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Alberta Energy Regulator
Regulatory Applications

RE: Statement of Concern regarding EPEA and *Water Act* renewal applications for Jackpine Mine

Please accept the following statement of concern, submitted on behalf of the Alberta Wilderness Association ("AWA"), the Keepers of the Water ("Keepers"), and the Athabasca River Basin. The statement of concern relates to the integrated renewal application by Canadian Natural Upgrading Limited ("CNUL") for the renewal of the following *Environmental Protection and Enhancement Act* ("EPEA")[1] approval and *Water Act*[2] approvals and licences for Jackpine Mine Oil Sands Processing Plant and Mine and the Jackpine Mine Expansion (JPME) Project (the "Jackpine Mine" or the "Mine"):

- Approval No. 153125-01-00, as amended, under EPEA;
- Approval No. 205433-01-00, as amended, under the *Water Act;*
- Approval No. 329253-00-00, as amended, under the *Water Act;*
- Water Diversion Licence No. 186157-01-00, as amended under the *Water Act;* and
- Water Diversion Licence No. 329252-00-00, as amended, under the *Water Act* (together, the "Application").

The Mine is located approximately 70 km north of Fort McMurray, Alberta, and about 500 km northeast of Edmonton. The Mine is contained within Townships 95, 96, and 97 and Ranges 8 and 9, W4M.

For the reasons discussed below, the Athabasca River Basin should be granted standing to participate in the review process of the Application, and AWA and Keepers should be allowed to bring forth substantive concerns on behalf of the waterbody.

AWA, Keepers, and the Athabasca River Basin respectfully request that the Alberta Energy Regulator ("AER") conduct a hearing pursuant to s.34(2) of the *Responsible Energy Development Act* ("REDA") to more fully consider the issues in the Application.

[1] *Environmental Protection and Enhancement Act*, RSA 2000, c E-12 ("EPEA").
[2] *Water Act*, RSA 2000, c W-3 ("*Water Act*").

1. Overview

AWA and Keepers request that the AER recognize that the Athabasca River Basin is a "directly and adversely affected person". This would grant *procedural* rights to the Basin, namely, standing in this proceeding to address substantive issues with CNUL's Application, as described below.

The AWA and Keepers do not seek, at this time, a declaration by the AER about the *substantive* rights of the Athabasca River Basin, such as a declaration that the Basin has the right to exist, the right to continue to exist, or the right to be restored.

The AWA and Keepers seek to speak for the Athabasca River in this proceeding, acting as representatives on behalf of the Basin, which cannot speak for itself.

If the Athabasca River Basin is not granted standing, in the alternative, AWA and Keepers seek permission to appear before the AER to address the substantive issues raised in this statement. These groups have advocated and worked for the protection of the land, waters, and communities in the Athabasca oil sands region for many years and should be allowed to present their knowledge, experience, and concerns for the AER's consideration.

Substantively, this statement of concern focuses on the Application's failure to provide the information required by the *EPEA Guide to Content for Energy Project Applications* and *Manual 025: Applications Under the Water Conservation Policy for Upstream Oil and Gas*. The Application omits information about the setting and environmental conditions in the local and regional study area, how they have changed and how they are expected to change, and the contribution of the Jackpine Mine to these conditions. The Application also omits to describe the substances that are released from the mine each day and fails to include a cumulative effects assessment of water flows in the regional watershed. These information gaps prevent an accurate and rigorous assessment of the impacts of the Jackpine Mine to the Athabasca River Basin over the next 10 years, and the identification of the approval and licence conditions necessary to mitigate these impacts.

2. Introduction to AWA, Keepers, and the Athabasca River Basin

2.1 Alberta Wilderness Association

For more than 50 years, AWA has worked for the protection of Alberta's wilderness, which provides habitat for wildlife and clean drinking water for all Albertans. With more than 7,000 members and supporters across Alberta and globally, AWA raises the profile of Alberta's wilderness, and inspires communities to care by educating Albertans about the values of our wilderness and wildlife. Over the past two decades, AWA has participated in efforts to govern water withdrawals from the Athabasca River, intervened in regulatory hearings for oil sands projects (including the Jackpine Mine Expansion Project), sat on the Athabasca Watershed Council, and was a delegate in oil sands monitoring programs.

2.2 Keepers of the Water

Keepers of the Water is a coalition of First Nations, Métis, Inuit, environmental groups, and citizens working together for the protection of water, land, air, and all living things today and tomorrow, including in the Athabasca River watershed. Their work is guided by both Indigenous Elders' Traditional Knowledge and Euro-centric science.

Many Board members, staff, and supporters of Keepers live, work, and exercise Treaty rights within the Athabasca River basin and in the vicinity of the Jackpine Mine. As such, Keepers has long been

concerned about the environmental and health effects of the oil sands, including the ongoing contamination of air, water, animals, plants and soils resulting from the Jackpine operations.

2.3 The Athabasca River Basin

The Athabasca River Basin spans approximately 159,000 square kilometres.[3] It originates in the Columbia Icefield in Jasper National Park and flows more than 1,231 km before emptying into Lake Athabasca and the Peace-Athabasca Delta. From there, its waters flow north as Rivière des Rochers and join the Peace River to form the Slave River, which empties into the Great Slave Lake. These waters discharge through the Mackenzie River system into the Arctic Ocean. The Athabasca River flows through the Alberta oil sands, and the Jackpine Mine is located along the east side of the Athabasca River.

The Athabasca River is listed as a navigable water under the *Canadian Navigable Waters Act* and part of the river is designated as a Canadian Heritage River for its historical and cultural importance.[4] The name *Athabasca* comes from the Woods Cree word ᐊᐦᐸᓀᑲᐤ *aðapaskāw,* which means "where there are plants one after another."

The Muskeg River is a tributary of the Athabasca River. It is located within the Athabasca oil sands region of northern Alberta and drains an extensive area of boreal forest wetlands. The mouth of the river is located about 55 km north of Fort McMurray and about 5 km east of Fort MacKay. The area of the Muskeg River watershed is about 1,480 km^2. There are several major tributaries to the Muskeg River, including Jackpine Creek.[5]

3. The Athabasca River Basin is a "directly and adversely affected person"

AWA and Keepers submit this statement of concern on behalf of the Athabasca River Basin as a directly and adversely affected person. While a waterbody is not a traditional participant in a proceeding before the AER, the following sections demonstrate that:

i) Recognition of the Athabasca River Basin as a legal person that can be "directly and adversely affected" is consistent with Alberta law, national and international precedent, and Indigenous legal traditions; and

ii) Recognizing the Athabasca River Basin as a directly and adversely affected person is essential for the AER to fulfill its mandate under EPEA and the *Water Act* in assessing the Application.

3.1 Support for recognizing the Athabasca River Basin as a legal person

As described below, the recognition of the Athabasca River Basin by the AER as a legal person that can be "directly and adversely affected" is consistent with the REDA, Alberta's *Interpretation Act,* precedent from Canada and around the world, and Indigenous legal traditions and values.

3.1.1 Recognition is consistent with REDA and the Interpretation Act

Under REDA, "[a] person who believes that the person may be directly and adversely affected by an application may file a statement of concern with the Regulator in accordance with the rules."[6]

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[3] Alberta Water Portal Society (2022) *Climate Change in the Athabasca River Basin*, accessed online.
[4] *Canadian Navigable Waters Act*, RSC 1985, c N-22, Schedule, Part 2: Rivers and Riverines; Canadian Heritage Rivers System (n.d) *Athabasca River,* accessed online.
[5] Alberta Environment (2008) *Management Guidance for Aquatic Components of the Muskeg River Watershed*, accessed online.
[6] *Responsible Energy Development Act*, SA 2012, c R-17.3, ("REDA") s.32.

REDA does not define the term "directly and adversely affected person" or "person". The *Interpretation Act* does not define the term "directly and adversely affected person", but it does define "person" in the following way:

> "person" includes a corporation and the heirs, executors, administrators or other legal representatives of a person.[7]

Alberta case law that has considered who is directly affected focuses on the interpretation of directly affected, not who (or what) is a person.

REDA gives the AER broad powers in carrying out its duties and functions. Section 14 states:

> (1) The Regulator, in the carrying out of duties and functions imposed on it by this Act or any other enactment, may do all things that are necessary for or incidental to the carrying out of any of those duties or functions.
>
> (2) The Regulator, with the approval of the Lieutenant Governor in Council, may take any action and may make any orders and directions that the Regulator considers necessary to carry out the mandate of the Regulator and the purposes of this Act or any other enactment that are not otherwise specifically authorized by this Act or any other enactment.[8]

The above provisions suggest that the AER can recognize the Athabasca River to be "person" for the purposes of being considered a "directly and adversely affected person." The definition of "person" in the *Interpretation Act* is sufficiently broad and inclusive to recognize a non-human natural entity such as the Athabasca River as a "person" under the law. There are no relevant definitions in REDA that exclude the Athabasca River from being considered a person or a directly and adversely affected person. In fact, REDA gives the AER broad authority in carrying out its duties and functions, which allows the AER to accept the Athabasca River as a "person" and a "directly and adversely affected person" for the purposes of assessing this Application.

3.1.2 Recognition is consistent with precedent in Canada and around the world

Recognizing the Athabasca River as a legal person is consistent with Canadian and international precedent, in which non-human entities, including corporations, trusts, rivers, and nature more broadly already enjoy rights and legal personhood.

For over 100 years, corporations have had legal standing, like human beings. Today, CNUL is afforded the right to participate in this review process, despite not being a human person. The AER itself is established as a corporation and has the "powers and privileges of a natural person" under REDA.[8] A similar recognition of rights and legal personhood for nature is a more recent development, but it is present in Canada and around the world.

Here in Canada, environmental protection laws such as the *Fisheries Act* and the *Species at Risk Act* protect the rights of individual animals and plants by prohibiting harm to those entities or the destruction of their habitat.[9] In 2018, the Magpie River in Quebec received formal recognition of its legal personhood and rights via joint resolutions issued by the Minganie Regional County Municipality of and the Innu

[7] *Interpretation Act*, s.28(1)(nn)
[8] REDA, s.14.
[9] *Fisheries Act*, RSC 1985, c F-14; *Species at Risk Act,* S.C. 2002, c. 29.

Council of Ekuanitshit.[10] The resolutions declare the Magpie River and its watershed to be a legal person and grant nine substantive rights to the Magpie River, including the right to sue. The resolutions also authorize the municipality and the Innu Council to enforce the rights.

Ecuador and Bolivia have enshrined broad rights to nature, including personhood, in their constitutions.[11] A number of jurisdictions have legislated rights and/or legal personhood to the following waterbodies:

- The Whanganui watershed (Te Awa Tupua) in New Zealand;[12]
- The Yarra River (Birrarung) in Australia;[13]
- The Mar Menor lagoon and its basin in Spain;[14]
- The Klamath River in California, USA.[15]

Several countries have granted rights of nature and legal personhood through the courts. For example:

- In 2017, Bangladeshi Supreme Court granted all of its rivers the same legal status as humans.[16]
- In 2016, the Constitutional Court of Colombia granted legal personhood to the Atrato River Basin;[17]
- In 2017, the High Court of Uttarakhand at Nainital in India recognized the Ganga and Yumuna Rivers, glaciers, and other ecosystems as legal persons;[18]
- In Ecuador, the Provincial Court of Loja upheld the constitutional rights of the Vilcamba River.[19]

Over the course of history, the law has expanded to recognize the rights and personhood of new entities, both human and non-human, in order to ensure they received fair and just consideration before the law. At one time, corporations, women, Indigenous people, people of colour, and children were not considered "persons" and it would have seemed impossible and unbelievable that they could have been considered as such. More recently, legal rights and personhood have been extended to nature and elements of nature, including rivers, lending precedent to the recognition by the AER of the Athabasca River as a "directly and adversely affected person" in this proceeding.

3.1.3 Recognition is consistent with Indigenous declarations and values

There are publicly available statements and declarations that suggest Indigenous support for the recognition of the Athabasca River Basin as a person.

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[10] Minganie Regional County Municipality (2021) *Résolution 025-21: Reconnaissance de la personnalité juridique et des droits de la rivière Magpie-Muteshekau Shipu*, accessed online; Conseil des Innu de Ekuanitshit (2021) Résolution 919-082, accessed online; Stuart-Ulin, C.R. (2021) *Quebec's Magpie River becomes first in Canada to be granted legal personhood,* National Observer, accessed online.

[11] Constitution of the Republic of Ecuador, accessed online; Constitution of Bolivia, accessed online.

[12] New Zealand (2017) *Te Awa Tupua (Whanganui River Claims Settlement) Act 2017*, s.14, accessed online

[13] Parliament of Victoria (AUS) (2017) *Yarra River Protection / Wilip-gin Birrarung murron Act 2017*, s.1(a), accessed online

[14] Krämer, L. (2023) R*ights of Nature in Europe: The Spanish Lagoon Mar Menor Becomes a Legal Person.* Journal for European Environmental & Planning Law, 20(1), 5-23, accessed online.

[15] Yurok Tribal Council (2019) *Resolution Establishing the Rights of the Klamath River*, accessed online.

[16] Islam, M.S. (2020) *Legal rights for the Turag: rivers as living entities in Bangladesh*, Asia Pacific Journal of Environmental Law 23(2):160, accessed online.

[17] Constitutional Court of Colombia (2016) *Center for Social Justice Studies et al. v. Presidency of the Republic et al. Judgment T-622/16*, accessed online.

[18] Amina Mundi Law Initiative (n.d) *Rights of Nature Case Study: Ganga River and Yamuna River*, accessed online.

