river travel impossible.

In recognition of navigational challenges at low flows, the *Surface Water Quantity Management Framework for the Lower Athabasca River* incorporates a preliminary Aboriginal Navigation Index (ANI; Appendix G), which is based on the concepts of Aboriginal Base Flow (ABF; 1600m^3/s) and Aboriginal Extreme Flow (AXF; 400 m^3/s). The ABF and AXF are proposed by Candler *et al.* (2010) as the range in stream flow where navigability declines from excellent to poor. This indicator will be preliminary and subject to continuous improvement, as more knowledge around navigation becomes available.

Within its work, the CEMA Phase 2 Framework Committee considered various aspects of Aboriginal navigation. River bathymetry data were analyzed, based on a depth requirement of 0.6 metres for a boat with an outboard motor. Subsequent information, most notably the report *As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change* (Candler *et al.*, 2010), has indicated that, because boats used by Aboriginal communities are often fully loaded, a depth greater than 0.6 metres is required. Candler *et al.* (2010) include the following comments about flow and navigation in the Athabasca River:

1) Based on interview responses, and later verification with the Athabasca Chipewyan First Nation (ACFN) elder's council, the safe navigational depth (including start-up) for this kind of boat, fully loaded, with an outboard motor, "was confirmed to be approximately four feet (1.2 metres)."
2) Based on participant interviews, the lowest flows in memory were during the fall of 2009 and mid-May 2010.
3) The report defines an Aboriginal Base Flow (ABF) at 1600 m^3/s, reflecting "a level on the Athabasca River and adjacent streams where ACFN members are able to practice their rights, and access their territories fully".
4) The report defines an Aboriginal Extreme Flow (AXF) at 400 m^3/s, reflecting "a level at which widespread and extreme disruption … occurs along the Athabasca River, delta, and tributaries due to a loss of access related to low waters".

During October of 2009, flows in the Athabasca River below McMurray (Water Survey of Canada hydrometric station 07DA001) ranged from 259 to 390 m^3/s, averaging 310 m^3/s, while flows in mid May 2010 (May 12 to 23) ranged from 398 to 493 m^3/s, averaging 443 m^3/s.

Although the ABF and AXF are described in Candler *et al.* (2010) as approximate, conservative, and preliminary, they correspond reasonably well with river bathymetry and hydraulic modelling studies carried out to support the P2FC recommendation process (Appendix E).

The calculated fall season ANI varies significantly from year to year (Figure 6) and has generally decreased over time. The average ANI was 0.423 from 1958-1980, 0.355 from 1981-1997, and 0.213 from 1998-2011. Average water withdrawal in 2011 and 2012 from weeks 34 to 43 was 3.5 m^3/s. A water withdrawal of 4 m^3/s would have reduced the 1998-2011 ANI by 2 per cent to 0.209.

The P2FC recommendation allows for withdrawals of up to 29 m^3/s in the summer/fall season (weeks 24 to 43). A sustained withdrawal of 29 m^3/s would have reduced the Fall ANI from 1998-2011 by almost 15 per cent to 0.187, while a sustained withdrawal of 16 m^3/s (the withdrawal rate modelled by P2FC in the fall season) would have reduced the Fall ANI by 8 per cent to 0.199. Figure 7 shows how various levels of withdrawal would have changed the ANI under historic flow conditions (1958-2011).

The P2FC recommendation allows for sufficient withdrawal to potentially reduce fall season navigability of the Athabasca River in low flow years, even before consideration of possible climate change influences (it must be emphasized, however, that the impacts of current withdrawal rates are relatively small). Given this apparent challenge, as well as the fact that fall has been reported as an important time period for Aboriginal navigation, the following Aboriginal Navigation Trigger has been included in this framework:

- **A management response would be initiated if the change in fall season (weeks 34 to 43) ANI were to exceed 10 per cent in any year.**

The ANI trigger is designed to act as a highly conservative indicator, and is intended to provide advance notice of a potential change in river navigability. Exceedance of the trigger represents a small change in water depth (less than 3 cm) at a very specific point in the river, which has been identified as particularly challenging to navigation (Appendix E). As such, exceedance of the trigger is unlikely to represent an immediate limitation to navigation or river access. **Given the preliminary nature of the ANI, the management response associated with this trigger will initially focus on a comprehensive assessment of the factors potentially contributing to the exceedance**. This approach takes into consideration that a broad range of influences, beyond oil sands water withdrawals, could potentially impact or influence mitigation or management efforts. These could include, but are not limited to, natural climatic and hydrological cycles, climate change, upstream water use, changes in associated management practices (e.g., river dredging), and broader water use within the oil sands area. Additional information on the derivation of the ANI and trigger is presented in Appendix G.

Calculation and reporting of the ANI at regular intervals enables assessment and communication of cycles and changes in river flow, in a manner that is likely to provide enhanced context for some users of the Athabasca River. The derived information is intended to be applied toward further development and refinement of the ANI over the coming years.

Further Development of Aboriginal Navigation Index and Trigger
The ANI is currently based on a) two approximate flow levels identified in Candler *et al.* (2010), and b) the modelled flow-depth relationship of a single critical navigation point. Future work toward further development of the ANI is anticipated. This could include, for example, other navigation points along the Athabasca River, tributary access, and navigation in the Athabasca Delta.

Community-Based Monitoring System
The existing Community-Based Monitoring system, run by the Athabasca Chipewyan and Mikisew Cree First Nations, will be augmented to facilitate enhanced understanding of the relationship between river navigability and stream flow. Through this system, community members will have the opportunity to contribute qualitative navigational and traditional activity information for the Athabasca River.

Knowledge and understanding derived through the system will be used to inform updates of the preliminary Navigation Index over time. Community -based monitoring will be complemented by additional research and information, as these become available.

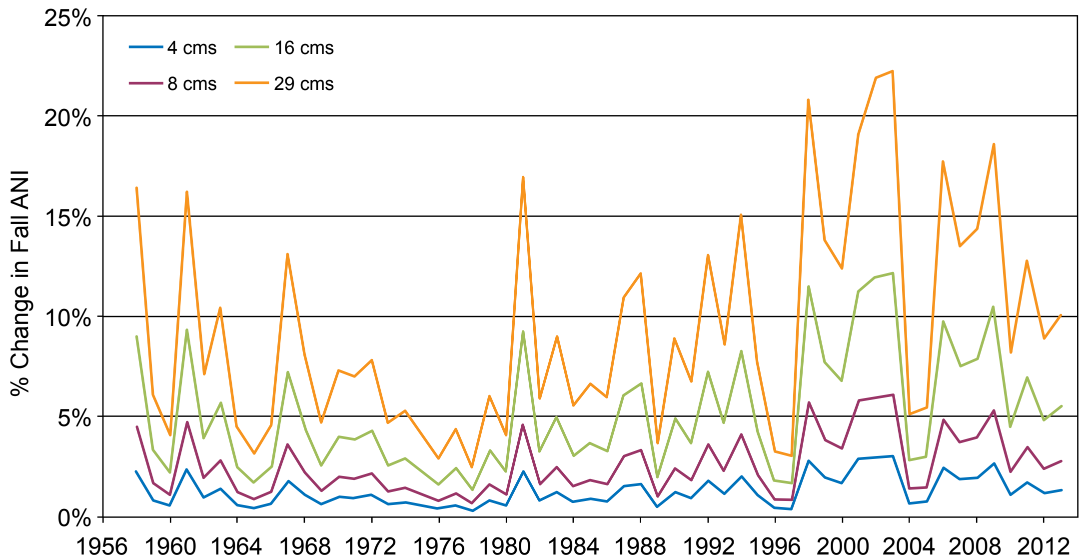


Figure 6.
Change in ANI from 1958 to 2011 for various hypothetical water withdrawal scenarios.

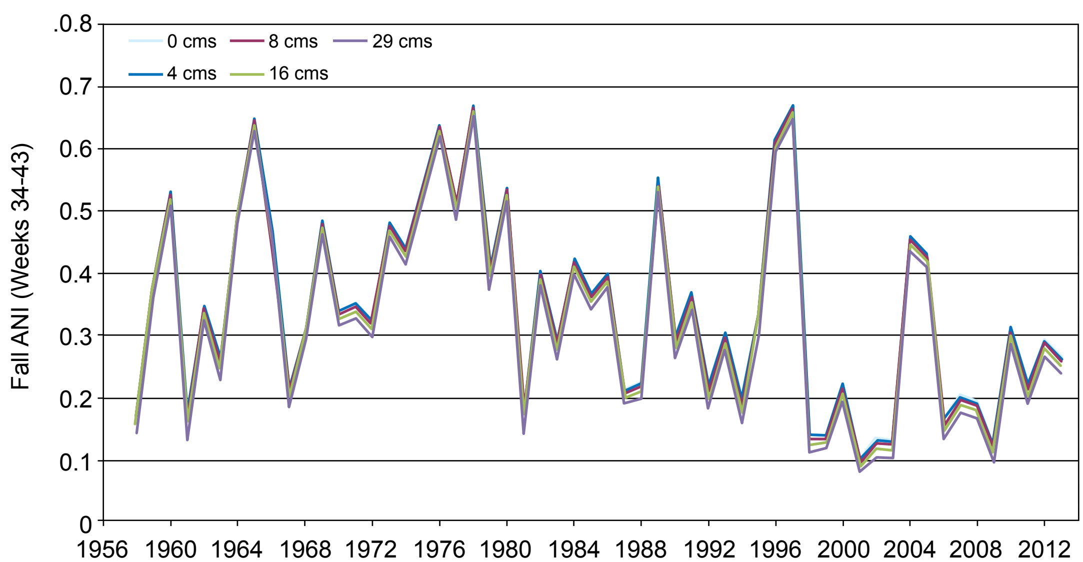


Figure 7.
Annual Variation in ANI from 1958 to 2011 for various hypothetical water withdrawal scenarios.

10.0

The Management System

This framework introduces the following elements to the existing surface water quantity management system:

- A regional objective for surface water quantity for the lower Athabasca River;
- Weekly management triggers and associated water withdrawal limits for mineable oil sands operations;
- Adaptive management triggers, to indicate when river flow or water use conditions are close to- or outside of the modelled predictions that were used to develop the water withdrawal limits; and
- A management response, when adaptive management triggers are reached or exceeded.