[19] Global Alliance for the Rights of Nature (2011) *The first successful case of the Rights of Nature implementation in Ecuador,* accessed online.

For example, the Dene Nation is an organization that represents Dene people whose territories stretch from present day Alaska to the southern-most tip of North America. The Athabasca River flows through Dene territory and the Jackpine Mine is located within Dene territory. The Dene Nation has published a Declaration of the United Dene declaring their independence as a distinct people.[20] The Declaration states that "[w]e, the Dene, do not separate ourselves from the land, waters, air, animals and environment. Our lands akin to our body, our waters akin to our blood." The declaration also notes the Dene's sacred responsibility to the land and to act on its behalf. In the Statement of Traditional Dene Values and Principles, the Dene Nation recognizes "our equality with this land and all living creatures."[21] These statements support the position that lands and waters – such as the Athabasca River Basin – should have the same rights and personhood that a human Dene person would.

Moreover, the Athabasca River basin has cultural, economic, and historical significance to many Indigenous peoples. Standing for the Athabasca River through representatives in this regulatory process is also necessary for meaningful implementation of Indigenous peoples' stewardship relationship with the Athabasca River Basin and its ecosystem. The traditional knowledge held and derived from the river basin are found in several publicly available reports.[22]

3.2 Recognizing the Athabasca River Basin as a person supports the purposes of EPEA and the Water Act and the legal accountability of the AER

EPEA and the *Water Act* seek to protect the environment.[23] REDA requires the AER to regulate the protection of the environment and its regulations require the AER to consider the social, economic, and environmental effects of an energy resource activity.[24] EPEA and the Water Act include public input into decision-making as one of their underlying purposes.[25] The courts have highlighted the importance of public participation in resource development.[26]

However, in practice, Alberta has extremely restrictive standing rules for participation in environmental reviews of natural resource projects. The "directly and adversely affected" test in REDA is narrowly interpreted by the AER and courts to exclude anyone who does not have a distinct right or interest that is discernable from that of the community.[27] This means that, in the remote parts of Alberta where oil sands projects operate and few people (outside the boundaries of the mines) live, work, or recreate, opportunities

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[20] Dene Nation (2021) *Declaration of the United Dene*, accessed online.
[21] Dene Nation (2021) *Statement of Traditional Dene Values and Principles*, accessed online.
[22] See for example:
- Mikisew Cree First Nation (2022) *The Sacred Virtues: Kinship and the Red-Winged Blackbird*, accessed online;
- Mikisew Cree First Nation and Athabasca Chipewyan First Nation (2010) *As Long as The Rivers Flow: Athabasca River Use, Knowledge,* accessed online;
- Mikisew Cree First Nation and Athabasca Chipewyan First Nation (2014) *Phase 2 Report: Water is a living thing - Environmental and Human Health Implications of the Athabasca Oils Sands for the Mikisew Cree First Nation and Athabasca Chipewyan First Nation in Northern Alberta*, accessed online;
- Mikisew Cree First Nation (2016) *Written Brief to the Standing Committee on Environment and Sustainable Development*, accessed online; and
- Mikisew Cree First Nation (2016) *Written Brief to the Standing Committee on Fisheries and Oceans*, accessed online.

[23] EPEA, s.2(a); *Water Act*, s.2(a).
[24] REDA, s.2(1)(a)(ii); *Responsible Energy Development Act General Regulation,* Alta Reg 90/2013, s.3.
[25] EPEA, s.2(g); *Water Act,* s.2(d).
[26] *Kelly v Alberta (Energy Resources Conservation Board)*, 2012 ABCA 19, paras 33-34; *Coulas v Ferus Natural Gas Fuels Inc*, 2016 ABCA 332, para 10; and *Fort McMurray Métis Local Council 1935 v Alberta Energy Regulator*, 2022 ABCA 179, para 22.
[27] *Kostuch* v. *Alberta (Director, Air and Water Amending Approvals Division, Environmental Protection)*, 1996 CanLII 10565 (ABKB), para 25.

for public participation by concerned citizens and representatives of the environment are virtually non-existent. Legal scholars have concluded that "there is currently no legal right to public participation in resources and environmental project decision-making in Alberta."[28]

This narrow interpretation of "directly and adversely affected" deprives the AER of its ability to fulfill its statutory mandate, including of considering the social, economic, and environmental effects of this Application. This interpretation also limits public scrutiny of the AER's decision-making, which undermines the legal accountability of officials exercising public power over resource development in Alberta.

By recognizing the Athabasca River as a "directly and adversely affected person" and allowing the AWA and Keepers to make statements on its behalf, the AER can allow the public participation that REDA, EPEA and the *Water Act* require. This will bring relevant expertise to help ensure the protection of the Athabasca River Basin and introduce necessary public accountability regarding whether the AER is carrying out the purposes of these laws in assessing the Application.

In *Reece v Edmonton*, 2011 ABCA 238, the reasons of Chief Justice Fraser, albeit in dissent, are relevant to this matter.[29] In this case, an animal welfare organization sought to have an elephant at an Edmonton zoo moved to better conditions. The Chief Justice concluded that if animals are to be protected in any meaningful way – as intended by the legislature – then the animals, or their advocates, need to have legal standing. Granting legal standing in this way supports the rule of law because it allows citizens, on their own behalf or on behalf of an animal, to ensure that their government complies with its own laws.

The legislature, through EPEA and the *Water Act*, mandates the consideration and protection of the environment as well as the inclusion of public input in decision-making. Including an element of nature – such as the Athabasca River Basin – that is directly and adversely affected by an application allows meaningful dialogue with the AER on issues that are central to the application. This approach benefits the AER, Alberta's natural environment, and the health and safety of Albertans throughout the province. It also necessarily flows from – and supports – Alberta's reconciliation obligations and recognition of Indigenous knowledge.

3.3 The Athabasca River Basin is directly and adversely affected by the Application

The Athabasca River Basin is directly and adversely affected by the Application because, if approved, it permits the Jackpine Mine to continuing operating over the next 10 years. The Jackpine Mine has a high degree of proximity and connection to the Basin as it is located with 15 km of the Athabasca River and is within a watershed that feeds directly into the Athabasca River. The Mine's operations impact the Basin in several ways, including:

- The Mine withdraws water directly from the Athabasca River and diverts water from the surrounding watershed that would otherwise feed the Athabasca River. This amounts of millions of cubic metres of water each year;
- The Mine releases hundreds of tonnes of contaminants of concern into the air, which are deposited in the Athabasca River Basin and accumulate in the land, water, sediment, and living organisms;

[28] Shaun Fluker (2015) *The Right to Public Participation in Resources and Environmental Decision-making in Alberta*, Alberta Law Review 52:3, p.602.
[29] *Reece v. Edmonton (City)*, 2011 ABCA 238.

- The Mine discharges water that has collected in the Mine's sedimentation ponds and contains several contaminants of concern into the Muskeg River;
- The destruction and degradation of wetlands and old growth forests, which disrupts the storage and filtration of freshwater;
- The leakage of tailings effluent into groundwater, which is hydrologically connected to the Athabasca River; and
- The Mine releases greenhouse gas emissions into the atmosphere, which contributes to climate change and warming trends that impair water flow in the River.[30]

The Application does not adequately address any of these concerns and, as stated more fully below, lacks the data, analysis and context required by the AER for approval.

4. Concerns with the Application

As noted above, the Application fails to provide the information required by the *EPEA Guide to Content for Energy Project Applications*[31] (the "EPEA Guide") and *Manual 025: Applications Under the Water Conservation Policy for Upstream Oil and Gas*[32] ("Manual 025"). The following sections highlight these information requirements, information gaps in the Application, and make recommendations for the revision of the Application to permit a more comprehensive assessment of the Application and its impacts on the Athabasca River Basin.

4.1 Information Requirements for the Application

In exercising its responsibilities under EPEA, the AER is required to fulfill the purposes set out in the Act and its regulations, which include the *Approvals and Registrations Procedure Regulation* (the "Regulation").

The Regulation states that the purpose and scope of the review of EPEA applications is "to determine whether the impact on the environment of the activity, the change to the activity or the amendment, addition or deletion of a term or condition of an approval is in accordance with the Act and the regulations made under the Act."[33] The Regulation also stipulates the information that proponents must provide in an application for an EPEA approval, including the renewal of an approval.[34] This information includes:

> (h) a list of substances, the sources of the substances and the amount of each substance that will be released into the environment as a result of the activity, the change to the activity or the amendment, addition or deletion, as the case may be, the method by which the substances will be released and the steps taken to reduce the amount of the substances released; (…)

[30] CEAA & ERCB (2013) *Decision 2013 ABAER 011: Shell Canada Energy, Jackpine Mine Expansion Project*, accessed online ("*Jackpine Mine Expansion JRP Report*"); Pembina Institute (2012) *The case against the proposed Shell Jackpine oil sands mine expansion*, accessed online.
[31] Alberta Energy Regulator (2014) *Environmental Protection and Enhancement Act – Guide to Content for Energy Project Applications*, accessed online ("EPEA Guide").
[32] Alberta Energy Regulator (2022) *Manual 025: Applications Under the Water Conservation Policy for Upstream Oil and Gas,* accessed online ("Manual 025").
[33] *Approvals and Registrations Procedure Regulation*, Alta Reg 113/1993 ("*Approvals Regulation*"), s.6(1).
[34] *Approvals Regulation,* s.1(b)(i); EPEA, s.1(f).

(k) the justification for the release of substances into the environment as a result of the activity, the change to the activity or the amendment, addition or deletion, as the case may be;

(l) the measures that will be implemented to minimize the amount of waste produced, including a list of the wastes that will or may be produced, the quantities and the method of final disposition of them; and

(s) any other information required by the Director, including information that is addressed in a standard, code of practice or guideline in respect of the activity that is published or adopted by the Department.[35]

The AER has published the EPEA Guide to supplement the Regulation and provide further clarity on information requirements in an application. CNUL is obliged to provide the information specified in the EPEA Guide under the Regulation, and if the AER receives an incomplete application, it is required to "notify the applicant in writing and request the information necessary to make the application complete."[36] EPEA also authorizes the AER to require CNUL to submit any additional information that the Director considers necessary[37] and to impose any terms and conditions on an approval, which "may be more stringent, but may not be less stringent, than applicable terms and conditions provided for in the regulations."[38]

4.2 Information Gaps in the Application

The Application states that it follows the EPEA Guide and Manual 025.[39] However, even a cursory read of the Application shows that the EPEA Guide and Manual 025 have not been followed, as required.

4.2.1 Changes and risks in the environmental setting

The EPEA Guide states that information submitted in the renewal application is intended to, *inter alia*, "assess changes in the nature or magnitude of potential risks to achieving environmental outcomes and of contributing to potential environmental adverse effects in the area of the activity".[40]

Section 12 of the EPEA Guide asks the proponent the following questions:

- What is the setting for the activity and what has changed in the setting?
- What environmental risks must be addressed and have they changed?
- What environmental objectives must be achieved and have they changed?[41]

It also notes that the information provided in the Section 12 assessment will:

- ensure that the proponent is considering the broader implications of the activity in the area throughout its full life cycle;
- inform the nature of current and future environmental issues in the area;

[35] *Approvals Regulation, s.3(1).*
[36] Approvals Regulation, s.4(2).
[37] EPEA, s.66(2).
[38] EPEA, s.68(3).
[39] CNUL Application - Executive Summary, pdf p.2.
[40] EPEA Guide, p.36.
[41] EPEA Guide, p.40.

- identify and assess the consequence of other existing and emerging influences and environmental pressures to environmental conditions in the area, such as other activities and land or water uses.[42]

The following information requirements in section 12 are particularly relevant:

12.1 For this section, update the current setting and environmental conditions description, and also assess the facility's contributions to the influences (effects) in the area, highlighting changes over the past approval period.

12.2 Describe the current setting and any changes to features of the local and regional landscape, drainage and surface watercourses, and groundwater. Identify and highlight any changes in land use and zoning for the site and adjacent lands, since the last approval period.

12.3 Describe the current ambient air quality and identify influences and environmental pressures within a 5-kilometre radius of the site, and assess any changes over the last approval period. Include:
- topography and elevation;
- any collected ambient air environmental monitoring data at or near the site and its collection location;
- the various environmental influences, effects and trends; and
- all constraints and limiting factors in the receiving environment.

The Application Guide to Content states that the section 12.1 information requirement can be found in Volume 3: Sections 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0 of the Application.[43]

As described below, the Application fails to respond adequately to the section 12.1 information requirement. It does not adequately describe the setting and environmental conditions relevant to the Jackpine Mine, how they have changed, or the contribution of the Jackpine Mine to the influences in the area. This undermines the AER's ability to assess the changes in the nature and magnitude of potential risks to achieving environmental objectives and mitigating potential environmental adverse effects in the area of the Jackpine Mine.

4.2.1.1 Missing Years

The Application provides the data collected during the last approval period, from 2019-2022, about the following aspects of the setting and environmental conditions:

- Local wind
- Local temperature
- Local & regional Air Quality Monitoring data, including continuous monitoring & exceedance summaries of AAAQ objectives for SO_2, NO_2, CO, PM, H_2S, TRS, VOCs, PAHs, metals.
- Fort McKay air quality
- Air Quality Assessment – see Appendix A (WSP Report)
- Hydrogeology – current groundwater conditions and changes over the last approval period
- Hydrology – surface water hydrology in the current setting and environmental conditions, and changes over the last approval period

[42] EPEA Guide, p.40.
[43] Canadian Natural Jackpine Mine *Environmental Protection and Enhancement Act* and *Water Act* Renewals (2023) Guide to Content, ("CNUL Application - Guide to Content"), pdf p.14.

- Local and regional climate monitoring data, including annual temperature, precipitation, rainfall, snowfall, aerial evapo-transpiration & daily precipitation over the past approval period
- Local Water Quantity Monitoring data from hydrometric stations on the Jackpine and Muskeg Creeks and the Muskeg River.

The Application also provides data of historical mean daily temperatures, precipitation, and daily wind for the period of 1981-2010.

It is important to note that section 12.1 requires the proponent to "highlight" changes over the past approval period; it does not require the proponent *only* include data from the past approval period and exclude data from other relevant years. As such, the Application fails to provide a complete picture about the setting and environmental conditions because it does not provide data for ***all of*** the years between 2010, when the Jackpine Mine started operations, and the present day.

We are also concerned that there is also no discussion of whether and how the Jackpine Mine has contributed to the changes in the setting and environmental conditions between 2010 and today. This makes it difficult to for the AER to assess the changes in the nature or magnitude of potential risks to achieving environmental outcomes and the contribution of the Jackpine Mine to potential environmental adverse effects in local and regional study areas. It also makes it difficult for the AER to assess whether previous conditions imposed on the Jackpine Mine were adequate to address environmental concerns over time.

Recommendation: Require CNUL to revise the Application to include wind, temperature, air quality, hydrogeology, hydrology, climate, and water quantity data for ***all of the years*** for which data is available between 2010 and the present day and state how the Mine has contributed to the settings and environmental conditions.

4.2.1.2 Inaccurate air quality data.

The Application fails to provide necessary data about the settings and environmental conditions because it uses air quality data that has recently been demonstrated to grossly under-estimate the magnitude of air emissions from the oil sands.

The Application states that it uses historical and recent air quality data derived from available ambient air quality measurement collected through regional (Wood Buffalo Environmental Association [WBEA]) and national (Environment and Climate Change Canada [ECCC]) monitoring networks.[44] The air quality assessment of existing and potential future conditions in Appendix A states that it used "the most current emissions information available."[45]

However, the completeness of this air quality data is under serious question based on a recent study published in the journal *Science*. Using aircraft-based measurements, He et al. found that total gas-phase organic carbon emissions exceed oil sands industry-reported values by 1900% to over 6300%.[46] The study noted that emission rates from three of the highest emitting facilities – Syncrude Mildred Lake, Suncor, and CNRL – *were 20 to 64 times greater than those in the AEIR and Canada's National Pollutant Release Inventory*.

[44] CNUL Application, Vol. 3, pdf p.16.
[45] CNUL Application, Vol. 3, pdf p.260.
[46] He, M. et al. (Jan 2024) *Total organic carbon measurements reveal major gaps in petrochemical emissions reporting*, Science, 383, 426-432 ("*He et al.: gaps in petrochemical emissions reporting*").

As such, the Application cannot be said to accurately reflect the historical and current state of air quality in the local and regional study areas.

Recommendation: Require CNUL to revise the Application to include a comparison of its air quality modelling and predictions with the findings in He et al. study and undertake top-down measurements of air quality in the local and regional study areas.

4.2.1.3 Failure to compare against baseline data and original EIA predictions.

In several instances, the Application fails to compare observed data against baseline data and predictions that were made in the original environmental impact assessments (EIAs). This makes it difficult to assess whether the Mine is operating as expected and to validate and refine the original modelling. It also does not follow the scientific rigor required in the EPEA Guide and Manual 025. The Application fails in this regard with respect to:

- Air quality; and
- Aquatic ecology (fish habitat, fish populations, and benthic invertebrate community).

Recommendation: revise the Application to include a comparison of observed data about air quality and aquatic ecology with relevant baseline data that was collected before the Jackpine Mine started operations and predictions that were made in the original EIAs.

4.2.1.4 Exclusion of the Athabasca River

Section 4.0 of the Application presents a summary of the surface water hydrology in the current setting and environmental conditions. However, it only includes a hydrology analysis of the Muskeg River watershed, which constitutes the Muskeg River, Jackpine Creek, Muskeg Creek, and Kearl Lake.[47]

However, the Application fails to provide a complete picture of the setting and environmental conditions because it does not include a hydrologic analysis of the Athabasca River. There is no reason provided for this exclusion, even though the Jackpine Mine impacts the Athabasca River by diverting water within the Muskeg River watershed that would otherwise enter the Athabasca River and by withdrawing water from the Athabasca River for use in the operation of the Jackpine Mine.

Recommendation: Require CNUL to revise the Application to include a hydrologic analysis of the Athabasca River.

4.2.1.5 Outdated water flow predictions

At section 4.6, the Application compares monitored data of flow conditions in the Muskeg River watershed with modelled hydrologic conditions presented by Shell in 2007 and 2008 when the Jackpine Mine was originally seeking project approval.[48] This data is more than 16 years old and cannot be reliably accepted.

While we generally consider it good practice to compare current conditions to modelled predictions from the EIA, we note the importance of using new and up-to-date models that reflect the latest scientific knowledge, Indigenous knowledge, and modelling technology. This will ensure that any predictions are as accurate as possible.

In this instance, the acceleration of climate change and our increased understanding of its risks and impacts since the EIAs means that we are concerned about continued reliance on the modelling that was conducted almost two decades ago and whether it can still serve as an accurate tool for assessing current

[47] CNUL Application Vol. 3, pdf p.103.
[48] CNUL Application Vol. 3, pdf pp. 112-122.

and future hydrological conditions. In particular, we note that in the intervening years, climate change has continued to intensify, and we have an increased understanding of the risks and impacts of climate change, including natural disasters such as wildfires and droughts. As such, it is unlikely that the original model continues to offer accurate predictions that are suitable for comparing existing and future flows in the Muskeg River watershed and the Athabasca River.

Climate change is already impacting the hydrology in the Athabasca River Basin and will continue to do so. A 2018 report on Indigenous navigability of the Athabasca River (appended below), considered the impact of climate change on Athabasca River hydrology and concluded that, under future climate scenarios:

> The incoming hydrograph has significant implications for the navigability of the lower Athabasca River and for possible opportunities for oilsands withdrawals … *These periods of water scarcity increase the significance and relative contribution of oilsands water withdrawals in affecting Indigenous navigability. The decline in magnitude of the open-water flows mean that there is less discretionary flow available for other activities like oilsands mining* …[C]limate change on its own, without increasing water withdrawals, has the potential to worsen Indigenous navigability and when the increasing water withdrawals are also considered, a precarious picture emerges that needs assessment.[49]

As such, it is critical that the Application assess the impact of climate with the most update information and models.

We also note that the predictions in section 4.6 of the Application only depict water flows as far as the year 2030 (see figures 4.6-1 to 4). This Application purports to provide an outlook for activities within the next 10 years, and the EPEA and *Water Act* approvals and licences will be renewed for that period. As such, any modelling and predictions in the Application – including for water flows - should have an outlook of least 10 years, until 2034. However, given that oil sands mines have long lifespans and need to plan their operations far in advance, we encourage the AER to require longer term modelling as well.

Recommendation: Require CNUL to revise the Application to include updated hydrologic models and predictions that consider the impact of climate change on the Athabasca River and the Muskeg River watershed until at least 2034. Modeling from 2007 and 2008 should be rejected by the AER and not found to meet the requirements in the EPEA Guide and Manual 025.

4.2.1.6 Emerging influences and environmental pressures

Section 12 of the EPEA Guide requires the assessment to "identify and assess the consequence of other existing and emerging influences and environmental pressures to environmental conditions in the area."[50] However, the Application contains no substantive discussion of climate change and its impacts – such as drought or wildfire – on the operations of the Mine or as part of the cumulative effects assessment of the Mine. This is critical given that climate change is – and will continue to be – a critical influence and environmental pressure over the next 10 years (and beyond).

Recommendation: Require CNUL to revise the Application to assess the risks and impacts associated with climate change and its impacts (particularly drought and wildfire) on the operations and the effects of the Mine.

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[49] Carver, M. (2018) *Indigenous Navigability of the Lower Athabasca: Alberta's SWQMF & Syncrude's Proposed Mildred Lake Extension Project*, ("*Review of SWQMF and Syncrude MLX*"), p.24.
[50] EPEA Guide, section 12, p.40.

4.2.2 Substances generated at the facility – air emissions

Section 13 of the EPEA Guide, *Design and Equipment Performance Evaluation*, requires information regarding the potential environmental risks of the activity due the activity's processes, materials and substances, layout and disturbance, the effectiveness of mitigation measures to prevent adverse effects, and the ability to contribute to meeting required environmental objectives in light of changes to environmental conditions or commitments.[51]

The information requirement in Section 13.3 requires the Application to describe the substances that are generated in a typical operating day at the plant or facility and makes the following information requirements for substances from each process stream:

- their characterization, including their nature, fate and transport (physical, chemical or biological properties or characteristics), and potential effects on the environment,
- their quantity used or generated (note range variation in production or due to upsets). Tables in Appendix D and Appendix E [of the EPEA Guide] can be used as examples for the types of sources of substances,
- their source of introduction, and
- the process streams' range of variation due to production changes or upsets.

Section 13.3 also requires information about waste that is generated and waste that is accepted at the site.

The Application Guide to Content states that the section 13.3 information requirement is located in Volume 1: Sections 4.4 and 10.0 and Volume 2: Section 2.5, 3.3, and 4.7 of the Application.[52]

However, the relevant sections of the Application do not provide all of the information required by EPEA Guide section 13.3. These sections largely deal with waste generated on site (Vol 1: sections 4.4, 10.0), raw materials, products, and by-products used in mining (Vol 2: section 2.5), tailings (Vol 2: section 3.3), and materials, products, and by-products related to utilities (Vol 3: section 4.7). Further, there is no mention in these sections of the "potential effects on the environment" from this waste or tailings, as required by section 13.3.

The Application Guide to Content does not point to any sections of the Application that provide information about substances released as part of air emissions or discharges into water bodies. This includes the following substances listed in Appendix E of the EPEA Guide:

- Nitrogen Oxide
- Nitrogen Dioxide
- Sulphur Dioxide
- Ammonia
- $PM_{2.5}$
- PM_{10}
- Total Particulate Matter
- Carbon Monoxide
- Benzene
- Volatile Organic Compounds
- Arsenic
- Cadmium
- Chromium
- Mercury
- Nickel
- Selenium
- Hydrogen Sulphide
- Vanadium
- Naphthalene
- Benzo(a)pyrene
- Acetaldehyde
- Acrolein
- Formaldehyde
- Hexane
- Carbon Disulphide
- Total Reduced Sulphur
- Carbon Dioxide
- Nitrous Oxide
- Methane
- Other Specified Gases
- Other NPRI substances

[51] EPEA Guide, section 13, p.43.
[52] CNUL Application - Guide to Content, pdf p.17.

The WSP Air Quality Assessment (Appendix A of the Application) provides information about the quantity and sources of some of these substances. However, there is no information about the nature, fate, transport, and range of variation of these substances. The Assessment does state the potential frequency of exceedances of the AAAQO and odour thresholds, but there is no discussion about other potential effects on the environment, such as accumulation of these substances in water, soil and river sediment, and organic matter (i.e. bioaccumulation), as required.

Notably, the Application fails to include information required by section 13.3 about carbon dioxide and methane, both of which are substances that are listed in Appendix E of the EPEA Guide. This is particularly concerning given that oil sands mines are significant contributors of these greenhouse gas emissions to the atmosphere, which exacerbate the ongoing climate crisis. The climate crisis is a relevant environmental condition as it has serious implications for the Mine, including the availability of water and the risk of forest fire in the local and regional study areas.

This information is important to help assess the Mine's potential contribution to adverse environmental effects, particularly given the findings of the study by He et al. that the oil sands industry-reporting is underestimating their air emissions[53] and a study Wren et al. that the oil sands industry is under-estimating its GHG emissions.[54] The He et al. study noted that emission rates from three of the highest emitting facilities – Syncrude Mildred Lake, Suncor, and CNRL – *were 20 to 64 times greater than those in the AEIR and Canada's National Pollutant Release Inventory*.

Recommendation: Require CNUL to revise the Application to include information about the above substances as required by section 13.1 of the EPEA Guide. Require inclusion of information about their nature, fate and transport (physical, chemical or biological properties or characteristics), and potential effects on the environment, their quantity used or generated (note range variation in production or due to upsets), their source of introduction, and the process streams' range of variation due to production changes or upsets.

4.2.3 Substances generated at the facility – water discharges and groundwater

Despite the requirement in EPEA Guide s.13.3, the Application also fails to include a description of the substances that are generated by the Mine and released via the sedimentation ponds into Shelly Creek, which discharges into the Muskeg River. The Application does discuss water quality monitoring data in the receiving waterbodies, but it does not contain all of the information required by s.13.3.[55]

Further, while the Application notes a number of exceedances and upward trends in contaminants of concern in groundwater monitoring wells,[56] there is no discussion of the Mine's contribution to these exceedances, their effects on the setting and environmental conditions (e.g. water quality in groundwater and connected waterbodies), or what steps that CNUL is taking to reduce the frequency and magnitude of these exceedances. We expect that information requirements in EPEA Guide s.13.3 would also apply to substances generated at the Mine that are released into groundwater.

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[53] *He et. al: gaps in petrochemical emissions reporting*

[54] Wren, S. et al. (2023) *Aircraft and satellite observations reveal historical gap between top–down and bottom–up CO_2 emissions from Canadian oil sands,* Proceedings of the National Academy of Sciences Nexus 2(5), accessed online.

[55] CNUL Application Vol. 3, pdf pp. 127-182.

[56] CNUL Application Vol. 3, pdf pp.75-98.