Within this framework, river flow at the McMurray station will be used as an indicator of of surface water quantity. The Framework identifies weekly management triggers and water withdrawal limits that reflect seasonal variability in river flows and become more restrictive as flows decrease. The Framework also includes adaptive management indicators and triggers that will identify when river flow or water use conditions are close to or outside of the modelled predictions that were used to support development of the weekly flow triggers and water withdrawal limits. If adaptive management triggers are reached or exceeded, a management response (Section 10.2) will be initiated.

Overall, this framework fits within and supports broader provincial water legislation and policy that applies to the Athabasca River. Management responses outlined in this framework are specifically targeted toward the oil sands sector. However, collective requirements may have implications for all current and future water licence holders in the Athabasca River watershed. Requirements established through this framework do not replace existing policies guiding the development of individual licence conditions; they are additional requirements that will be formally incorporated into new applications and approval and licence amendments and renewals.

While existing *Water Act* licences specify annual allocation volume and maximum withdrawal rates, this framework introduces specific conditions, in the form of weekly management triggers (Table 4). All new, renewed and amended water licences for the mineable oil sands sector that either withdraw from the Athabasca River, or will have a significant cumulative effect on the Athabasca River downstream of Fort McMurray, will include conditions that require adherence to the weekly management triggers and withdrawal limits specified in this framework.

This framework contributes to the accomplishment of objectives identified in the *Lower Athabasca Regional Plan*. Identified water withdrawal limits will come into effect at the start of the Early Winter period of 2015 (Table 4).

The following sections further describe the new elements of the management system:

- Weekly Management Triggers and Limits;
- Management Response to Adaptive Management Triggers;
- Flow, Use and Ecosystem Status Monitoring; and
- Evaluation and Communication.

10.1 Management Actions for Weekly Management Triggers and Withdrawal Limits

Alberta Environment and Sustainable Resource Development will determine the flow at the McMurray station, determine the flow status compared to the management triggers, and communicate the weekly cumulative water withdrawal limits. The Alberta Energy Regulator will review the mineable oil sands sector's withdrawal reports for compliance with individual licence and cumulative withdrawal limits (Table 4), as well as for compliance with the individual quantities specified in the annual industry sharing agreement.

The oil sands sector will submit an industry sharing agreement to Fisheries and Oceans Canada and Alberta Environment and Sustainable Resource Development by November 1st every calendar year. This agreement will describe how the oil sands sector will share the cumulative withdrawal amount (Table 4) for each operator within the terms and conditions of their water licence. If required, an amendment to the industry sharing agreement within the year can be undertaken, subject to the agreement of the parties involved as well as Fisheries and Oceans Canada and Alberta Environment and Sustainable Resource Development. The agreement will further identify how water management decisions, including storage plans, will help ensure maintenance of the 29 m^3/s withdrawal limit during high flow periods. As development progresses, an elevated need for this, in conjunction with enhanced coordination and collaboration among operators, is anticipated. With this in mind, future framework reviews will also consider the need for similar industry guidance for high flow withdrawals, as is currently provided for low flows.

The industry sharing agreement for withdrawals below the weekly management trigger of 87 m^3/s will be allocated as follows:

- a maximum of 2 m^3/s to each of Suncor and Syncrude;
- a maximum of 0.2 m^3/s to each of Shell Muskeg River and Canadian Natural Horizon for freeze protection of existing infrastructure; and

- zero to all other mineable oil sands water license holders.

If an industry sharing agreement is not submitted to Fisheries and Oceans Canada, Environment and Sustainable Resource Development, and the Alberta Energy Regulator by November 1st, ESRD and the Alberta Energy Regulator will prescribe the necessary agreement by November 30th each year.

If a mineable oil sands operator is in non-compliance with their water licence or industry sharing agreement, they are required to report the incident to the Alberta Energy Regulator.

10.2 Management Response to Adaptive Management Triggers

The terms "management response" and "management action" for the adaptive management triggers have distinct meanings in the context of management frameworks under the *Land Use Framework*. The management response is a series of steps that will be undertaken (in whole or in part) if an adaptive management trigger is reached or exceeded. Part of the management response is a determination of the need for management actions.

The management response begins with verification of data, followed by an assessment of whether or not a trigger has been reached or exceeded, and the completion of any necessary investigation. Depending on the findings of the investigation, parties responsible for exceedance of a given adaptive management trigger may be required to take mitigative actions.

Alberta Environment and Sustainable Resource Development will provide oversight of the management response, including any management actions, evaluate the effects of implementation, and communicate progress. Figure 8 describes the steps of the management response.

To provide further detail around management responses to long term-planning triggers, two example scenarios are presented in Appendix H. These scenarios have been developed strictly for illustrative purposes and are not based on real or predicted data.

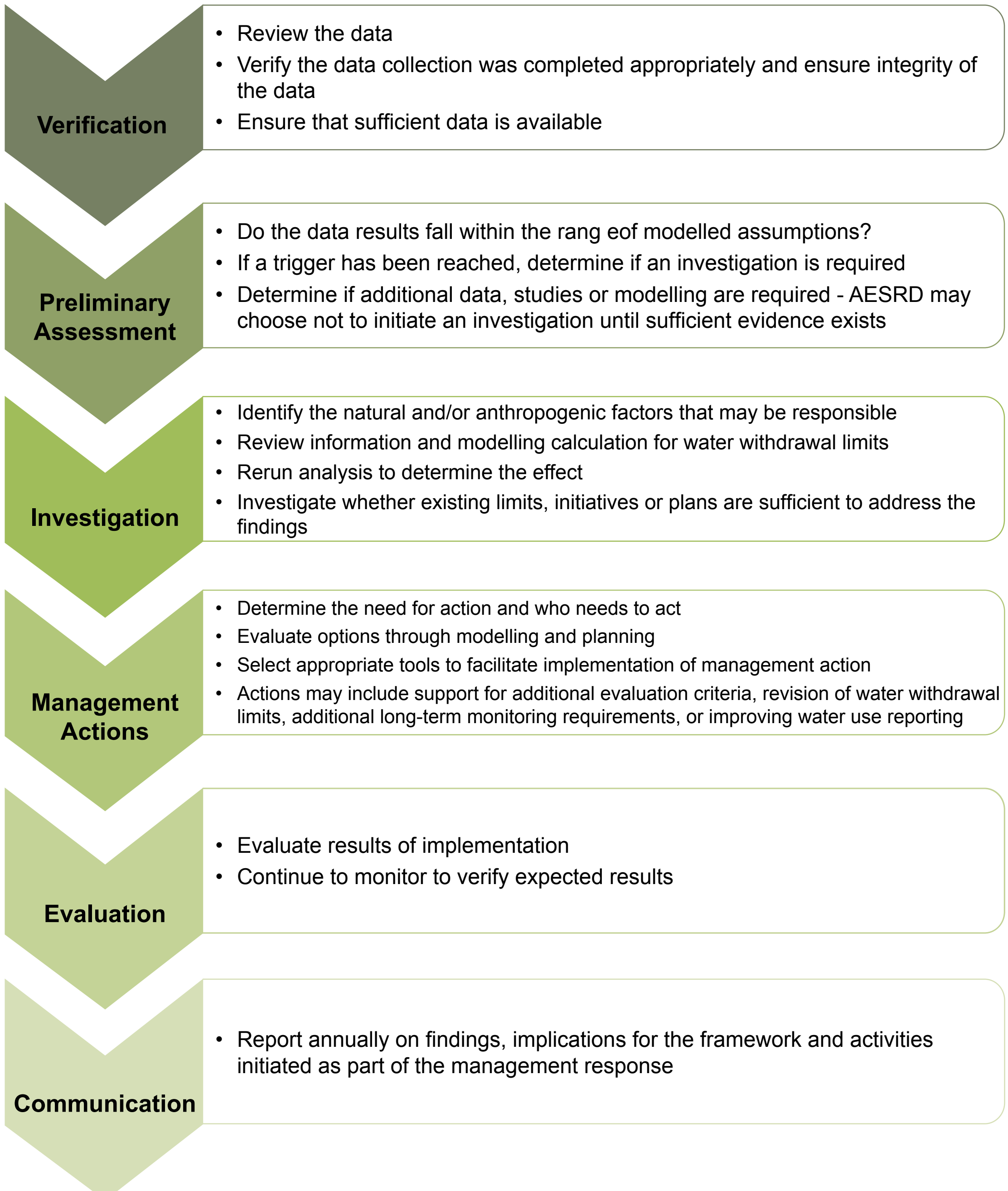


Figure 8.
Management Response for Adaptive Management Triggers.

11.0

Flow, Use, and Ecosystem Status Monitoring

Ongoing monitoring and reporting of river flow and water use will be essential to implementing the provisions of this framework. In addition, further research and monitoring will be required to improve our understanding of the aquatic ecosystem in the lower Athabasca River and, ultimately, the impacts of water withdrawals on the ecosystem.

11.1 Flow and Use Monitoring

To support initiation of the management responses indicated above (Section 10.2), the management system includes evaluation of how close the adaptive management indicators are to their triggers. The following monitoring in the current system must continue, to permit evaluation of indicators included in the Framework:

- flow monitoring at the McMurray station;
- supplemental flow measurements, as needed, when the river is ice-covered;
- monitoring of water withdrawals as required in licences; and
- monitoring of the Aboriginal Navigation Index.

As described in Section 6.1, monitoring of water withdrawals by licensees has undergone recent changes. More frequent reporting is now required on most licences and reports are submitted to a new electronic data collection system (http://esrd.alberta.ca/water/reports-data/water-use-reporting-system/default.aspx). All current oil sands licensees are required to submit daily withdrawal information on a monthly basis.

The Government of Alberta is committed to ensuring that river flow conditions and oil sands sector water withdrawals within the lower Athabasca River downstream of the Grand Rapids are monitored, evaluated, and reported to the public. In support of this framework, Alberta Environment and Sustainable Resource Development intends to enhance the current web pages that report flow estimates and corresponding withdrawals limits, such that they also report on withdrawals. The intention is to advance the data collection systems so that it will be possible to provide daily withdrawal information on a more frequent basis (e.g., weekly or daily).

11.2 Ecosystem Status Monitoring

Additional monitoring and research are required to establish reference conditions and support further enhanced understanding of ecological response relationships. This knowledge will enable the establishment of indicators and triggers and will be used to test the validity of model predictions used to develop the Framework.