Recommendation: Require CNUL to revise the Application to include all the information required by EPEA Guide s.13.3 with respect to discharges from the sedimentation ponds and releases into groundwater.

4.2.4 Discrepancies in water volumes

Volume 4 of the Application provides several different figures relating to the amount of water that is allocated and used by the Jackpine Mine, which makes it difficult to understand the nature of the Mine's impact on local and regional hydrology, aquatic systems, and water use. For example:

- In Table 1.2-1, the Total Requirement for Maximum Annual Diversion under Water Act licence 186157-01-00 is 81,200,000 m^3/year. However, that total is not the sum of the volumes given in Table that are associated with diversions from the Athabasca River, Groundwater Diversion, and Site runoff. Further, this total is different from Table 2.3-1, which states that the total licenced allocation volume under *Water Act* Licence 186157-01-00 is 70,200,000 m^3.
- The maximum annual diversion for the Athabasca River (stage 2) is given as 35,300,000 m^3/year in Table 1.2-1 but 53,300,000 m^3/year in Table 1.2-3. (This appears to be a typo, as the *Water Act* licence states 35,300,000 m^3/year.[57])
- Tables 1.2-1 and 1.2-2 state that the rate of diversion from the Athabasca River is "up to 4.17 m^3/s." However, Table 1.2-3 states that the maximum diversion rate is 4.72 m^3/s. No explanation is given for this discrepancy.
- Table 2.3-1 states the volume of water diverted annually from 2019-2022 under *Water Act* licence 186157-01-00 from the Athabasca, Surface Water, and Groundwater, and in total. However, these volumes do not appear to match those depicted in Figure 2.3-1, which shows annual diversions under the same licence over the same time period. The chart shows much higher diversions for each source and in total.
- Figure 3.2-1 depicts annual Jackpine Mine plant water usage from 2019-2022, showing both fresh water (Athabasca River) and Recycle Water Use. Total usage was approximately 60 million m^3/year. However, Figure 3.2-3 shows that Recycled Water use was approximately 90 million m^3/year during the same period. This figure shows similar volumes of diverted water as Figure 2.3-1, but much higher than the volumes stated in Table 2.3-1.
- In its justification of water diversion volumes, the Application states that "combined plant production for the Project at 300,000 bbl/day would require 14,900 m^3/h (Section 3.2, JPM EIA 2007) which is 130,524,000 m^3/year of water."[58] However, Figure 3.2-3 demonstrates that the Mine is already using more water than that - approximately 160 million m^3/year from 2019-2022 – at current production levels of 130,000 bb/day.[59] There is no explanation of how the Mine would reduce its water use and, at the same time, more than double its production.

Recommendation: Require CNUL to revise the Application to explain and correct as necessary, the above discrepancies.

[57] CNUL Application Vol. 1, pdf p.202.
[58] CNUL Application Vol. 4, pdf p.22.
[59] CNUL Application Vol. 1, pdf p.9.

4.2.5 Unexplained increase in water use

The purpose of a renewal application is to assess changes in the nature or magnitude of potential risks to achieving environmental outcomes and of contributing to potential adverse environmental effects. However, the Application fails to explain how the expected changes in water use will help to achieve environmental outcomes or contribute to adverse environmental effects.

Table 3.1-1 provides the water balance from the 2022 Life of Mine Plan.[60] The table presents a significant increase in annual water inputs and outputs starting in 2032; approximately five times greater than annual water inputs and outputs in the years 2022-2031. The timing of this increase is within the 10-year term contemplated by this renewal application. However, the Application fails to provide any explanation for this increase or its expected impacts on hydrologic conditions in the Muskeg River watershed and the Athabasca River.

***Recommendation**:* Require CNUL to revise the Application to explain the reason for the drastic increase in water use in 2032 and the expected project-specific and cumulative effects to the setting and environmental conditions (including the hydrology) of the local and regional study areas.

4.2.6 Failure to conduct a cumulative effects assessment

Manual 025 states that the evaluation of the potential environmental impacts of a *Water Act* licence should determine the cumulative effects within the geographical area where the water diversion is proposed. According to Manual 025, the cumulative effects assessment should include at least the following:

- The rationale for the geographic area being assessed and timeframe considered.
- A description of the water sources within the geographic area for flowing and nonflowing water bodies, groundwater, and wetlands.
- A description of the hydrologic conditions and restrictions, including historic flows and variability, seasonal flow variation, instream flow needs, and water conservation objectives.
- A listing of the different uses, including licensed, statutory, and nonlicensed, including recreational (e.g., boating), habitat (e.g., wetlands), and the water source potentially impacted by the proposed diversion and use trends.
- A quantitative evaluation and description of the impacts resulting from or caused by the proposed diversion and cumulative impacts caused by the proposed diversion, other existing diversions, pre-existing conditions, and future proposed projects as known.
- Identify mitigation options where the resource is currently stressed (e.g., the point of diversion is in a water-short or potentially water-short area) and the proposed diversion increases the impact on the aquatic environment or high-quality nonsaline water resources. All relevant reasonable mitigation measures should be identified, including monitoring of the aquatic environment and engaging Indigenous communities and other users to identify water supply issues or limitations.[61]

Although the Application states that it follows Manual 025,[62] it fails to include a cumulative effects assessment of the Muskeg River watershed and the Athabasca River. This is particularly important given changes to the hydrology in the region due to climate change and industrial use since the Jackpine Mine

[60] CNUL Application Vol. 4, pdf p.15.
[61] Manual 025, p.18.
[62] CNUL Application - Executive Summary, pdf p.2.

started operations and the potential impacts to regional hydrology from climate change and industrial use in the coming years.

Recommendation: Require CNUL to revise the Application to include a cumulative effects assessment of the Muskeg River watershed and the Athabasca River that considers – at a minimum – next 10-year term of the Water Act licence and provides the information required by Manual 025.

5. Requested water rights for renewal

The Application seeks to renew the existing water withdrawal volumes with no proposed changes and states that the total combined water withdrawal volume is 123,700,000 m^3/year.[63] However, the Application notes that the Mine only diverted between 17-22% of the licenced allocation volume between 2019-2022.[64] According to Table 3.1-1 Water Balance from 2022 Life of Mine Plan, this diversion does not appear to change until a significant, but unexplained, increase in water use in 2032, though the differences in terminology and numbers make it difficult to compare the data in this Table to the rest of the Application.

Given the increasing impact of climate change on the availability of water in the Athabasca River Basin, there is no certainty that the volume of water allocated to the Mine will be available over the next 10 years and beyond. Therefore, since the Mine only diverts a relatively small percentage of its total allocation, the withdrawal volume in the licences should be reduced to ensure that water allocations are not over-subscribed. Accordingly, if the Mine requires additional water in the future, CNUL should be required to apply for an amendment to its licences. This will allow the AER to consider the new allocation demand in the current context of water availability and competing uses for water (e.g. ecosystem health and Indigenous navigability for the exercise of Treaty Rights).

Recommendation: the *Water Act* licences should be amended to reduce the allocation of water withdrawals to more closely match the volume of water that the Jackpine Mine currently diverts from the Athabasca River Basin.

6. Inadequacy of LARP and its frameworks

Section 11.1 of the EPEA Guide requires the Application to identify all government approved regional initiatives or plans that pertain to the area with requirements that relate to environment and resource management for the activity.

The Application responds to this information requirement in Volume 1, sections 6.0 and 7.0, where it lists the government-approved regional initiatives and regional joint monitoring programs, participation, and cooperation. The first item this list is the Lower Athabasca Regional Plan and its frameworks.

6.1 LARP directly and adversely affects Indigenous communities

In 2015, a statutory review panel concluded that the several local First Nations have been "directly and adversely affected" by health effects, loss of income, and the loss of quiet enjoyment of property as a result of LARP.[65] However, LARP has not been amended to address these issues. Today, LARP is under its 10-year statutory review for ongoing relevancy and effectiveness, but consultation has been minimal

[63] CNUL Application Vol. 4, pdf pp.4, 6.
[64] CNUL Application Vol. 4, pdf p.11.
[65] *Review Panel Report 2015 – Lower Athabasca Regional Plan*, accessed online.

and there is no legal requirement that Alberta will amend LARP if the review concludes that it is not relevant or effective.

Recommendation: Alberta must amend LARP and its frameworks, in consultation with local Indigenous communities and the public.

6.2 Inadequacy of the Surface Water Quantity Management Framework

The list in Volume 1, Section 6 includes the *Surface Water Quantity Management Framework (SWQMF).* In Volume 3, section 4.72, the Application compares its water withdrawals from the Athabasca River with the thresholds in the SWQMF. The Application states that all water withdrawals from 2019-2022 are within the Project's regulatory allowance because the Mine only takes small portion of the cumulative water withdrawal and because the Athabasca River flows have not dropped below the Ecosystem Base Flow.[66]

However, the Application fails to assess the status of Indigenous navigability on the Lower Athabasca River since the Mine started operations, over the next 10 years, and the impact of the Mine on navigability. Over the past decade, Indigenous communities in the Lower Athabasca Region have raised concerns the SWQMF fails to adequately protect Indigenous navigability on the Lower Athabasca River, which is critical for access to their reserves and territories.[67] Therefore, CNUL's compliance with the SWQMF does not mitigate a project's impacts to Indigenous navigability.

Recommendation: Alberta must amend the SWQMF to adequately protect Indigenous navigability; in consultation with local Indigenous communities and the public.

6.3 Failure of Alberta to complete a Biodiversity Management Plan

The list in Volume 1, section 6.0 does not include a Biodiversity Management Framework under the Lower Athabasca Regional Plan. This omission is a reminder that the Government of Alberta has failed to complete this Framework, despite committing to do so by the end of 2013.[68]

In its 2013 report on the Jackpine Mine Expansion Project, the Joint Review Panel noted that Shell "relied heavily" on Alberta's commitment to develop and implement a biodiversity management framework under LARP[69] and repeatedly urged the Government of Alberta to "fast-track " the completion of the Framework and made a recommendation to that effect.[70] The JRP further recommended to Alberta that the Framework take into account the loss of wetlands and provide thresholds to ensure enough wetlands, including peatlands, are maintained in the Lower Athabasca Region.[71] This is critical because wetlands are an integral part of regional hydrology and the health of the Muskeg River watershed and the Athabasca River.

Recommendation: Alberta must complete the Biodiversity Management Framework, in consultation with local Indigenous communities and the public.

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[66] CNUL Application Vol. 3, pdf pp.123-124.
[67] *Review of SWQMF and Syncrude MLX,* p.4*;* Carver, M. (2018) *Indigenous Navigability of the Lower Athabasca River: Alberta's SWQMF & Teck's Effects Assessment,* p.4.
[68] Government of Alberta (2012) *Lower Athabasca Regional Plan 2021-2022*, p.28.
[69] *Jackpine Mine Expansion JRP Report*, para 820.
[70] *Jackpine Mine Expansion JRP Report,* paras 684, 701, 716, 789, Recommendation 58 (p.380).
[71] *Jackpine Mine Expansion JRP Report*, Recommendation 78 (p.382).

7. Conclusion

AWA and Keepers request that the AER recognize the Athabasca River Basin as a "directly and adversely affected person" with respect to the Jackpine Application and accept the foregoing statement of concern. This statement of concern seeks to ensure that the welfare of the Athabasca River Basin is a key consideration in the AER's assessment of the Application. In the alternative, if the Athabasca River Basin is not granted standing, AWA and Keepers request that the AER receives this statement of concern on their behalf as organizations with a history of environmental advocacy in the Lower Athabasca Region.

As described above, the Application has failed to provide the information required by the EPEA Guide Manual 025. The Application omits information about the setting and environmental conditions in the local and regional study area, how they have changed, how they are expected to change, and the contribution of the Jackpine Mine to these conditions. The Application also fails to describe the substances that are released into the environment from the Mine and fails to include a cumulative effects assessment of water flows in the regional watershed. These information gaps prevent an accurate and rigorous assessment of the impacts of the Jackpine Mine over the next 10 years to the Athabasca River Basin and the identification of the approval and licence conditions necessary to mitigate these impacts.

We thank the AER for its careful consideration of the important issues raised in this statement of concern.

Sincerely,

Matt Hulse
Barrister & Solicitor

Susanne Calabrese
Barrister & Solicitor

Zachary Biech
Barrister & Solicitor

Encl.: Carver, M. (2018) *Indigenous Navigability of the Lower Athabasca: Alberta's SWQMF & Syncrude's Proposed Mildred Lake Extension Project*.

cc: Debborah Donnelly, Executive Director, Alberta Wilderness Association
Jesse Cardinal, Executive Director, Keepers of the Water

Indigenous Navigability of the Lower Athabasca River: Alberta's SWQMF & Syncrude's Proposed Mildred Lake Extension Project

Submission to the Alberta Energy Regulator for the Syncrude MLX Hearing

Prepared for:

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Project #418-02

December 14, 2018

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EXECUTIVE SUMMARY

The Athabasca Chipewyan First Nation's (ACFN) and Mikisew Cree First Nation's (MCFN) ability to efficiently traverse the waters located throughout their territories, and in a rhythm reflecting long-standing seasonal-use patterns, is fundamental to the viability and sustainability of their cultures, economies, and way of life. The Athabasca River - including its tributaries, side channels, back channels and cut throughs - is critical to ACFN's and MCFN's ability to access reserves and territory to hunt, trap, fish, gather and practise other land uses.