Suitable indices will be established to identify biologically significant changes in fish populations and communities. For example, if the maximum allowable water withdrawals under the Framework are taken, modelling predicts that measurable but reversible declines in some fish populations would occur, but that biodiversity would be maintained (Cumulative Environmental Management Association 2010). The prediction should be verified through monitoring. With limited data available on Athabasca River fish populations, further study is necessary to understand the link between flow and ecological responses, such as changes in fish populations or fish health (Alberta Environment and Fisheries and Oceans Canada 2007).

The Framework proposes to use Alberta Environment and Sustainable Resource Development standards and protocols for reporting and tracking of fish information. Fish will be tracked at the population level using the fish sustainability index, and at the community level using the index of native fish integrity. These metrics directly address recommendations from the *2007 Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River* to develop suitable indices of biotic health and sustainability. A review of available methods supports the use of these two indices for biotic health and sustainability.

Fish community health and ecosystem health are influenced by the cumulative effects of natural and human factors and not one single factor, such as water withdrawals. Numerous contributing factors may confound the interpretation of results if only a single cause-effect relationship is assumed (Korman and Walters 2007). Therefore, any long-term monitoring program must recognize all contributing factors (e.g., water quality, climate change, land-use change) that could influence a response variable. In recognition of contributing factors, the Cumulative Environmental Management Association (2011) proposed additional sampling of fish populations that would allow population vital rates (i.e., recruitment or survival) to be related to naturally occurring low-flow events.

As new data are collected and knowledge gaps are addressed, monitoring programs will evolve. New field techniques and analytical tools may also emerge that will affect future monitoring. An effective monitoring program will acknowledge and incorporate new information and technology over time, to ensure that it remains relevant. This monitoring program will provide a scientifically valid assessment of the environmental effects of withdrawals and the effectiveness of the weekly management triggers and withdrawal limits in the Framework, and take into consideration a future Biodiversity Management Framework for the region. Pilot studies to field test the Fish Sustainability Index and the Index of Native Fish Integrity protocols within the lower Athabasca River watershed will provide valuable information and will be evaluated for suitable contribution to this framework. Monitoring in the lower Athabasca River will also be coordinated through the *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring,* to ensure that the best program is put forward without duplicating other monitoring work.

12.0

Evaluation and Communication

Alberta Environment and Sustainable Resource Development will use annual evaluations under this framework, in conjunction with other data sources, to assess if triggers, limits, and associated management response are achieving anticipated results and desired outcomes over time.

In addition, Alberta Environment and Sustainable Resource Development will prepare an annual *Surface Water Quantity Framework for the Lower Athabasca River* report. The Report will summarize the status of flow conditions and provide an account of water use. The Report will also supply an update on ecosystem status monitoring and studies that are being undertaken to fill knowledge gaps.

13.0 Implementation

The weekly management triggers and water withdrawal limits (Table 4) will come into effect at the start of the Early Winter period (October 29) of 2015 and will be implemented by the Alberta Energy Regulator.

Implementation details, including timelines and allocation of resources, will be determined when the management framework is approved.

An implementation plan will be developed, including the following:

- an inventory of tasks that must be done to meet the requirements of the Framework;
- confirmation of roles and responsibilities of government and other parties for implementation of the Framework; and
- an assessment of resources needed to fulfill the tasks and commitments of the Framework, including human resources and data requirements.

Implementation will include ongoing evaluation of the Framework's alignment with other policies and initiatives, to ensure consistency of management intent and process.

In the future, Alberta Environment and Sustainable Resource Development, in cooperation with the greater Athabasca River Basin community, will consider developing an integrated, basin-wide water management plan.

13.1 Roles and Responsibilities

Alberta Environment and Sustainable Resource Development, the Alberta Energy Regulator, Fisheries and Oceans Canada, the Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA), environmental and community associations, and regulated parties (*Water Act* licence holders) all have a number of responsibilities related to managing water withdrawals. These roles and responsibilities are described briefly below. This description should not be regarded as an exhaustive list.

13.2 Alberta Environment and Sustainable Resource Development

Alberta Environment and Sustainable Resource Development is the lead ministry responsible for ensuring that the *Surface Water Quantity Framework for the Lower Athabasca River* is implemented. The engagement of licence holders and stakeholders remains important to the overall management intent. The responsibilities of Alberta Environment and Sustainable Resource Development include:

- decisions regarding what flow data is collected in the Athabasca River and tributaries, in partnership with Water Survey of Canada;
- supplementing winter flow measurements, when deemed necessary;
- communicating flow conditions and corresponding cumulative water withdrawal limits to oil sands water licence holders;
- tracking cumulative water allocations and reporting annually;
- tracking cumulative water use and reporting annually;
- initiating a management response when required, based on the assessment of flow conditions, water use data, aquatic ecosystem monitoring data, or other information related to the management response triggers identified in the Framework;
- assessing management actions implemented through other frameworks or initiatives, to determine impacts on water quantity;
- defining timelines and selecting or recommending management approaches and tools, if required, to manage water quantity; and,
- communicating the implementation status of management responses.

Alberta Environment and Sustainable Resource Development will continue to collaborate with multi-stakeholder organizations, the *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring*, the Alberta Energy Regulator, and the Alberta Environmental Monitoring, Evaluation and Reporting Agency, as well as other appropriate organizations, in the implementation of the Framework. These partnerships will be instrumental in addressing ecological and navigation knowledge gaps.

13.3 Fisheries and Oceans Canada

Alberta Environment and Sustainable Resource Development will continue to work with Fisheries and Oceans Canada to ensure the effective overall implementation and continuous improvement of the *Surface Water Quantity Framework for the Lower Athabasca River*. The Framework will guide regulatory decision making when evaluating the effects of cumulative water withdrawals on fish habitat during oil sands development. The responsibilities of Fisheries and Oceans Canada include:

- Collaborating with Alberta Environment and Sustainable Resource Development on management responses, as required, for the adaptive management triggers (e.g., negotiation of additional evaluation criteria, revision of weekly management triggers and limits, additional long-term monitoring requirements, improved water use reporting);

- Providing science support to the design and implementation of aquatic ecosystem monitoring studies and the evaluation and interpretation of results; and
- Administering regulatory provisions of the federal *Fisheries Act*.

13.4 Regulated Parties and Proponents

Oil sands water licence holders are the primary regulated group affected by the Framework. Roles and responsibilities for industry operators include:

- Mineable oil sands operators – adhering to weekly management triggers and withdrawal limits;
- Providing water use and water storage information to Alberta Environment and Sustainable Resource Development when requested;
- Participating in regional water quantity and aquatic ecosystem monitoring initiatives (e.g., *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring*);
- Modelling and assessing how current and planned operations will influence local and regional water use requirements;
- Participating in the development of the annual industry sharing agreement; and
- Reporting on implementation progress of management actions, as required.

13.5 Alberta Energy Regulator

The Alberta Energy Regulatory (AER) is authorized to make decisions on applications for energy development, monitoring for compliance assurance, decommissioning of developments, and all other aspects of energy resource activities. This authority includes managing water allocations for oil sands operators. As such, the AER will be responsible for ensuring that oil sands operators are adhering to water management requirements specified within their *Water Act* approvals, as derived from the Framework.

13.6 Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA)

The Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA) is the provincial organization established to monitor, evaluate, and report on key air, water, land, and biodiversity indicators to better inform decision making by policy makers, regulators, planners, researchers, communities, industries, and the public.

The mandate of AEMERA is to provide open and transparent access to scientific data and information on the condition of Alberta's environment, including specific indicators, as well as cumulative effects, both provincially and in specific locations. In the context of this framework, AEMERA is responsible for annual review and assessment of water quantity conditions. It will also play a supporting role in the design and execution of management responses.

14.0

Integration

This framework is part of a series of environmental management frameworks developed by Alberta Environment and Sustainable Resource Development for the Government of Alberta's *Lower Athabasca Regional Plan*. As the regional plan is implemented, all of the outcomes and objectives in it, including those for air, surface water, and groundwater, will be considered in planning and decision-making for the region by all provincial government departments and municipal governments. This will help to drive integration across environmental media.

This management framework was developed in consideration of a number of other key initiatives, such as the *Water for Life* action plan, the *Land-use Framework*, the J*oint Canada-Alberta Implementation Plan for Oil Sands Monitoring*, and ongoing transboundary water management negotiations.

Key areas of integration for management of surface water quantity include aquatic biodiversity, surface water quality, and groundwater.

- **Surface Water Quality, Biodiversity, and Water Quantity:** Comprehensive management of the region's surface water resources will require the careful, integrated management of linked ecosystem components: water quality, water quantity and the aquatic environment (species and habitat). In time, the intention is for management of all of these components to be integrated for the Lower Athabasca Region. Continuing work in the region will include the development of a management framework for biodiversity, including biodiversity of aquatic ecosystems. There are challenges to making integration happen. However, development of additional management frameworks and advances in knowledge, understanding and analytical tools will support these efforts moving forward.
- **Surface Water and Groundwater:** A second critical point of integration is between surface water management and groundwater management. Implementation of the *Groundwater Management Framework*, the *Surface Water Quality Management Framework*, and the *Surface Water Quantity Management Framework* will support better understanding of these environmental components and the interaction of impacts on them. Other environmental frameworks will also contribute as they are completed. Integrating monitoring, evaluation and reporting for surface water with groundwater will help to manage the interaction between them.

15.0 Glossary

For the purposes of this document, the following definitions apply.

Allocation

The *Water Act* defines allocation as ”the volume, rate and timing of a diversion of water”. In most cases, however, allocation refers to the annual volume of water that is specified on a *Water Act* licence, which is the maximum amount that may be withdrawn from the source specified.

Aquatic Ecosystem

For the purposes of this framework, “aquatic ecosystem” is synonymous with the definition of “aquatic environment” under the *Water Act*: “the components of the earth related to, living in or located in or on water or the beds or the shores of a water body, including but not limited to: 1. all organic and inorganic matter, and 2. living organisms and their habitat, including fish habitat, and their interacting natural systems”.

Authorization

An authorization under the *Fisheries Act* is a legal document that allows the named proponent to cause a HADD defined in the Authorization according to subsection 35(2) of the *Fisheries Act* (see HADD).

Conditions on Licences

The terms of the licence under the *Water Act* that must be followed. These conditions can include timing restrictions for water withdrawals, instream flow objectives for the source water, and monitoring and reporting requirements.