The ability of ACFN and MCFN to access and navigate their territories is currently impaired by low water levels in the lower Athabasca River and associated waterways. Water withdrawals from the Athabasca River by oilsands developments along the river contribute to this low water. Syncrude Canada Ltd (Syncrude) has proposed to build the MLX Extension Project (MLX Project) in ACFN and MCFN territory. As the MLX Project will withdraw a significant amount of water from the Athabasca River, ACFN and MCFN are concerned about further deterioration in the timing and quantity of flow in the Athabasca River and about related impacts to the river's navigability.

In light of the importance of navigability of the lower Athabasca River to the way of life of ACFN and MCFN, I was asked to review:

- Syncrude's proposed MLX Project and its general potential to affect Indigenous navigability;
- the content of the Government of Alberta's (GoA) Surface Water Quantity Management Framework (SWQMF); and
- the GoA's management of the water quantity of the lower Athabasca River in relation to ACFN and MCFN needs for Indigenous navigability.

This report reaches the following conclusions:

1. GoA's SWQMF does not provide protection to Indigenous navigability associated with the lower Athabasca River. Despite affirming the importance of river navigability for downstream First Nations and recognizing the leading science on the topic, the SWQMF provides subjectively-adjusted thresholds applied in such a way that it delivers no protection to Indigenous navigability.
2. As a consequence of the deficiencies with the SWQMF, compliance by oilsands operators with SWQMF (or its precursor, the *Water Management Framework*) gives no assurance to ACFN and MCFN that the effects of oilsands mines on Indigenous navigability will be negligible and/or mitigated. This applies to existing mines and would also apply to the MLX Project, if it were approved.
3. Syncrude does not provide an assessment of the impacts of its proposed Project on Indigenous navigability. It makes the assumption that compliance with the SWQMF will mitigate downstream effects, however, this assumption is incorrect in relation to Indigenous navigability. It also refers to the precursor to the SWQMF which is now out of date. As a result, the potential effects of the MLX Project on Indigenous navigability remain unassessed by Syncrude.

4. Revisions to SWQMF are needed for it to provide protection to Indigenous navigability. Required modifications include:
    - creation of two new weekly triggers that apply to all operators:
        - a trigger at the updated Aboriginal Extreme Flow (AXF) of 500 m^3/s that prohibits oilsands water withdrawals below the AXF (and without the current exemption which is in place for winter purposes); and
        - a trigger at 700 m^3/s that requires a reduction of total oilsands water withdrawals to 20 m^3/s in the transition to the AXF;
    - reconfiguration of the Aboriginal Navigation Index to reflect known thresholds for Indigenous navigability;
    - revision of the Aboriginal Navigation Trigger to be a proactive and effective advanced-warning system in support of Indigenous navigability;
    - incorporation of downstream flow monitoring data into SWQMF decision-making;
    - support for Indigenous-led community-based monitoring (CBM) and the incorporation of resulting CBM data in the SWQMF; and
    - expanded public reporting in the form of annual reporting of the State of Indigenous Navigability.

ACFN and MCFN are already experiencing serious challenges to riverine navigability in their territories. The SWQMF gives priority water use to oilsands water withdrawals. While the SWQMF provides some protection to fish, it does not protect Indigenous navigability. Perversely, in its effort to provide protection for winter fish survival while ensuring the priority of water use for oilsands operators, the SWQMF facilitates the deterioration of Indigenous navigability during the critically important fall hunting season by encouraging withdrawals during the SWQMF's Fall and late Summer seasons.

Navigability challenges experienced by ACFN and MCFN will only increase as a result of the impacts of climate change. Results are reported on from the application of a collection of simulation models describing river discharge and corresponding water depths under climates projected to occur during the life of the MLX Project. Consistent with other peer-reviewed scientific publications, results presented here show that flows in the Athabasca River during the latter half of the open-water season are projected to decline during the life of the MLX Project. Under the current emissions trajectory (which surpasses Representative Concentration Pathway 8.5), the declines are the largest and lead to 10-year and 100-year low flows that are below 300 m^3/s, and well below the AXF of 500 m^3/s. The river modelling and CBM data analysis also show that water depths associated with very low river flows (300-800 m^3/s) lead to increased loss of access to side channels, back channels, mainstem through-travel, pinch points, and other river situations where ACFN and MCFN members require sufficient water quantity in the lower Athabasca River to meet their minimum needs for navigability during the open-water season and especially during the fall hunting season.

The significant SWQMF performance deficiencies will become increasingly consequential for the exercise of Indigenous land use as the Athabasca River fall-flow declines and the demands of oilsands water withdrawals increase - as they are projected to do during the life of the MLX Project. This is of particular concern given the lack of any assessment by Syncrude of effects of the MLX Project on Indigenous navigability. If GoA wishes to minimize the impacts of oilsands water withdrawals to ACFN and MCFN navigability and environmental flow requirements, GoA needs to revise the SWQMF, examine possible changes to oilsands water demand and use, and re-assess the region's capacity for projected expansion of oilsands mining.

1.0 INTRODUCTION

Syncrude Canada Ltd. ("Syncrude") is proposing to construct, operate and reclaim the Mildred Lake Extension Project (MLX Project), located 35 km northwest of Fort McMurray in Townships 93 and 94 within the Regional District of Wood Buffalo. The MLX Project consists of open-pit mining activity within and adjacent to the current Mildred Lake Project Site with new mining pits and features, including two main locations: the West Project (MLX-W) area located west of the MacKay River and the East Project (MLX-E) area located between the Mildred Lake Settling Basin and the Athabasca River. MLX–W is bordered by the Dover River to the north, a Suncor facility to the west, Suncor leases to the south and the MacKay River to the east. MLX–E is adjacent to the existing Syncrude Mildred Lake Mine operation to the north and west, a Suncor mine to the south and the Athabasca River to the east.

In an update to its application, development is scheduled to begin in 2019 with mining beginning in 2024 at the MLX-W site and 2028 at the MLX-E site (Syncrude 2018). Development of the mine pits will extend the duration of mining activity on the Mildred Lake leases by about 14 years which, if approved, would suggest an end to active mining at about 2035. Reclamation activities would continue until 2097. Syncrude proposes to place most of the produced tailings in facilities currently approved for the Mildred Lake site.

The MLX Project is located within the territory of the Athabasca Chipewyan First Nation (ACFN) and the Mikisew Cree First Nation (MCFN). ACFN and MCFN access and use of this territory, critical for practising their culture and way of life, depends fundamentally on the navigability of the Athabasca River. ACFN and MCFN have raised concerns about the effects of oilsands water withdrawals on Indigenous navigability (Carver 2014a) and the adequacy of the SWQMF in managing oilsands water use and mitigating the impacts of oilsands and MLX Project water use on Indigenous navigability. ACFN and MCFN are concerned that not only do the GoA's existing rules endanger Indigenous navigability, but that Syncrude has not provided an adequate and accurate assessment of the effects on Indigenous navigability of its component of overall oilsands water withdrawals.

This report examines these concerns through a review of Indigenous navigability in the lower Athabasca River and in the context of the changing Athabasca River hydrograph, an overview of Syncrude's related assessment information, and a description of SWQMF priorities and performance particularly as they relate to navigability. In light of the findings presented here, and for consideration by the Alberta Energy Regulator (AER), recommendations are suggested for completing an accurate effects assessment on Indigenous navigability and for modifying GoA's SWQMF rules so that they provide protection to Indigenous navigability.

1.1 Objectives

ACFN and MCFN have retained Aqua Environmental Associates to carry out an analysis of the GoA's SWQMF and Syncrude's Environmental Impact Assessment (EIA) materials in relation to the navigability needs of ACFN and MCFN in the lower Athabasca River. Specifically, this study is asked to respond to the following three questions:

1. Does Alberta's Surface Water Quantity Management Framework (SWQMF) adequately protect and/or maintain Indigenous navigability of the lower Athabasca River? Explain.

2. Would Syncrude's compliance with the SWQMF mitigate and/or avoid impacts to Indigenous navigability on the lower Athabasca River? Explain.
3. What changes are required to improve the SWQMF's regulation of oil sands water withdrawals from the lower Athabasca River so that it minimizes and/or avoids the impact of those withdrawals on Indigenous navigability?

Section 3 addresses the first question through an analysis of the SWQMF's performance in relation to the maintenance of Indigenous navigability. Sections 2 and 4.1 address the second question. Sections 4.2 through 4.5 address the third question. Section 5 concludes by providing summary responses to the above questions along with 11 recommendations for the AER should the MLX Project be considered for approval.

1.2 Definitions

The following acronyms are used in this report:

ACFN	Athabasca Chipewyan First Nation
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
AESRD	Alberta Environment and Sustainable Resource Development
ACFN	Athabasca Chipewyan First Nation
AIRM	Athabasca Integrated River Model
ANI	Aboriginal Navigation Index
ARB	Athabasca River Basin
AWS	Alberta WaterSmart
CBM	Community-Based Monitoring
CEMA	Cumulative Environmental Management Association
EIA	Environmental Impact Assessment
GCM	Global Climate Model
GoA	Government of Alberta
IFN	Instream flow need
INI	Indigenous Navigability Index
IPCC	Intergovernmental Panel on Climate Change
MCFN	Mikisew Cree First Nation
PAD	Peace-Athabasca Delta
P2FC	Phase Two Framework Committee
RCP	Representative Concentration Pathway
SWQMF	Surface Water Quantity Management Framework
WMF	Water Management Framework
WSC	Water Survey of Canada

1.3 Limitations

This report is prepared for the Environmental Impact Assessment (EIA) process for Syncrude's Mildred Lake Extension project. The report should not be relied on for any other purpose. Any such unauthorized use of this report is at the sole risk of the user.

2.0 WATER REMOVALS PROPOSED FOR MLX PROJECT

2.1 Syncrude's Water Withdrawals and Diversions

Under its approved water license (no. 263297) for the operating Mildred Lake Mine, Syncrude is authorized to divert up to 39,840,000 m^3 of water annually (1.263 m^3/s) "from surface runoff sources tributary to the Athabasca River, Beaver River, MacKay River, and Poplar Creek" (Syncrude 2014, p799). Under this license, Syncrude is required to "establish a method of determining the volume of water diverted from each source on a monthly basis." A maximum instantaneous rate of withdrawal is not specified in the license. For the MLX Project, Syncrude has applied to increase this authorization by 11,700,000 m^3/yr (0.371 m^3/s) and for this increased water diversion to come from an expanded fenceline within the MacKay River watershed (Syncrude 2014, p771). If approved, Syncrude could divert an annual total of 52,540,000 m^3 from the MacKay River watershed.

In addition to these volumes, the Syncrude EIA indicates that the MLX Project will also require the following indirect water removals from the Athabasca River system:

- It will reduce groundwater flow to the MacKay, Dover and Athabasca Rivers during the construction, depressurization and operation stages of the MLX Project (Syncrude 2014, p126). Whereas Syncrude notes that the reduction will be "very low compared to the surface water flow in the rivers", it does not provide the proportion of base flow affected. During dry fall recession periods or during the annual winter low flow period, it does note that "sheet flow to the Athabasca River decreases due to groundwater drawdown" (p127). Syncrude "expects" the contribution of the MLX Project to regional cumulative groundwater effects to be "minimal and likely below measurable levels".
- Syncrude proposes that a "pit lake will form in the remaining excavation at the end of the mining activities at MLX-W." (p400). It proposes to create an end pit lake [EPL] from this pit by filling it passively "with freshwater from inputs from the natural watershed" over 20 years, likely starting in 2037. The total volume of water that Syncrude requires to fill this EPL is estimated at 123,000,000 m^3 (0.195 m^3/s). Given that this is natural runoff from a tributary watershed, this is equivalent to a 20-year removal (2037-2057) of 0.195 m^3/s from the Athabasca River.

Table 7.3-3 (Syncrude 2014, p1072) states that the Syncrude Base Mine holds water license no. 35216 which authorizes an annual Athabasca River diversion volume of 61,670,000 m^3/yr (1.934 m^3/s; peak of 4.16 m^3/s). Under this license, Syncrude currently pumps Athabasca River water to a sedimentation pond before directing it to Mildred Lake Reservoir (p576). In 2013, annual quantity of water diverted from the Athabasca River was 43,350,000 m^3 (1.486 m^3/s) (p576).

In addition to the above statements about proposed water use, Syncrude's EIA also states:

- "…no increase in annual water withdrawals from the Athabasca River" (p345);
- "No increase in annual import of fresh water is required for the proposed Project." (p429); and
- "The MLX Project will use Syncrude's existing Athabasca River withdrawal allocations to satisfy its fresh water requirements that cannot be met by groundwater and surface runoff within its closed circuit drainage areas, thereby limiting the amount of change to Athabasca River flows between the Baseline Case and the Application Case to that caused by changes in runoff." (p1114).

2.2 Assessment of Impact of Water Withdrawals Used by MLX Project

Syncrude provides a number of effect size and significance statements related to the potential downstream changes related to its water withdrawals on the lower Athabasca River and PAD.

Lower Athabasca River

Syncrude interprets the significance of its MLX Project water withdrawals by comparing them to the size of the Athabasca River. Consider:

> "The changes in Athabasca River flow are small due to the relatively small footprint of the MLX Project with respect to the Athabasca River basin. The Athabasca River basin, as measured below MacKay River, is approximately 142,100 km^2, while the largest extent of the MLX Project footprint is about 57 km^2, which is only about 0.04% of the Athabasca River basin area." (Syncrude 2014, p1114)

> "Changes in flows in the Athabasca River [due to these activities] are small due to the relatively small footprint of the MLX Project and are considered negligible as they are less than 0.1% change" (Syncrude 2014, p1433).

While Syncrude characterizes the general effect as small, it also recognizes that "the direction of the effect of river flows is negative during low flows" and it points out that some of this work is not supported by hydrologic modelling (p1433).

Syncrude continues with its assessment focus on relative size in the EIA's Executive Summary:

> "*Effects on the Athabasca River and the Peace-Athabasca Delta will be low due to relatively small disturbances of the MLX Project relative to the Athabasca River basin, the relatively low amount of water withdrawn* from the Athabasca River for oil sands operations and the withdrawal restrictions implemented by the Lower Athabasca Water Management Framework" (p128; emphasis added)

Peace-Athabasca Delta

The Syncrude EIA provides a memo from AMEC that "summarizes the current state of knowledge regarding the potential impact of upstream water demands (withdrawals) on the Peace Athabasca Delta" (p3474). In this four-page memo, it is stated:

> "Based on the projected magnitude of water withdrawals for the Athabasca River in the context of natural streamflow variability on the lower Athabasca River and other influences on PAD water levels such as wind set-up on Lake Athabasca and downstream hydraulic controls, there are unlikely to be any significant long-term impacts to the hydrology of the PAD that are attributable to the Fort McMurray area oil sands projects."

This statement is provided as professional opinion without supporting evidence. The memo goes on to state:

> "Winter water use during low flow periods may have local impacts on a seasonal basis affecting areas of shallow water within the PAD channel and lake network when the flow withdrawal in proportion to the total Athabasca River flow is much greater. However, the current regulatory framework provides instream flow needs targets and limits on water withdrawals that are designed to mitigate these effects to an acceptable level." (p3475)

This portion of the memo is applicable to the latter half of the open-water season which includes the fall hunting season. It is provided, without any reference to specific measures in the "regulatory framework" that provide the protection that it assumes. Earlier, in Volume 2, Syncrude refers to this memo implying that it was more than an opinion:

> "*It was determined* that oil sands mine water withdrawals will be too low to have significant long-term effects on the hydrologic characteristics of the PAD on an annual basis." (Syncrude 2014, p1114) (emphasis added)

Overall

Rather than conducting an assessment to determine the potential for its water withdrawals to negatively impact Indigenous navigability downstream of its MLX Project, Syncrude generally refers to what it considers the small relative size of the MLX Project and/or its water withdrawal. It does not provide further defense as to why this relative size argument would render the downstream effects insignificant at all critical times of the year and under future climates and river flows. In fact, it highlights a concern about declining open-water flows but fails to consider the consequences for Indigenous navigability. Additionally, as discussed in the next section, Syncrude relies on the GoA's water management rules for the lower Athabasca River as suitable means to mitigate Syncrude's downstream effects on water quantity.

2.3 Syncrude's Reliance on the Water Management Framework

Syncrude relies on Alberta's water management rules to address its potential impacts on the Athabasca River and the PAD. However, Syncrude does not provide an assessment demonstrating how the Water Management Framework for the Lower Athabasca River (AENV & DFO 2007) provides protection to Indigenous navigability downstream of its MLX Project. ACFN and MCFN have previously shown (Carver 2014a) the lack of protection provided by AENV and DFO (2007) for downstream environmental flows including that which is required for Indigenous navigability.

In addition, consider the following suggesting that Syncrude looks to the Water Management Framework to mitigate impacts, now and in the future, due to its water withdrawals:

Lower Athabasca River

In concluding its Hydrology assessment, Syncrude states:

> "Effects on the Athabasca River and the PAD will be low due to relatively small disturbances of the MLX Project relative to the Athabasca River basin, the relatively low amount of water withdrawn from the Athabasca River for oil sands operations and the withdrawal restrictions implemented by the Lower Athabasca Water Management Framework (AENV/DFO 2007)." (p1143)

In contrast with its conclusion regarding a low effect of its water withdrawals on the Athabasca River, in its climate change analysis, Syncrude projects that winter low flows will rise while fall and late summer flows will decline:

> "With respect to the Water Management Framework (Section 7.2.3.2), the climate change analysis for the Athabasca River indicates the current low flow thresholds during the winter will not be reached as often in the future. Thresholds during spring runoff will also not be reached as frequently because

spring runoff will occur earlier. *Later in the open water season, low flow thresholds may be reached more frequently due to a decrease in flow during that period*." (p1120, emphasis added)

However, despite this unfavourable projection, Syncrude does not mention the potential negative effects on Indigenous navigability resulting from these lower open-water flows nor does Syncrude provide any mitigations for this concern, reinforcing its view that the water management framework will appropriately limit and/or mitigate these resulting downstream effects related to water quantity.

Peace-Athabasca Delta

In the EIA Syncrude states:

> "However, the Water Management Framework for the Lower Athabasca River (Section 7.2.3.2) restricts water withdrawals during low flow periods, which should mitigate Athabasca River withdrawal impacts to the PAD during low flow periods." (p114)

Outdated Water Management Rules

Additionally, Syncrude's repeated reference in its EIA to the *Water Management Framework for the Lower Athabasca River* (AENV/DFO 2007) is outdated. AENV & DFO (2007) is overall a less-demanding set of rules than the current *Surface Water Quantity Management Framework* (SWQMF; GoA 2015). To the extent that Syncrude relies on Alberta's rules to mitigate Syncrude impacts, Syncrude should also be closely examining the *current* rules that are actually in force to see what mitigation they actually do offer to Indigenous navigability.

3.0 EFFECTS ON INDIGENOUS NAVIGABILITY OF ALBERTA'S WATER-WITHDRAWAL RULES FOR THE LOWER ATHABASCA RIVER

The GoA, with assistance from Fisheries and Oceans Canada (DFO), developed the SWQMF to manage water quantity in the lower Athabasca River and to balance its water-use interests on the river: oilsands water withdrawals and the maintenance of environmental flow needs for navigability and fish. This section examines what GoA has or has not accomplished in the SWQMF by describing the dynamics and requirements of Indigenous navigability and comparing how the SWQMF structure and priorities engage with those requirements. SWQMF performance is further examined by looking at these navigability requirements in relation to changes under future climates of the upstream hydrograph of the Athabasca River during MLX Project lifespan and unpacking some of the associated complexities of Indigenous navigability. The section ends with a review of GoA's responses to ACFN's and MCFN's continued efforts to provide GoA with appropriate information regarding Indigenous navigability and how the SWQMF can be revised to appropriately protect and maintain traditional-use opportunities.

3.1 Navigability Requirements for Traditional-Use Purposes

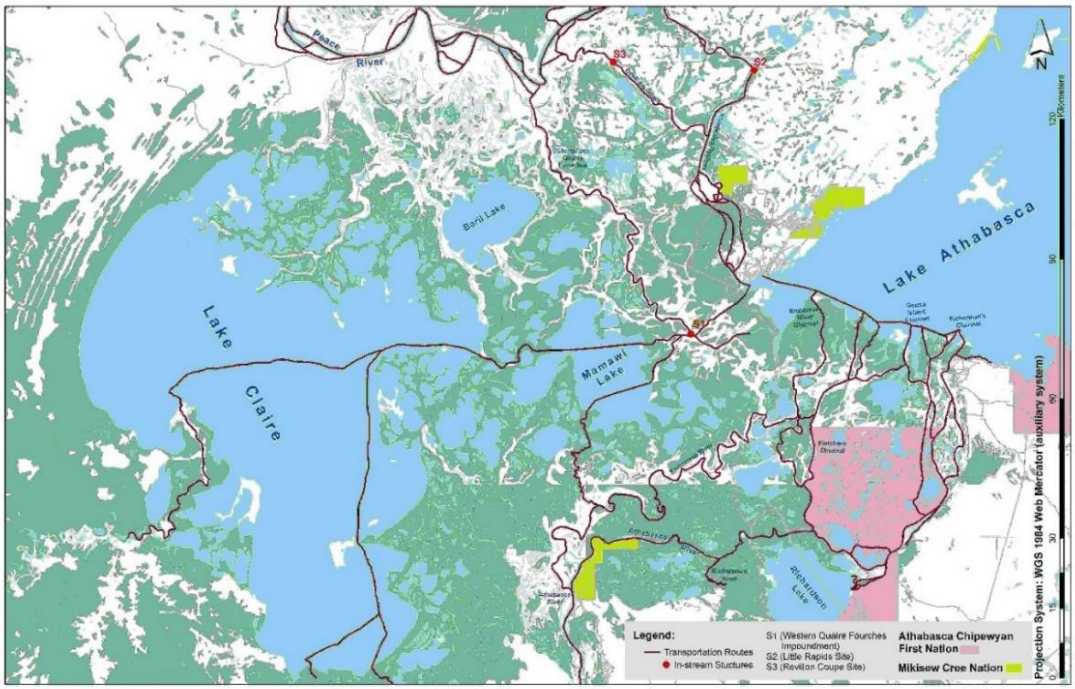
3.1.1 Navigability Dynamics in the lower Athabasca River and Peace-Athabasca Delta

Scope of Indigenous Navigability

ACFN's and MCFN's ability to efficiently navigate the waters located throughout their territories, in a rhythm reflecting long-standing seasonal-use patterns, is critical to the viability and sustainability of ACFN and MCFN culture, economy, and way of life. During the open-water season, the Athabasca River is the only traditional transportation route linking members living in Fort Chipewyan, Fort McKay and Fort McMurray and providing access to lower cost and sometimes unique goods and services in the larger service centre of Fort McMurray. The Athabasca River, and its tributaries, side channels, back channels and cut throughs also provides a fundamental, and often the only means for ACFN and MCFN members to access their reserves and territory along the river and in the PAD to hunt, trap, fish, gather and practise other land uses. Sufficient seasonal water availability is the single-most important environmental factor that shapes the ability of the river to support riverine opportunities for land use. See Figure 1 for a map of Indigenous navigation routes through the PAD.

Locations distributed along the Athabasca River and in and around the PAD, where ACFN and MCFN require sufficient water for Indigenous navigability to practise their land uses, form an interconnected system of access to traditional lands. Preferred hunting habitats, through travel, fishing locations, ceremonial sites, cabin sites, and gathering and other harvest sites contribute to an integrated network related to traditional-use requirements. The spatial layout leads to a complexity of navigability demands, particularly given the interconnections that exist in relation to specifics of many travel pathways and local destinations. Although it is not uncommon for deltaic environments to be locally dynamic, the direct changes in water quantity due to oilsands withdrawals and the long-term flow adjustments due to climate change (section 3.2) generate compelling dynamics in this navigability system that warrant careful study and responsive management.

Figure 1. Indigenous transportation routes within the Peace-Athabasca Delta.



Maintaining minimum navigability requirements is fundamental to sustaining ACFN and MCFN hunting practices. A prominent feature of the open-water season is the annual freshet which begins in the Early Spring[1] season and continues through the Late Spring and much of the Summer season, increasing flows in the lower Athabasca River and PAD. The annual freshet brings hunting opportunities. There are two hunting seasons of note: the spring and fall. The spring hunt occurs from after ice break-up to about mid-May and involves beaver, muskrat, and waterfowl. The fall hunting season occurs from late August to the end of October, and involves moose and waterfowl. Both seasons are important to ACFN and MCFN; however, the fall hunting season is emphasized in this report because of its relatively greater importance within the annual hunting cycle, its longer duration and because it is during this period when navigability challenges are most commonly experienced due to limitations of available flow. Fall flows fluctuate annually with prevailing hydrometeorological conditions; oilsands withdrawals are superimposed upon these flow dynamics leading to additional pressures on navigability.

Challenges to Indigenous Navigability

There is a diversity of navigability challenges distributed along the 213-km Athabasca River from Fort McMurray to Embarras. Depth limitations associated with the primary navigable channel (the thalweg) directly influence the opportunity, speed, and safety associated with accessing up-river locations and may include access in and out of short cuts. These aspects of Indigenous navigability associated with direct longitudinal connectivity along the Athabasca River are in addition to navigability requirements associated with more localized access to critical hunting locations. The local destinations focus on back channels, side channels, confluences, tributary mouths, and other sites critical to the fall hunt and not generally associated with the thalweg. Carver's (2018) analysis of data from Candler *et al.* (2010) shows that access to many of these sites is lost at flow rates well above the Aboriginal Extreme Flow (explained below).

[1] Capitalized seasons refer to seasons as defined in the SWQMF – see section 3.3.2, Table 1.

ACFN and MCFN river users also experience navigability challenges in parts of the PAD as a result of water flows in the Athabasca River. Based on five years of community-based monitoring (CBM) carried out by members of the MCFN and ACFN, Carver and Maclean (2016) show that lower Athabasca River discharge impacts water depth at sites in the southern portion of the PAD. Updated water flow and depth relations (using data from 2011-2017) for the Richardson River, Jackfish Creek and Embarras River sites in the southern delta are provided in Appendix A. (Further monitoring at Keane Creek has been discontinued.) In addition, Carver and Maclean (2016) identify relations at sites further north in the PAD where, although there is a wider range of factors at play shaping navigability and access, the effect of Athabasca River discharge is still evident. At these sites, Peace River is known to play an important role, particularly in terms of its *amplification* of any reductions or increases in Athabasca River recharge through the hydraulic-damming and flow-reversal mechanisms. (See box below.)

Three Complex Mechanisms Sustaining the PAD's Hydrologic Recharge

Hydraulic Damming: blockage of PAD outflows (from Lake Athabasca and other outflows – includes the Athabasca River) when the Peace River is higher in elevation. This phenomenon is also called obstructed flow and leads to higher water levels on Lake Athabasca and supports increases in water levels in the central lakes area.