Connectivity

Applies to the movement of energy, water, organisms and sediment to and within a riverine system through lateral, longitudinal, and vertical pathways, and also through time.

Cubic metres per second

Measure of the volume per time (rate) of streamflow, expressed as m^3/s, $m^3 \cdot s^{-1}$, cms, etc.

Ecosystem Base Flow

Flow at which any human-induced reductions in flow would result in not meeting the defined objective for the aquatic ecosystem.

Ecosystem Health

A healthy aquatic ecosystem is an aquatic environment that sustains its ecological structure, processes, functions, and resilience within its range of natural variability.

Fish Habitat

Defined in the federal *Fisheries Act* as spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes. Refers to aquatic environments that directly or indirectly support fish stocks or fish populations that sustain, or have the potential to sustain, subsistence, commercial or recreational fishing activities.

Geomorphology

The scientific study of patterns and processes that structure the surface of the earth. For rivers, this includes the distribution and movement of substrate (sediment and larger material) that makes up the channel bed and banks.

HADD

Harmful alteration, disruption or destruction (of fish habitat).

Hydrology

The study of the distribution and movement of water quantities within a system. Streamflow is measured (m^3/s) over a time period and the natural flow pattern of a river, within years and between years, can be analyzed and summarized. An understanding of natural flow patterns is required to be able to manage withdrawals and flow alterations and maintain hydrological flow conditions that are appropriate for riverine ecosystems.

Lower Athabasca River

The lower section of the Athabasca River from just downstream of the Grand Rapids (approximately 135 kilometres upstream of Fort McMurray) to the Athabasca River Delta.

Natural Flow / Natural Rate of Flow

Natural flow is the flow in rivers that would have occurred in the absence of any anthropogenic effects, including dams. Natural flow is a calculated value based on the recorded flows, withdrawals, canal diversions and storage structures such as dams. The calculated natural flow is also known as “naturalized flow.”

Reach

A portion of the entire length of a stream.

Riverine

Of or relating to systems that are influenced by a river.

Trigger

Triggers are established as early warning signals that enable proactive management responses. If specified conditions exceed a trigger at a defined monitoring location, a management response is initiated.

Water Act

A provincial government act intended to support and promote the conservation and management of water, including the wise allocation and use of water.

Water Approval

Under Alberta's *Water Act*, an approval provides authority for constructing works or for undertaking an activity within a waterbody. The approval includes conditions under which the activity can take place.

Water Licence

A water licence provides the authority for diverting and using surface water or groundwater. The licence identifies the water source, the location of the diversion site, an amount of water to be diverted and used from the source, the priority of the "water right" established by the licence, and the condition under which the diversion and use must take place.

Withdrawal

Water taken from a stream for off-stream use.

16.0

References

Alberta Environment. 1999. *Regional Sustainable Development Strategy for the Athabasca Oil Sands Area*. Pub. No. I/754, Edmonton, Alberta.

Alberta Environment and Fisheries and Oceans Canada (AENV DFO). 2007. *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River*. February 2007.

Candler, C., R. Olsen and Steven DeRoy. 2010. *As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change*. Prepared for and by the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation by the Firelight Group Research Cooperative.

Coombs, M. and L. MacPherson. 2013. *A generic rule set for applying the Alberta fish sustainability index, Second Edition (Draft)*. Alberta Environment and Sustainable Resource Development, Fish and Wildlife Division.

Cumulative Environmental Management Association (CEMA). 2010. *Phase 2 Framework Committee Report*. Prepared for: Cumulative Environmental Management Association Surface Water Working Group. Prepared by: D. Olsen and G. Long, Compass Resource Management, and T. Hatfield, Solander Ecological Research. January 2010.

Cumulative Environmental Management Association (CEMA). 2011. *Monitoring Recommendations for the Phase 2 Water Management System. Appendix B: fish population status and trend monitoring*. Prepared by the Monitoring Technical Task Group for the Cumulative Environmental Management Association Surface Water Working Group.

Fisheries and Oceans Canada (DFO). 2010. *Science Evaluation of Instream Flow Needs (IFN) for the Lower Athabasca River*. Canadian Science Advisory Secretariat Science Advisory Report 2010/055.

Government of Alberta. 2009. *Responsible Actions: A Plan for Alberta's Oil Sands. Edmonton*, AB: Treasury Board.

Government of Alberta. 2003. *Water for Life: Alberta's Strategy for Sustainability*. Pub. No. I/955. Edmonton, AB.

Government of Alberta. 2008. *Water for Life: A Renewal*. Edmonton, AB.

Government of Alberta. 2007. *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River* [Online]. Edmonton, AB. Available:. http://esrd.alberta.ca/water/programs-and-services/river-management-frameworks/documents/Athabasca_RWMF_Technical.pdf [Accessed February 5 2015].

Hurst, H.E., (1951), Long-term storage capacity of reservoirs, Trans. *Am. Soc. Civil Eng*. 116: 770–799.

Korman, J. and C. Walters. 2007. Report on the Lower Athabasca River Instream Flow Needs Monitoring Workshop. *Prepared for the Cumulative Environmental Management Association* by Econometric Research Inc.

Koscielny-Bunde, E., J.W. Kantelhardt, P. Braun, A. Bunde and S. Havlin. 2006. Long-term persistence and multifractality of river runoff records: Detrended fluctuation studies, *Journal of Hydrology*, 322, 120-137.

Stevens, C.E., T. Council and M.G. Sullivan. 2010. Influences of human stressors on fish-based metrics for assessing river condition in Central Alberta. *Water Qual. Res. J. Can*. 45: 1 12.

17.0

Appendices

Appendix A: Additional Information about Athabasca River Flows

Athabasca River flow information is based on data collected at approximately 60 Water Survey of Canada flow monitoring stations throughout the Athabasca River basin. Five stations are located on the mainstem of the river, at Jasper, Hinton, Windfall, Athabasca and Fort McMurray.

The Athabasca River basin includes a number of regions, each with their own hydrologic features (Figure 9). The hydrologic features are a combination of land characteristics and climate characteristics (e.g. temperature, precipitation). These regions contribute varying proportions to the river's flow over the course of the year, as shown in Figure 10.

Flows in the Athabasca River reach their seasonal minimum in the late winter (February and March) and then increase rapidly in April with the onset of spring runoff in the central plains and the foothills. Flows continue to rise into May when mountain snow melt adds even more flow. By June, mountain snow melt has peaked and runoff begins to come predominantly from summer rains across the basin. Glacial icemelt peaks with summer temperature in July and August. Flows continue to decline through late summer and into autumn. By early winter, about 40 per cent of the flow in the Athabasca River comes from Lesser Slave Lake and the Canadian Shield lakes in the Saskatchewan portion of the Clearwater River. The Athabasca River has historically been covered in ice from about mid-November to mid-April.

The lower portion of the Athabasca River basin begins at Fort McMurray, where the Clearwater River joins with the Athabasca River. At this point, about 88 per cent of the river's flow at Lake Athabasca has already been contributed. The remaining 12 per cent comes from the lower tributaries, most notably the Firebag, Richardson, MacKay, Ells, Muskeg and Steepbank Rivers.

Glaciers in the Athabasca River basin cover an area of 430 km^2. These glaciers have receded steadily over the 20th Century. Over this time, the glaciers in the Canadian Rockies have melted at an average rate of approximately 0.2 to 0.5 m/year (Demuth & Keller, 2006; Debeer & Sharp, 2007). The higher figure of 0.5 m/year translates to a total average annual volume of 215 million m^3, most of which would melt during the peak summer season (July and August).

The "glacier melt" component of Figure 8 represents the contribution from the shrinking glaciers, reaching 25 m^3/s in July and August. The flows at Fort McMurray have a small relative contribution from glaciers (Figure 10).

Literature Cited:

Debeer, C, and Sharp, M. 2007. Recent changes in glacier area and volume within the southern Canadian Cordillera. *Annals of Glaciology.* 46, p. 215-221

Demuth, M.N. and R. Keller. 2006. An assessment of the mass balance of Peyto Glacier (1966–1995) and its relation to recent and past century climatic variability. In: *Peyto Glacier: One Century of Science*. M.N. Demuth, D.S. Munro and G.J. Young (eds.). National Hydrology Research Institute Science Report 8: 83-132.

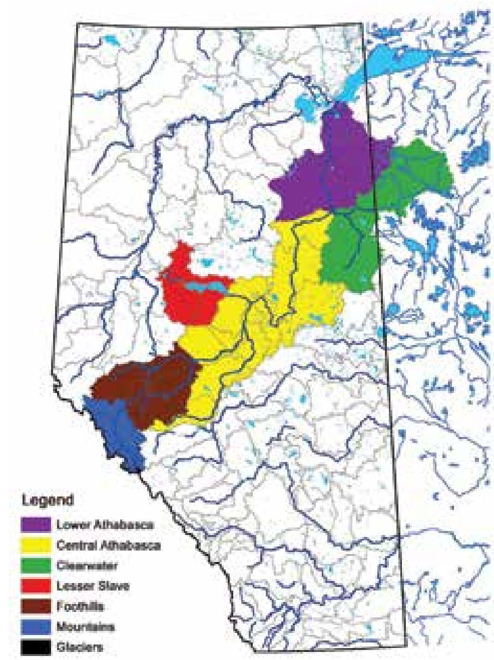


Figure 9.
The Athabasca River Basin

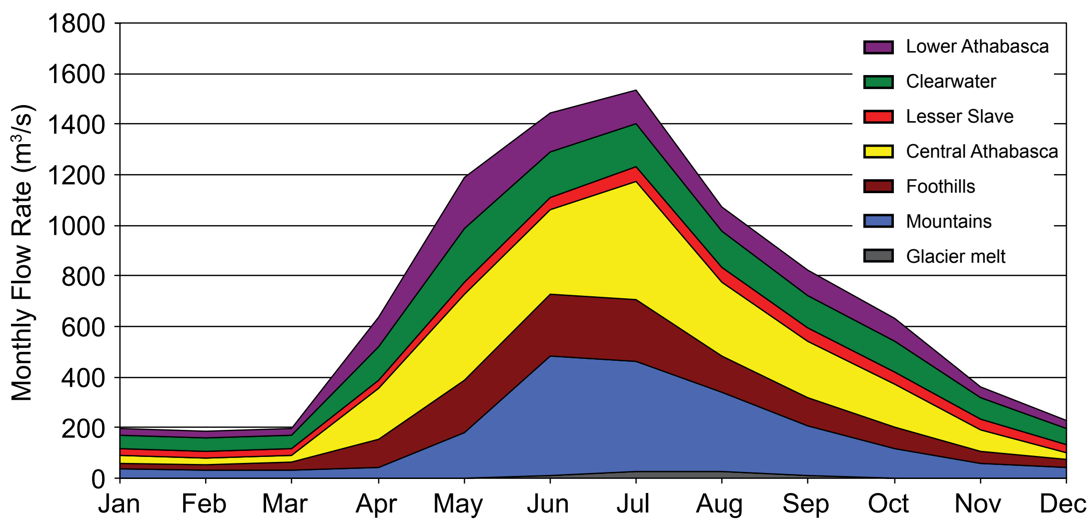


Figure 10.
Average Flow Contributions from Different Sub-regions in the Athabasca River Basin (1970 to 2010).