Flow Reversal: reversal of the flow in the rivers connecting the Peace River to Lake Athabasca and major PAD lakes (and other tributaries to the PAD) by the Peace River when the Peace River is higher in elevation. This phenomenon occurs when the Peace River is at a higher relative elevation causing flow to move from the Peace River to the PAD and Lake Athabasca rather than its normal south-to-north direction. The channels involved are the Riviere des Rochers (Lake Athabasca), Chenal de Quatre Fourches (Lake Athabasca), Baril River (Baril Lake), and the Claire River (Claire Lake). Although most commonly brought about by high open-water on the Peace River (i.e., the annual freshet), it may also come about for shorter periods due to ice-jams.

Ice-Jamming: blockage of the lower Peace River by ice rubble during dynamic/mechanical break-up of its ice cover in the Delta reach, typically in late April and early May. Under favourable conditions, ice jams can cause highly elevated flooding able to access the highest perched basins within the PAD that would otherwise receive no recharge from floodwaters. (The "Delta reach" is the section of the Peace River that flows through the PAD. It comprises the lowest 50 km of the river, starting about 15 km above Carlson's Landing and ending at the mouth of Peace River (Beltaos 2007).)

The present situation already threatens the viability of Indigenous use of the river (and the PAD) and this escalation is reflected in the Government of Canada's initiative to lead the creation of an Action Plan in response to the recommendations of the World Heritage Committee (WHC & IUCN 2017). Recent reports from land users (ACFN knowledge holders, personal communications 2018) clarify that the widespread and increasing navigability challenges documented under the CBM program (Carver and Maclean 2016) have persisted in the subsequent years and have only grown worse. In addition, the SWQMF does not take into account that the current status of PAD recharge and water depth is below functional levels able to sustain the ecosystems that are the hallmark of the PAD's Outstanding Universal Value. Section 3.3 provides a detailed review of SWQMF's deficiencies.

3.1.2 Thresholds for Preserving Indigenous Navigability

Through work with ACFN and MCFN river users, Candler *et al.* (2010) have assembled the most comprehensive known body of data describing limitations to Indigenous navigability on the lower Athabasca River. In that study, Indigenous land users described and mapped incidents and hazards along the river from Fort McMurray downstream to the PAD. In addition to providing the spatial distribution of river navigability challenges, these observations were used to develop two thresholds indicative of Indigenous navigability:

> ***Aboriginal Base Flow*** (ABF) is defined as the river discharge above which ACFN and MCFN are able to practise Indigenous navigation and access territories fully. Below this threshold, navigability and access are compromised to differing degrees around the territory and are generally impaired as flow declines.
>
> ***Aboriginal Extreme Flow*** (AXF) is defined as the river discharge below which widespread and extreme disruption of Indigenous navigation occurs due to loss of access related to low waters.

Based on their study, Candler *et al.* (2010) provided preliminary estimates for these two thresholds:

- ABF=1600 m^3/s
- AXF=400 m^3/s

Subsequent to that study, ACFN and MCFN undertook detailed water-depth monitoring at various locations throughout their territories through a CBM field program. Critical limiting sites are emphasized in this ongoing field program. This program identified a number of locations that require a water depth of 1.2 m in order for ACFN and MCFN members to pass through successfully: if that depth is unavailable, Indigenous river users can lose access to a broad swath of territory on the other side. These locations are referred to as "pinch points" (Candler *et al.* 2010).

Carver and Maclean (2016) provide an analysis of five years of those CBM data. They found evidence at the monitoring sites that widespread and extreme disruption of Indigenous navigability due to loss of access related to low waters actually occurs at 500 m^3/s. They proposed that the AXF threshold be revised to 500 m^3/s. This is the threshold that ACFN and MCFN now assert as necessary to ensure the minimum level of navigability in their territories. This report also asserts an AXF of 500 m^3/s.

3.1.3 Distribution of Water Depth with Athabasca River Flow

As discussed in the previous section, water depths less than 1.2 m are known to signify lost access for Indigenous river users. How is this threshold distributed in the Athabasca River at various low flows and how intensively is it experienced? To help illustrate this, reach-specific water-depth maps that illustrate the navigability requirements introduced in the previous section are examined here in relation to a range of low river discharge and interpreted by information provided by knowledge holders about Indigenous navigability along the entire river from Fort McMurray to Embarras. Water-depth maps from Carver (2018) are available developed through application of a river hydraulic model to four reaches of the lower Athabasca River and including a collection of access situations. Figures 2-5 provide a subset of those water-depth maps. Model information as provided by Carver (2018) is summarized in Appendix B.

Figure 2. Athabasca River water-depth maps at the Embarras site (Segment 2) corresponding to a Fort McMurray discharge of a) 300 m^3/s, b) 400 m^3/s, c) 500 m^3/s, and d) 800 m^3/s.

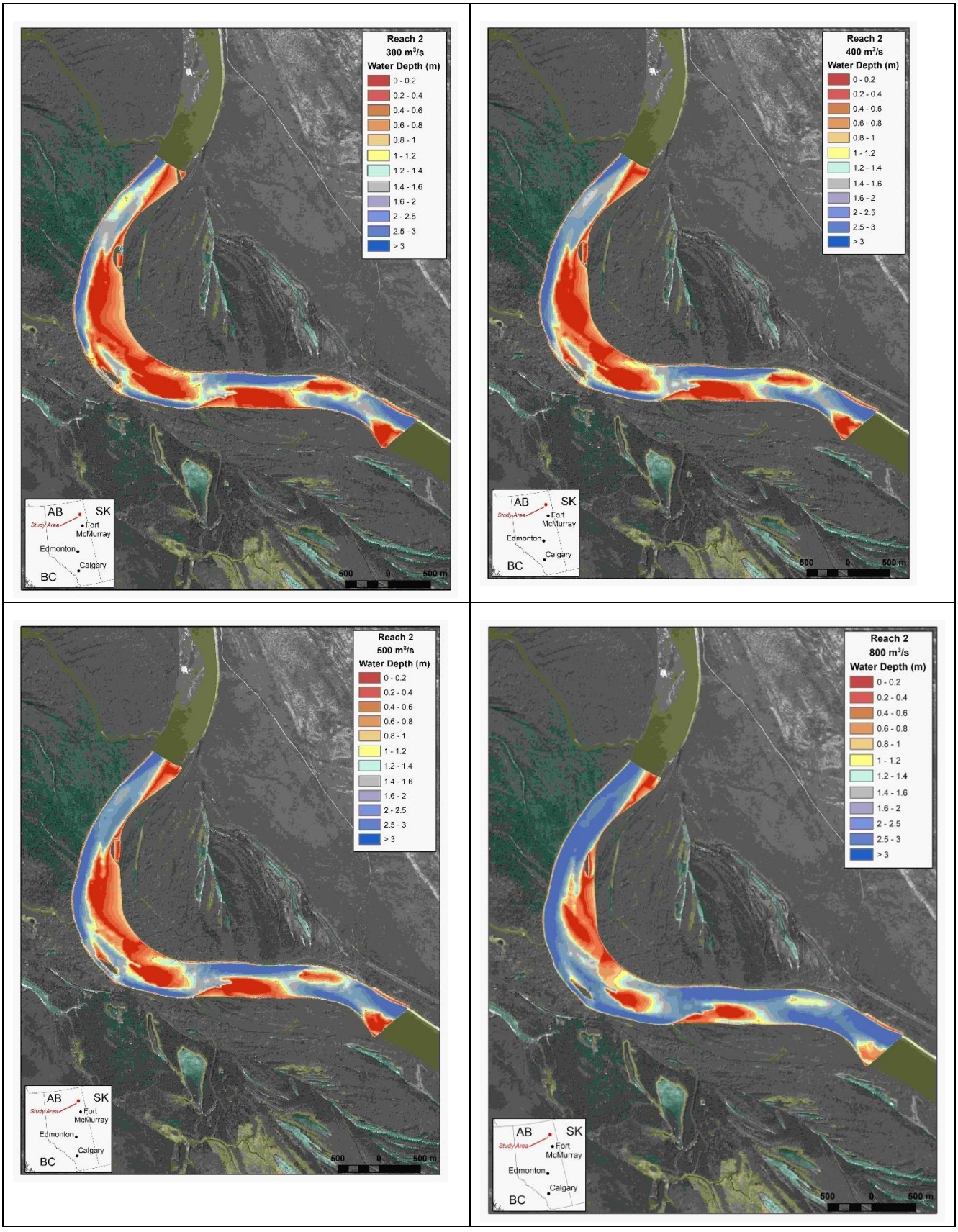


Figure 3. Athabasca River water-depth maps at the Poplar Point site (Segment 3) corresponding to a Fort McMurray discharge of a) 300 m^3/s, b) 400 m^3/s, c) 500 m^3/s, and d) 800 m^3/s.

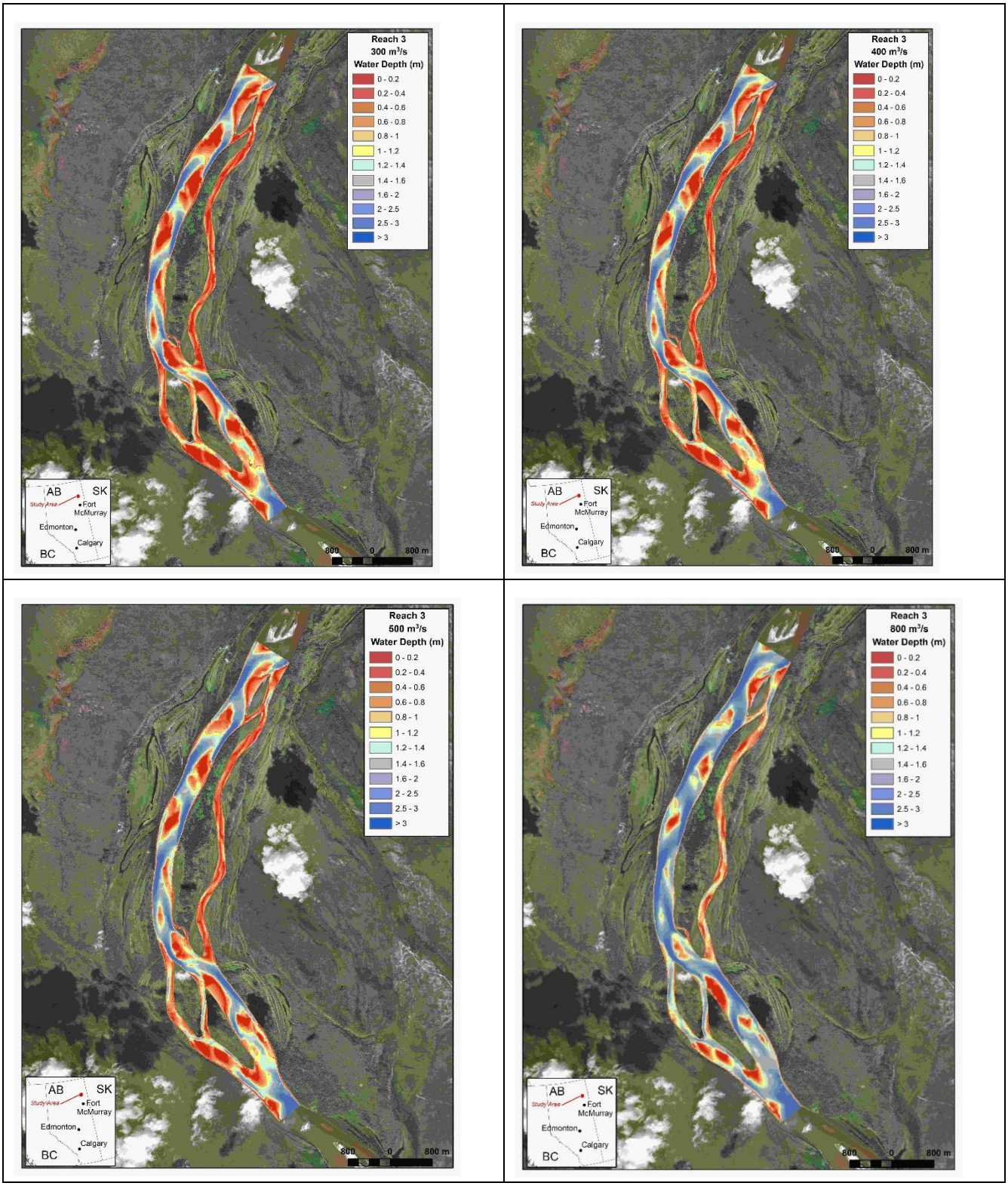


Figure 4. Athabasca River water-depth maps at the Bitumount site (Segment 4) corresponding to a Fort McMurray discharge of a) 300 m^3/s, b) 400 m^3/s, c) 500 m^3/s, and d) 800 m^3/s.