Appendix B: History of Framework Development

The *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River* was implemented by Alberta Environment and Fisheries and Oceans Canada in 2007; it is recognized as Phase 1 of a two-phased approach. The 2007 *Water Management Framework* provided short-term guidance for the management of cumulative water withdrawals from the lower Athabasca River and included a set of weekly flow triggers and withdrawal limits. The document is available at: http://environment.alberta.ca/documents/Athabasca_RWMF_Technical.pdf

Since 2007, the provincial and federal governments have continued working with stakeholders and Aboriginal communities to clarify issues and discuss interests, to conduct and review detailed technical assessments, and to develop and evaluate alternatives for the next phase of the Water Management Framework. Collaboration with the Cumulative Environmental Management Association, the Phase 2 Framework Committee, and Aboriginal Communities has been instrumental in developing Phase 2 of the *Water Management Framework*, now called the *Surface Water Quantity Management Framework for the Lower Athabasca River*. The Framework will update and replace the 2007 *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River. Additional information on First Nations use of the Athabasca River*, with particular emphasis on navigation, was derived from *As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change* (Candler *et al*., 2010).

Recommendations of the Phase 2 Framework Committee were reviewed through the Canadian Science Advisory Secretariat process (Fisheries and Oceans Canada, 2010), a peer review process that is designed to be objective, open, and transparent. The review process included the *National Science Advisory Workshop on Lower Athabasca River In stream Flow Needs*, which was held in Calgary from May 31 – June 4, 2010, and attended by participants from the provincial and federal governments, private industry, international experts, First Nations and Métis organizations, non-government organizations, and academia. Workshop participants examined what would constitute “serious and irreversible harm” to the lower Athabasca River ecosystem and whether the recommendations would effectively protect the aquatic ecosystem. Feedback from the workshop was incorporated into the Science Advisory Report presented to Fisheries and Oceans Canada and the Government of Alberta (www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2010/2010_055-eng.html).

While the ‘Phase 2’ water quantity management recommendations were being developed, the Government of Alberta was leading consultations with Albertans about land-use planning, including key aspects of advice provided by the Regional Advisory Council for the Lower Athabasca Region. The 2010 consultations (*Advice to the Government of Alberta Regarding a Vision for the Lower Athabasca Region*) provided opportunities for stakeholders, First Nations, and the public to offer input on the environmental management frameworks for the Lower Athabasca Region. A number of stakeholders and Aboriginal communities expressed a strong interest in surface water quantity management during the consultations.

The *Surface Water Quantity Framework for the Lower Athabasca River* incorporates recommendations from the ‘Phase 2’ water quantity management process, as well as input from the regional planning process. It includes consideration of input received from scientific advisors, Aboriginal organizations, government and non-governmental organizations, academia, industry, and the Alberta public. In addition, the Framework is cognizant of the need to consider the continued exercise of traditional activities by First Nations and Métis peoples. In establishing limits and triggers around river navigability, the Framework has considered information provided by the Athabasca Chipewyan and Mikisew Cree First Nations in *As Long as the Rivers Flow: Athabasca River Use, Knowledge and Change* (Candler *et al.,* 2010).

Stakeholder, Aboriginal, and Métis engagement sessions on a near-final draft of the Framework were begun in late 2013 and concluded in late August 2014. Consultation included face-to-face sessions in Fort McMurray, Edmonton, and Calgary, as well as receipt of written submissions.

All technical and editorial input received through consultative processes was thoroughly considered during the development of this framework.

Appendix C: Water Licences Under Alberta's *Water Act*

Municipalities, private companies, individuals and others can apply for a licence to divert water. The *Water Act* also provides a statutory right to water use for riparian household purposes that meet certain criteria, and gives this use top priority over all other water uses. The current water allocation management system – prior allocation or 'first in time, first in right' – provides some certainty for users that invested in water licences in the past. During times of shortage, senior water licence holders are entitled to their allocation of water before more junior water licence holders, regardless of purpose, although there are provisions in the *Water Act* that would allow the Minister of Environment and Sustainable Resource Development to address issues in an emergency.

Before a water licence is issued, Alberta Environment and Sustainable Resource Development considers a number of factors such as the volume, rate and timing of the water to be diverted, the natural water supply, the needs of the environment, and existing licences and apportionment agreements. The resulting licence, if issued, identifies the water source, the location of the withdrawal site, the volume, rate and timing of the withdrawal, and additional conditions that must be adhered to. The anticipated volumes of water expected to be returned to the river, or return flows, may also be included in the licence.

The focus of a *Water Act* licence is the annual allocation of water that can be diverted for use. This allocation is subject to requirements identified in the licence terms and conditions associated with its use. A common condition in licences associated with rivers is a flow rate, or seasonal flow rates, in the river below which the licence holder may not exercise the withdrawal of water. This is often called a "minimum flow" or "instream objective".

Appendix D: Fish Species in the Athabasca River

Common Name	Scientific Name	Common Name	Scientific Name
Arctic Grayling	*Thymallus arcticus*	Longnose Sucker	*Catostomus catostomus*
Brassy Minnow	*Hybognathus hankinsoni*	Mountain Whitefish	*Prosopium williamsoni*
Brook Stickleback	*Culaea inconstans*	Ninespine Stickleback	*Pungitius pungitius*
Bull Trout	*Salvelinus confluentus*	Northern Pike	*Esox lucius*
Burbot	*Lota lota*	Northern Redbelly Dace	*Phoxinus eos*
Cisco	*Coregonus artedii*	Pearl Dace	*Margariscus margarita*
Emerald Shiner	*Notropis atherinoides*	River Shiner	*Notropis hudsonius*
Fathead Minnow	*Pimephales promelas*	Rainbow Trout	*Oncorhynchus mykiss*
Flathead Chub	*Platygobio gracilis*	Slimy Sculpin	*Cottus cognatus*
Finescale Dace	*Phoxinus neogaeus*	Spoonhead Sculpin	*Cottus ricei*
Goldeye	*Hiodon alosoides*	Spottail Shiner	*Notropis hudsonius*
Iowa Darter	*Etheostoma exile*	Trout-perch	*Percopsis omiscomaycus*
Lake Chub	*Couesius plumbeus*	Walleye	*Stizostedion vitreum*
Lake Trout	*Salvelinus namaycush*	White Sucker	*Catostomus commersoni*
Lake Whitefish	*Coregonus clupeaformis*	Yellow Perch	*Perca flavescens*
Longnose Dace	*Rhinichthys cataractae*		

Appendix E: Environmental Assessment of Climate Change and Proposed Water Management on the Lower Athabasca River

Background

The Phase 2 Framework Committee (P2FC) used four primary evaluation criteria to assess ecosystem health when comparing various water management alternatives in their structured-decision making process and to make their final recommendation (Ohlson *et al*., 2010). The four evaluation criteria were fish habitat, mesohabitat, effective lake whitefish spawning habitat and walleye recruitment. The evaluation criteria used as input: a) weekly hydrology for a reference condition (taken as historical hydrology from 1958 – 2007); and, b) reference condition flows adjusted for a water management alternative of interest. Impacts were assessed by comparing various metrics of habitat or population structure for a water management alternative to the reference condition.

In addition to assessing water management alternatives, the P2FC also used the four evaluation criteria to assess cumulative impacts of two climate change scenarios under their recommended *Water Management Framework*[3] (Ohlson *et al*., 2010). However, shortly after release of the January 2010 report (Ohlson *et al*., 2010), an error was found in one of the climate change scenarios that mistakenly reversed projected summer and winter flow reductions (DFO 2010; Lebel *et al*., 2010).

Further analysis revealed that another climate change scenario, the Trend 1 scenario of a reduction in flows of 10.8 per cent in winter and 12.1 per cent in the open-water season by 2039 should actually have been a scenario of a reduction of 10.8 per cent in winter but only 10.9 (not 12.1) per cent in the open-water season. However, the Trend 1 climate change scenario using 12.1 per cent in the open-water season was maintained as input into calculation of the Adaptive Management Triggers described in Section 9.3 of the framework. This Trend 1 scenario, with the erroneous 12.1 per cent value for the open water season was not corrected as it: a) was the scenario evaluated by the P2FC in its assessment of water management alternatives, and b) is slightly more precautionary, relative to the impacts of climate change, than the corrected scenario of 10.9 per cent.

The ecosystem health evaluation criteria were re-analyzed following correction of the climate change scenarios captured in Lebel *et al*., (2010) but with the Trend 1 scenario remaining as used by the P2FC. Results of the re-analyses using the Lebel *et al*., (2010) correction were never formally documented. The following appendix is intended to capture this information.

---

[3] The recommended water management framework by the P2FC was termed 'Option H' in their report (Ohlson et al., 2010) and is the recommendation adopted in this Surface Water Quantity Management Framework.

At the time re-analyses of corrected climate change scenarios were completed, analyses of several more extreme climate change scenarios were also undertaken by Alberta Environment and Sustainable Resource Development. This appendix also captures these additional climate change alternatives.

Climate Change Scenarios

The P2FC evaluated two climate change scenarios based on the second generation Canadian coupled global climate model and extrapolation of a 50-year trend analysis (Ohlson *et al*., 2010; Lebel *et al*., 2010; Table 7). Following work of the P2FC, other more extreme climate scenarios were identified for the lower Athabasca River. While several of these additional climate alternatives were analyzed by ESRD, only two that substantially extend the impact range beyond that already explored by the P2FC are included here.

Table 7.
Climate change scenarios evaluated for comparative environmental effects, with and without the *Surface Water Quantity Management Framework for the Lower Athabasca River* (Alternative H in the Table).

Alternative Name	Description
H	Alternative H recommendation from P2FC and the Surface Water Quantity Management Framework of this document.
T1	Fifty-year climate scenario Trend1 from P2FC (Lebel *et al*. 2010). Uses summer reduction = 12.1% and winter = 10.8%.
HT1	Alternative H (Surface Water Quantity Management Framework) added to Trend1.
G1	Correct climate scenario GCM1 from P2FC (Lebel *et al*. 2010). Uses summer reduction = 3.5% and winter = 12.2%. Ohlson *et al*. (2010) mistakenly used a summer reduction = 12.2% and winter = 3.5%.
HG1	Alternative H (Surface Water Quantity Management Framework) added to the correct GCM1 prediction.
69M	Climate scenario 2040 - 2069 median. Uses summer reduction = 10.4% and winter = 30.9%.
H69M	Alternative H (Surface Water Quantity Management Framework) added to 69M.
69X	Climate scenario 2040 - 2069 extreme. Uses summer reduction = 28.3% and winter = 54.1%.
H69X	Alternative H added to 69X.

Assessing Environmental Impact

Following rationale of the P2FC, climate change was considered an impact to the aquatic ecosystem and evaluated using four evaluation criteria: fish habitat, mesohabitat, effective lake whitefish spawning habitat and walleye recruitment (Ohlson *et al*., 2010). A very brief discussion of the evaluation criteria follows; more detail can be obtained from their corresponding reference. Environmental effects are only reported for the winter season as impacts of water management to the aquatic ecosystem were generally greater during winter. However, for relevant evaluation criteria, impacts were always calculated throughout the entire year.

- **Mesohabitat** (Paul and Locke 2009a) – Aquatic habitat was divided into 27 different categories based on three classifications for each of depth, velocity and substrate. The categories were intended to capture a natural portfolio of riverine habitat types necessary to meet needs of all biological communities (e.g., algae, invertebrates and fish). Mean change (i.e., loss or gain) in each mesohabitat type was calculated for the driest 20 per cent of years. Relative change in the most sensitive habitat type ≥10 per cent was expected to result in detectable changes to the biological community; if the change was ≥30 per cent, changes may be potentially irreversible and a biodiversity threshold was considered to have been crossed.
- **Fish Habitat** (Paul and Locke 2009b) – Four fish species and two different life-history stages were examined for losses in their habitat relative to reference hydrologic conditions. Mean losses were calculated for the driest 20 per cent of years as it was expected habitat would be most limiting under these conditions. Any loss of habitat (relative to the reference) for the most sensitive species and life stage during these low-flow conditions was expected to result in a detectable decline in some fish populations. If the loss in habitat was ≥10 per cent, then population declines may potentially be irreversible and a biodiversity threshold was considered to have been crossed.
- **Effective Lake Whitefish Spawning Habitat** (Paul 2009a) – Water withdrawals may influence the quantity and quality of lake whitefish effective spawning habitat by: a) reducing quantity and quality of habitat for fall spawning fishes; b) causing selection of alternate lower quality spawning sites; and, c) affecting incubation and hatching of eggs and embryos through the winter. Mean relative loss in effective spawning habitat ≥10 per cent was expected to result in detectable population-level declines; a loss ≥30 per cent may potentially be irreversible and a biodiversity threshold was considered to have been crossed.
- **Walleye Recruitment** (Paul 2009b) – An empirical relationship was developed that correlated recruitment of walleye in the delta to winter flow in the Athabasca River, with reduced recruitment in low flow winters. Using a simple population model, walleye population viability was assessed using winter-flow variability as a stochastic driver for population recruitment. If the probability of dropping below an extinction threshold within 100 years was ≥1 per cent, population viability was considered to be at increased risk; if the probability was ≥10 per cent, the population was considered to be threatened.

Results and Discussion

Singular Impacts (Climate Change or Water Management Alone)

The *Surface Water Quantity Framework for the Lower Athabasca River* by itself is predicted to result in detectable but reversible changes to the aquatic ecosystem of the lower Athabasca River (Figure 11). The detectable but reversible impacts are present in three (fish habitat, mesohabitat and effective lake whitefish spawning habitat) of the four evaluation criteria. The two climate change alternatives evaluated by the P2FC (G1 and T1; Table 7) also produced detectable but reversible changes for the same three evaluation criteria. All three of these alternatives (H, G1, and T1) resulted in no effect on walleye recruitment and population viability.

In contrast, the two more extreme climate change scenarios (69M and 69X) resulted in predicted impacts to all four evaluation criteria that would be irreversible with expected loss in biodiversity (Figure 11). This is perhaps most evident for walleye population viability that has a predicted 100 per cent extinction probability within 100 years for these two climate change scenarios.

Cumulative Effects (Climate Change and Water Management)

The effects of climate change scenarios T1 and G1 combined with the *Surface Water Quantity Framework for the Lower Athabasca River* tended to be additive and predictable for each of the evaluation criteria (Figure 11). Furthermore, impacts for these two climate scenarios combined with the Framework were very similar and within the detectable but reversible threshold regions for all criteria except lake whitefish spawning. This suggests the mistaken values for alternative G1 originally used by the P2FC for their evaluation did not likely result in a different decision being made by the group; or in other words, scenarios T1 and HT1 produce similar results to the correct scenarios for G1 and HG1.

The effect, however, of scenarios G1 and HG1 on effective lake whitefish spawning habitat is quite different from T1 and HT1 (Figure 11). The predicted loss in effective spawning habitat (4 per cent and 14 per cent, respectively) using incorrect values for G1 and HG1 as evaluated by the P2FC (Ohlson *et al*., 2010) is substantially different from the analyses presented here (21 per cent and 31 per cent, respectively). This occurs because effective spawning habitat is maximised when flows in the fall and winter tend to be equalized (i.e., fewer eggs are lost from desiccation if water levels through the winter are similar to the fall). Applying (incorrectly) a summer decrease of 12.2 per cent and a winter decrease of only 3.5 per cent would tend to make fall and winter flows more similar; thereby, underestimating potential impacts of water management on effective spawning habitat. Applying the correct G1 climate change scenarios to the Framework resulted in the evaluation criteria just crossing the irreversible/biodiversity threshold. Whether this corrected result would have altered the P2FC's decision is unknown.

Cumulative effects of the Framework combined with the two more extreme climate scenarios (69M and 69X) are relatively small, compared to the substantial individual effects of these climate change scenarios alone (Figure 11).

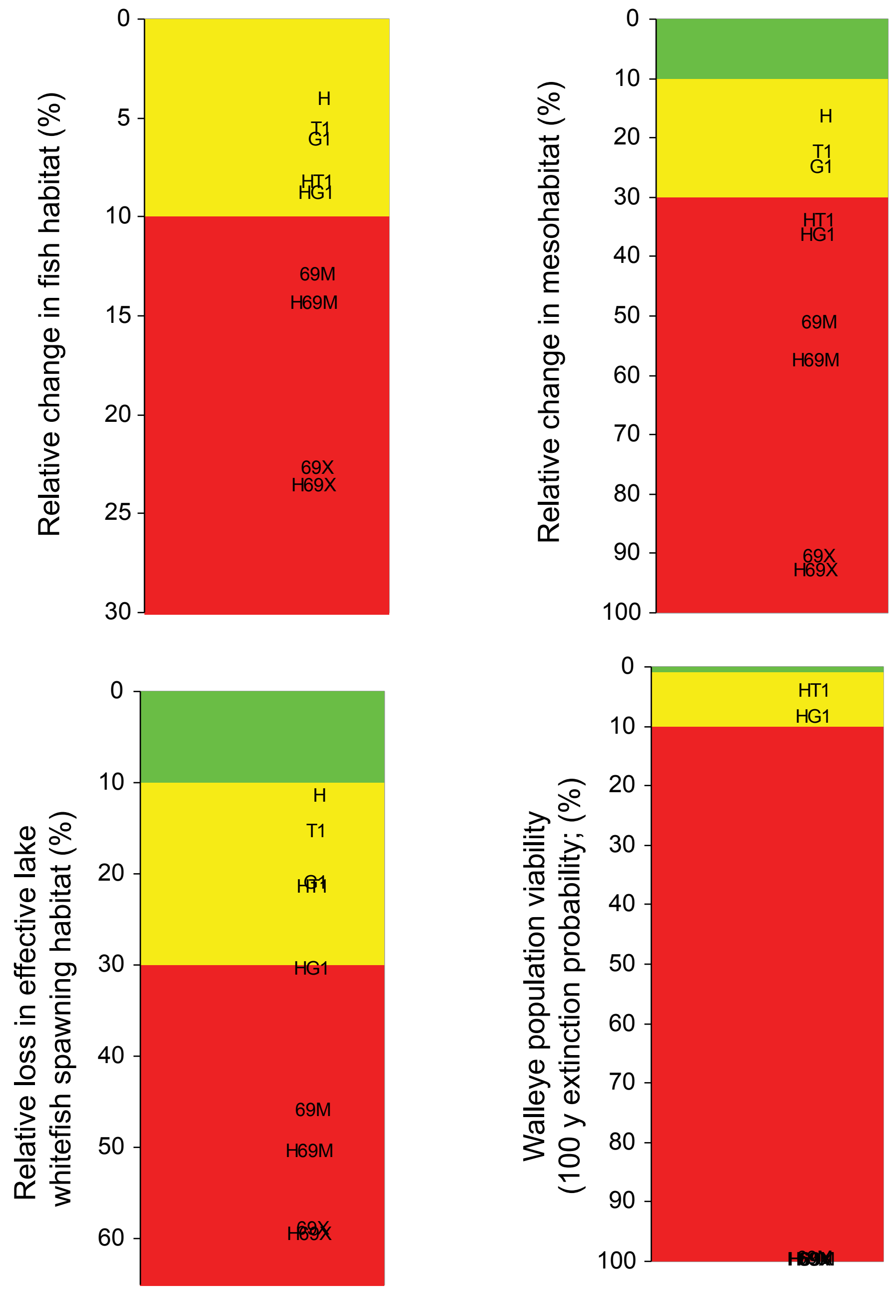


Figure 11.
Response of four environmental evaluation criteria to climate change scenarios (Table 6) with and without full build-out of the Framework (indicated by the prefix ‘H’). Response of each evaluation criteria to the Surface Water Quantity Framework (H) by itself is also shown. Green regions are predicted undetectable changes; yellow regions are detectable but reversible changes; and red regions are irreversible changes and indicate a biodiversity threshold.

Literature Cited

Fisheries and Oceans Canada (DFO). (2010) *Science Evaluation of instream flow needs (IFN) for the Lower Athabasca River*, Fisheries and Oceans Canada/Canadian Science Advisory Secretariat, Science Advisory Report 2010/055.

Lebel, M., Kerkhoven, E., Bothe, R., Hornung, J. and Ohlson, D. (2010) *Climate Change Sensitivity Analysis (revised August 2010)*, Report Prepared for the Phase 2 Framework Committee.

Ohlson, D., Long, G. and Hatfield, T. (2010) *Phase 2 Framework Committee* Report, Prepared by Compass Resource Management and Solander Ecological Research for the Phase 2 Framework Committee.

Paul, A.J. (2009a) *Evaluation Criteria for Flow Alterations in the Lower Athabasca River - Effective Spawning Habitat for Lake Whitefish*, Prepared by Fish and Wildlife Division, Alberta Sustainable Resource Development for the Instream Flow Needs Technical Task Group, Surface Water Working Group, CEMA.

Paul, A.J. (2009b) *Evaluation criteria for flow alterations in the lower Athabasca River - walleye recruitment*, Prepared by Fish and Wildlife Division, Alberta Sustainable Resource Development for the Instream Flow Needs Technical Task Group, Surface Water Working Group, CEMA.

Paul, A.J. and Locke, A. (2009a) *Evaluation criteria for flow alterations in the lower Athabasca River - abundance and diversity of mesohabitat*, Prepared by Fish and Wildlife Division, Alberta Sustainable Resource Development for the Instream Flow Needs Technical Task Group, Surface Water Working Group, CEMA.

Paul, A.J. and Locke, A. (2009b) *Evaluation criteria for flow alterations in the lower Athabasca River - fish habitat*, Prepared by Fish and Wildlife Division, Alberta Sustainable Resource Development for the Instream Flow Needs Technical Task Group, Surface Water Working Group, CEMA.

Appendix F: Clarifying the response to the Knowledge Gaps and Adaptive Management and Monitoring Recommendations from P2FC and CEMA

At the end of the P2FC process (December, 2009), various knowledge gaps were still outstanding and could not be filled due to limited data. Participants agreed to move forward with recommendations to the regulators on the understanding that these knowledge gaps would be filled in a reasonable time frame to support the framework. Subsequent to that, CEMA's Monitoring Technical Task Group (MTTG; this team is now known as the Surface Water Technical Group; SWTG) reviewed these outstanding knowledge gaps in addition to a variety of other sources (Candler *et al*., 2010; CEMA, 2010; DFO, 2010; ERCB/CEAA, 2011[4]; Franzin, 2009; Hood *et al.,* 2009; Korman & Walters, 2007; Ohlson *et al.,* 2010; PADEMP, 2010; Public Works and Government Services Canada, 2010) and other monitoring components required to support the framework. In 2011, the MTTG produced the report "Monitoring Recommendations for the Phase 2 Water Management System, September 27, 2011". The recommendations included long-term status and trend monitoring and a research programme to fill knowledge gaps covering ecological, hydrological and navigational topics (CEMA, 2011).

The *Surface Water Quantity Framework for the Lower Athabasca River* acknowledges these recommendations from the P2FC and CEMA, which read as follows:

Status and Trend Monitoring

- Fish population status and trends
- Gauging and reporting of water withdrawals
- Installation of a gauge near Firebag River confluence with winter capability
- Improve accuracy and timeliness of winter flow monitoring at Fort McMurray
- Hydroclimatic trend analyses and modelling

Knowledge Gaps

- Validation of the walleye evaluation criteria
- Beaver and muskrat in the delta
- Riparian areas in the delta
- Winter ecology in the delta – hydraulic modelling, mesohabitat, dissolved oxygen
- Navigation in mainstem and delta

[4] Note that draft recommendations of the Joint Review Panel were reviewed in 2010 during development of the monitoring recommendations.

- Dissolved oxygen in segments 2-5
- Access to tributaries
- Perched basins in the delta
- Connectivity of Richardson Lake during the open water season

The current status of the long-term monitoring items is as follows:

Status and Trend Monitoring (Long-term) Item	Status
Fish population status and trends	• Acknowledged in Framework Sections 9.1, 9.3.6, 11.2, 12.0. The intent is to fulfill the fish population monitoring recommendation in collaboration with the Biodiversity Management Framework and report on indicators such as the Index of Native Fish Integrity and the Fish Sustainability Index.
Gauging and reporting of water withdrawals	• Acknowledged in Framework Section 6.1, 11.1, 13.4.
Installation of a gauge near Firebag River confluence with winter capability	• This has already been implemented as JOSM station S46 (Athabasca River upstream of Embarras)
Improve accuracy and timeliness of winter flow monitoring at Fort McMurray	• Currently, flows are monitored on a regular basis and under-ice winter flows measured based on the current flow conditions (near a trigger). There are safety and technology limitations during freeze-up and break-up. As new technologies become available, they will be reviewed to determine suitability for this application.
Hydroclimatic trend analyses and modelling	• The intent of this is captured in Section 9.3.2 and the long-term climate change triggers and limits.

Knowledge gaps are acknowledged in the Framework in Sections 9.1, 9.3.6, and 12.0. The intent of the Framework is to fill these knowledge gaps in a reasonable time frame to support future development and revisions of the Framework. This is ongoing work, in collaboration with regulators and other regional agencies.

Knowledge Gap	Status
Validation of the walleye evaluation criteria	• Work completed, SWTG advises it is not expected to be a concern for framework. • Recommendation to GOA • Could be used as long-term monitoring tool
Riparian areas and aquatic mammals in the delta	• Field work completed, report submitted • Further field work planned for 2015
Winter ecology in the delta	• Mesohabitat component complete; no concerns for Framework • Recommendation to GOA • Work ongoing on hydrology, hydraulics and dissolved oxygen
Dissolved oxygen in segments 2-5	• Work ongoing within CEMA (by SWTG).
Access to tributaries	• Remote sensing methodology tested • Results inconclusive, further work required • Work planned for 2015
Perched basins in the delta	• Work planned for 2015
Connectivity of Richardson Lake during the open water season	• Work planned for 2015
Navigation in mainstem and delta	• Work in the mainstem initiated by Transport Canada (June 2014) • Work in the Delta planned for 2015 • Referenced in 9.3.7 • Preliminary Adaptive Management indicator and trigger developed, based on Candler *et al*. (2010), see 9.1, 9.3, 9.3.7

Literature Cited

Candler, C. and R. Ohlson, S. DeRoy, and the Firelight Group Research Cooperative, with the Athabasca Chipewyan First Nation. 2010. *As Long As The Rivers Flow: Athabasca River Use, Knowledge and Change*, ACFN Community Report August 16, 2010.

Cumulative Environmental Management Association (CEMA). 2010. *Summary of community workshops for Phase 2 monitoring program*. Prepared by Melanie Dubois, November 30, 2010. CEMA, Fort McMurray, Alberta.

Cumulative Environmental Management Association (CEMA). 2011. *Monitoring Recommendations for the Phase 2 Water Management System*. Prepared by the Monitoring Technical Task Group for the Cumulative Environmental Management Association Surface Water Working Group.

DFO. 2010. *Science evaluation of instream flow needs (IFN) for the lower Athabasca River*. DFO Canadian Science Advisory Secretariat, Science Advisory Report 2010/055.

ERCB/CEAA 2011 *Report of the Joint Review Panel established by the federal Minister of the Environment and the Energy Resources Conservation Board*. Decision 2011-005: Total E&P Joslyn Ltd., Application for the Joslyn North Mine Project.

Franzin, W. G. 2009. *Estimating effects of water withdrawals from the Lower Athabasca River: IFNTTG Final Report* Prepared for the Cumulative Environmental Management Association Surface, Water Working Group by Laughing Water Arts & Science, Inc.

Hood, G., C. Bromley, and N. Kur. 2009. *A review of existing models and potential effects of water withdrawals on semi-aquatic mammals in the lower Athabasca River*. Report for Cumulative Environmental Management Association.

Korman, J. and C. Walters. 2007. *Report on the Lower Athabasca River Instream Flow Needs Monitoring Workshop*. Calgary, Alberta, March 27-28, 2007. Prepared by Ecometric Research Inc. for the Instream Flow Needs Technical Task Group, Cumulative Environmental Management Association. 45pp.

Ohlson, D., Long, G. and Hatfield, T. (2010) *Phase 2 Framework Committee Report*, Prepared by Compass Resource Management and Solander Ecological Research for the Phase 2 Framework Committee.

Peace Athabasca Delta Environmental Monitoring Program 2010. *A Traditional Knowledge Based Assessment of the Ecosystem Health, Human Health and Community Health of the Peace-Athabasca Delta*. Project Number: 09-2877. Report submitted to Parks Canada prepared by Dillon Consulting Limited.

Public Works and Government Services Canada 2010. *Synthesis of Ecological Information Related to the Peace-Athabasca Delta*. Project Number: 60144637. Report prepared by AECOM Environment.

Appendix G: Development of the Aboriginal Navigation Index and Preliminary Trigger

A key part of the modelling work used to support the P2FC recommendation was hydraulic modelling of four reaches between Fort McMurray and the Athabasca Delta. Together, these reaches account for 30 km of this 213 km river run. These reaches were selected to be representative of river conditions, particularly fish habitat, of the full length of the river. However, they were not selected based on known critical river navigation points. Nevertheless, two of these reaches (Reaches 3 and 4) include sand bars that are identified in Map 2 (Page 6) of *As Long as the Rivers Flow: Athabasca River Use, Knowledge and Change* (Candler *et al*., 2010) as "Navigational Incidents and Hazards". For all four reaches, the hydraulic model output was analyzed to identify critical navigation points. The flow-depth relationships of these points were compared to identify the location that was most likely to control navigation. The most critical point was found to be in Reach 3 (Figure 12), near a sand bar in the same location as a sand bar identified in Map 2 of Candler *et al*. (2010), adjacent to Athabasca Chipewyan First Nation reserve 201G. This location is also one of two sites of the Mikisew Cree First Nation/Athabasca Chipewyan First Nation navigation monitoring stations upstream of the Athabasca Delta (site Q8). Based on P2FC hydraulic modelling data (CEMA 2010), the flow-depth relationship for this point is:

$$D = 0.0319Q^{0.605} \quad (1)$$

Where, D is the flow depth in metres and Q is the volumetric flow rate of the river in cubic metres per second. Based on this equation, water depth at this point reaches 1 metre at 300 m^3/s, 1.2 metres at 400 m^3/s, and 2.8 metres at 1600 m^3/s. This relationship matches very well with Candler *et al* (2010), particularly the 1.2 metre safe navigation depth occurring at the AXF (Aboriginal Extreme Flow of 400 m^3/s).

Preliminary Aboriginal Navigation Index

Equation 1 was combined with the information provided by Candler *et al.* (2010) to produce a preliminary Aboriginal Navigation Index (ANI; Figure 13) such that,

1) ANI = 1 for flows at 1600 m^3/s (Aboriginal Base Flow; ABF) and above, reflecting full access to traditional activities.
2) ANI = 0 when water depth at the critical point is 1 metre or less, reflecting a depth at which navigation may become impossible with a fully loaded boat.
3) ANI is approximately 0.1 at a flow of 400 m^3/s (AXF), reflecting extremely limited access to traditional activities. Navigation is expected to be very difficult and slow and loads probably will need to be decreased to allow for confident navigation. However, while navigation is probably limited, it is likely not impossible.

The proposed ANI equation is (Figure 2):

$$ANI = \begin{cases} 0 & Q < 300\ m^3/s \\ 0.018Q^{0.605} - 0.563 & 300 m^3/s \le Q < 1600\ m^3/s \\ 1 & 1600\ m^3/s \le Q \end{cases} \quad (2)$$

The Fall Season ANI would be calculated from,

$$ANI_{Fall} = \frac{1}{10}\sum_{i=34}^{43} ANI(Q_i) \quad (3)$$

Where, i is the week number, and Qi is the average flow at hydrometric station WSC 07DA001 for week i. Weeks 34 to 43 run from August 20 to October 28.

The difference between Fall Season ANI and adjusted Fall Season ANI (due to oil sands withdrawals) would be calculated from,

$$\triangle ANI_{Fall} = \frac{\sum_{i=34}^{43} ANI(Q_i) - \sum_{i=34}^{43} ANI(Q_i - Q_{os,i})}{\sum_{i=34}^{43} ANI(Q_i)} \quad (4)$$

Where Qos,i is the average withdrawal from the Athabasca River by oil sands industry in week i.

Preliminary Aboriginal Navigation Trigger

Fall Season ANI varies significantly from year to year and has generally decreased over time. Average ANI was 0.423 from 1958-1980, 0.355 from 1981-1997, and 0.213 from 1998-2011. Average water withdrawal in 2011 and 2012 from weeks 34 to 43 was 3.5 m^3/s. A water withdrawal of 4 m^3/s would reduce the 1998-2011 ANI by 2 per cent to 0.209.The CEMA recommendation allows for withdrawals of up to 29 m^3/s in the Summer/Fall Season (weeks 34 to 43). A sustained withdrawal of 29 m^3/s would reduce the Fall ANI from 1998-2011 by almost 15 per cent to 0.187 while a sustained withdrawal of 16 m^3/s, the withdrawal rate modelled by P2FC in the fall season, would reduce the Fall ANI by 8 per cent to 0.199. Figure 4 shows how various levels of withdrawals would change ANI under historic flow conditions (1958-2011).

The P2FC recommendation therefore allows for enough withdrawal to significantly reduce Fall season navigability of the Athabasca River in low flow years even before considering potential changes due to climate change, although the impacts of current withdrawal rates are relatively small. The fall has been reported as a key time period for Aboriginal navigation. The following preliminary trigger has therefore been included in this framework:

A management action would be triggered if the difference between Fall Season (weeks 34 to 43) ANI and adjusted Fall Season ANI were to exceed 10 per cent in any year.

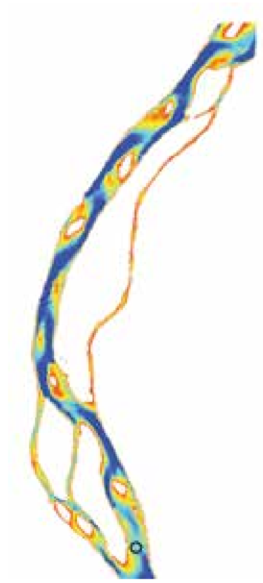


Figure 12.
Modelled flow depth in reach 3 of Athabasca River at a flow rate of 400 m^3/s. Blue areas indicate deeper water and red areas indicate shallow water. The black circle indicates the location of the pinch point used to develop the Aboriginal navigation Index.

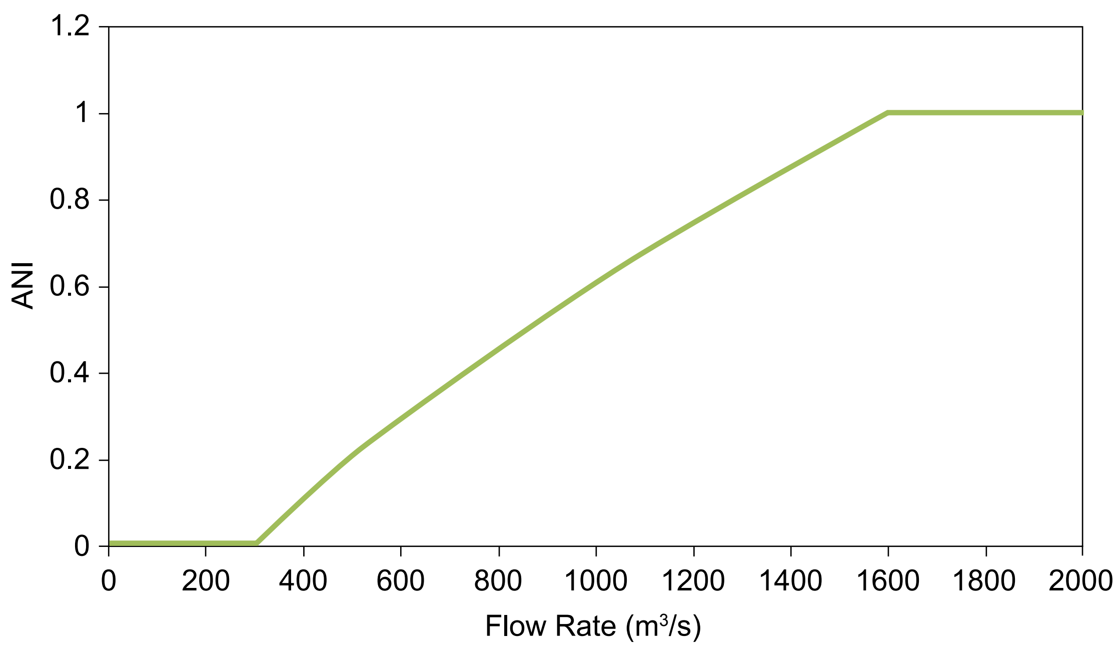


Figure 13.
The Aboriginal Navigation Index

Appendix H: Management Action Scenarios

Scenario 1: Low Seasonal Flow (Fall)

Scenario:

Median fall (Weeks 34 to 43) flow at the Athabasca below McMurray hydrometric station (WSC 07DA001) drops below 298 m^3/s for the third time in the last 10 years.

Verification:

Daily flow data from Water Survey of Canada is compared with ESRD, JOSM, and/or AEMERA data. All information confirms the finding of a third low flow fall in the last 10 years.

Preliminary Assessment:

Observed flows are compared with the modelled flows and climate scenarios used to develop the Framework and are found to be outside the modelled range. Further investigation is therefore required.

Investigation:

Upstream net water use is found to be below 2 m^3/s. All major tributaries of the Athabasca River experienced low flows, as well as most major rivers in adjacent river basins. Regional meteorological analysis shows that precipitation has been low and temperatures high in most of Northern Alberta. Conclusions is drawn that low flows are due to climate conditions, specifically numerous dry and hot summers over the past 10 years.

Withdrawals by industry are found to have not yet reached full build out levels (annual demand is less than 10 m^3/s). Aboriginal Navigation Index (ANI) is at record low levels, which is corroborated by numerous reports from traditional land users. It is concluded that the poor state of navigation is primarily due to low upstream flows, but oil sands withdrawals have been sufficient to reduce ANI by approximately 10 per cent.

Ongoing ecological monitoring indicates that fish populations are responding within the range anticipated by modelling.

Management Actions:

A multi-stakeholder committee will be set up to design additional weekly withdrawal rules during the summer and fall seasons (weeks 24 to 43). Until a recommendation is submitted to AESRD, a precautionary withdrawal limit is set when weekly flows drop below 400 m^3/s.

Scenario 2: Ecological Knowledge Gap Completed

Scenario:
One of the ecological knowledge gaps (e.g., riparian vegetation in the delta) identified in the framework (Section 9.3.6) is completed and the findings communicated to the regulators.

Verification:
Regulators to review findings received and determine relevance for the Framework in completing the knowledge gap.

Preliminary Assessment:
Findings are compared to preliminary analysis used in developing the Framework withdrawal rules (or P2FC recommendations) if appropriate. Depending on the findings, there are two general paths the management response could follow.

A. If there is no significant incremental impact of oil sands water withdrawals on ecological item of interest, then knowledge gap is closed and no further work required.
B. If there is a significant incremental impact of oil sands water withdrawals on ecological item of interest, further investigation is required.

Investigation:

A. No further investigation required.
B. The significant incremental impact of oil sands water withdrawals on the ecological topic (previous knowledge gap) is confirmed by investigation by Regulators.

Management Actions:

A. No further management actions required aside from reporting of closing the ecological knowledge gap in the annual report on Framework progress.
B. Regulators, in collaboration with a multi-stakeholder science committee, will review whether changes are necessary to short-term weekly management triggers and limits and/or adaptive management triggers. They will also review the potential need for adding a new long-term ecological topic to the ecosystem status monitoring (Section 11.2) in addition to fish communities and populations. Upon determination of need, either or all of these will be implemented.