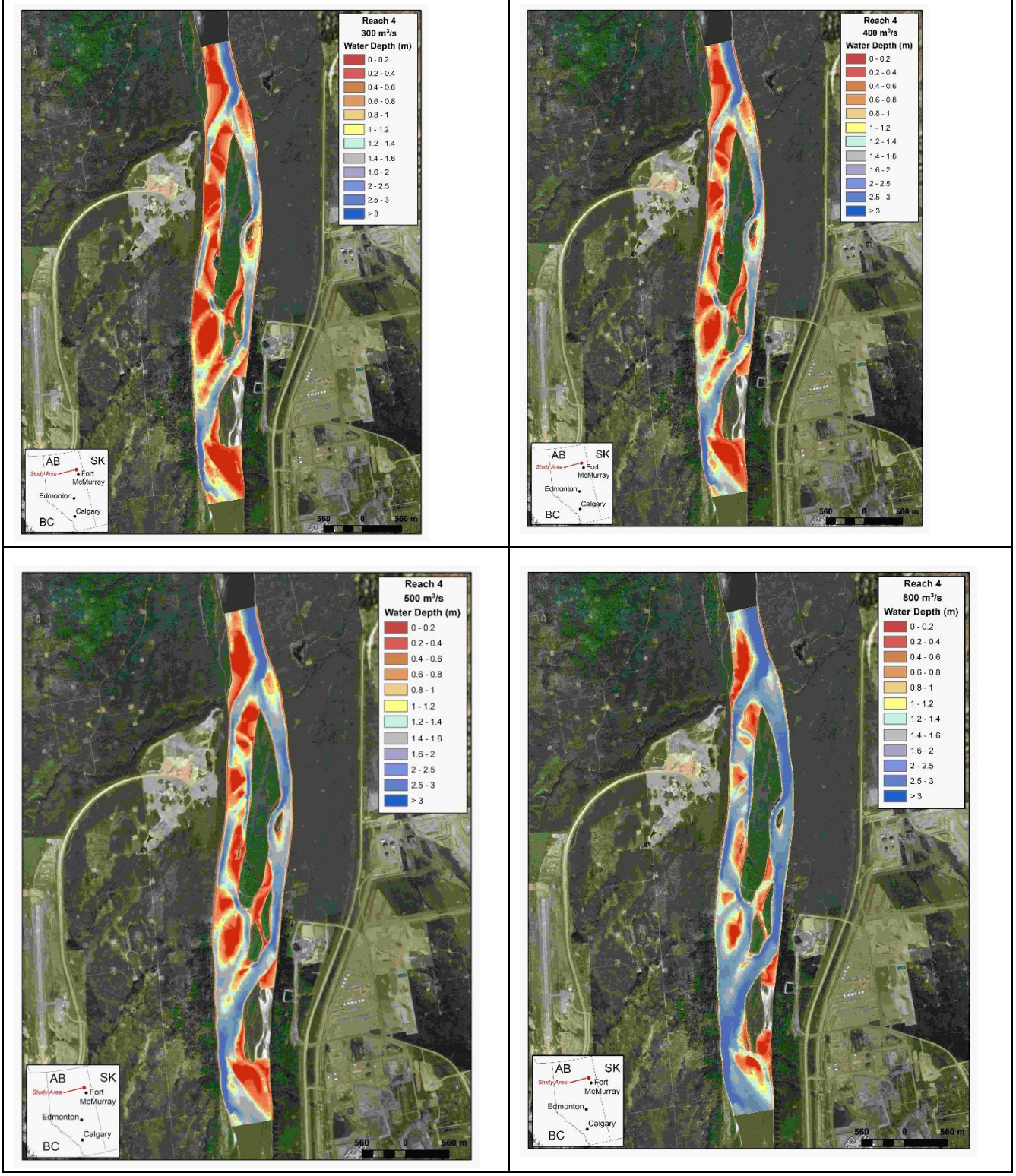
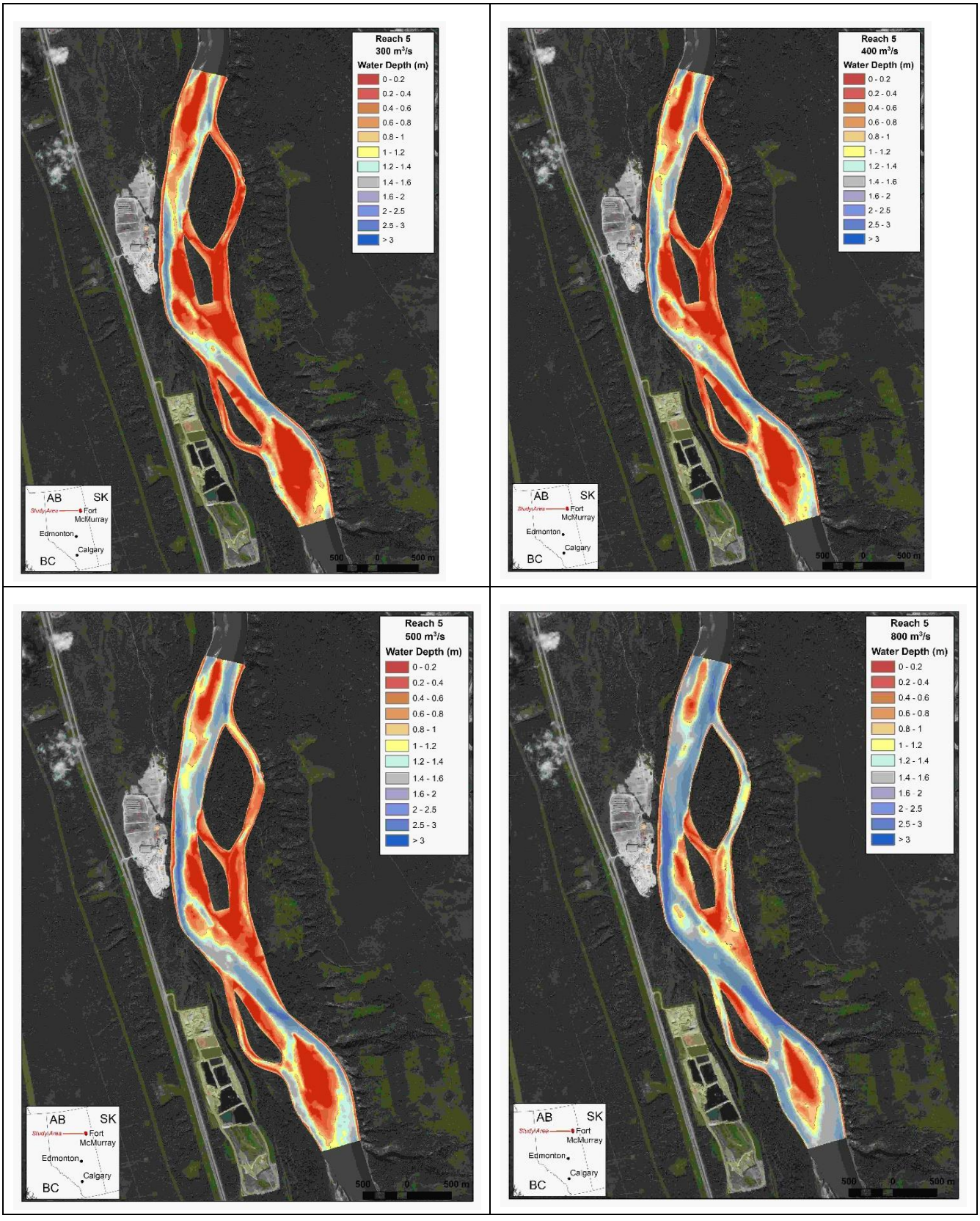


Figure 5. Athabasca River water-depth maps at the Northlands site (Segment 5) corresponding to a Fort McMurray discharge of a) 300 m^3/s, b) 400 m^3/s, c) 500 m^3/s, and d) 800 m^3/s.

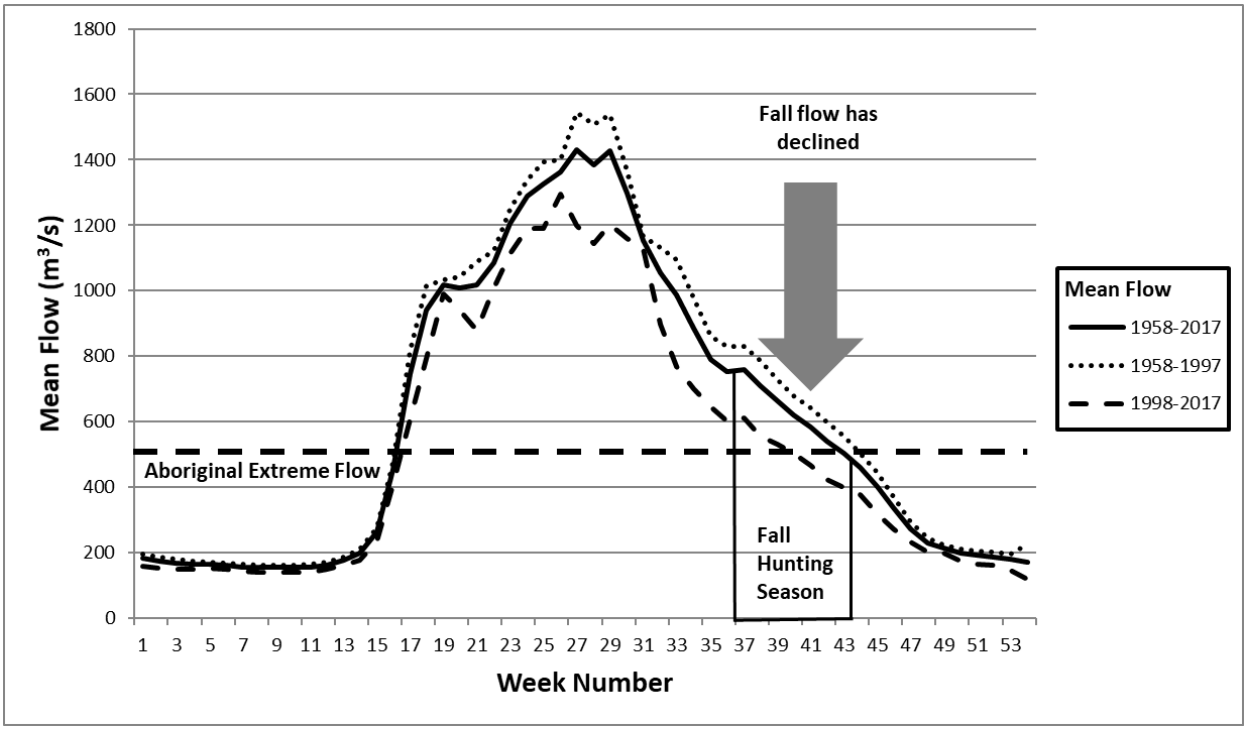


In Figures 2-5, the pale blue areas in these figures approach the 1.2-m threshold (access still plausible but very difficult) whereas the yellow areas go beyond it (access is seriously impaired or lost). In other words, the pale blue and yellow areas illustrate the zone of transition to lost access. Throughout the 300-500 m^3/s range displayed in these figures (flow rates which are projected to occur frequently in the 2050s and 2080s – see next section), it is evident that access is lost in the thalweg. (Access is difficult and can also be unsafe or compromised at higher flow rates.) Also, the maps associated with 800 m^3/s illustrate that access is lost to side channels and back channels at flow rates much higher than the AXF (and higher than 800 m^3/s). In addition, tributary confluences are known to encounter more frequent shallowing due to mainstem deposition of tributary sediment. These four reaches largely exclude confluences thus these especially vulnerable locations are also largely absent from these four examples.

3.2 Navigability and the Changing Athabasca River Hydrograph under Future Climates

Oilsands water withdrawals are not the only factor affecting Athabasca River hydrology, and its navigability, now and into the future. In recent decades, there has been a decline in fall flow of the Athabasca River due largely to climate change and based on measurements made at Fort McMurray, upstream of the oilsands region (see Figure 6). To further evaluate how the SWQMF is tasked with protecting navigability, this section considers changes to the fall flow of the Athabasca River projected to come about during MLX Project lifespan as a result of climate change and asks whether this added context adds further implications for Indigenous navigability and to the management burden of the SWQMF.

Figure 6. Change in measured discharge of the 60 years of instrumental record of the Athabasca River during the fall hunting season (weeks 36-43), contrasting the most recent 20 years with the previous 40 years (1998-2017 relative to 1958-1997).



The method of modelling future climates and Athabasca River flows is described in Appendix C (from Carver 2018). In brief, an ensemble of six Global Climate Models (GCMs) is forced with two greenhouse gas emissions pathways (RCP4.5 and RCP8.5) to generate future climates during the MLX Project lifespan. The projected climates are then used as input to a watershed model to identify future discharge in the lower Athabasca River. These discharge values can be related directly to navigability thresholds as elaborated in the previous section.

The climate futures indicated by the GCMs, and as forced by the respective RCPs, lead to changes in the hydrograph of the Athabasca River. Seasonal water yield is presented in Figures 7 and 8 in comparison to that which occurred during the baseline period (1971-2000) at the site on the Athabasca River where the Water Survey of Canada (WSC) hydrometric station 07DA001 is located (AIRM node 510) - here called "WSC 07DA001" and "Fort McMurray" in some plots. Seasons are defined following those of the SWQMF, namely, Early Winter, Late Winter (called "Mid-Winter" in the SWQMF), Early Spring, Late Spring, Summer, Fall and an added result for the combined Summer/Fall season (Table 1).

The modelling demonstrates that seasonal water yield adjusts substantially to future climates. ("Water yield" refers to the total river volume, at a point, determine over a specified period, and often expressed as the equivalent mean flow, in m^3/s.) During the baseline period (1971-2000), the seasonal water yield reflects the established pattern evident since 1958 when Athabasca River flow monitoring began. In that pattern, snowmelt produces a rapid rise during the Early Spring with a peak during the Summer, followed by a significant decline.

Although that general annual pattern in annual flow persists under future climates, the seasonal yields are significantly different. Early Spring and Late Spring yields increase with the advance of the hydrograph, while both the Summer and Fall yields decline. These findings are consistent with those of Leong and Donner (2015) and Eum *et al.* (2017): climate change advances the timing of spring runoff and shortens the persistence of late-season flow in the river leading to an increase in flow in the first half of the year and a decrease in the second half of the year. These changes are summarized in Table 2 for five hydrograph metrics: Fall and Summer seasonal yields and Fall, Summer and Late Winter 100-year low flow, and the 10-year low flow is also provided for the Fall season. These statistics reflect a decline in water availability during the Fall and late Summer and a modest increase in low flow during the Late Winter.

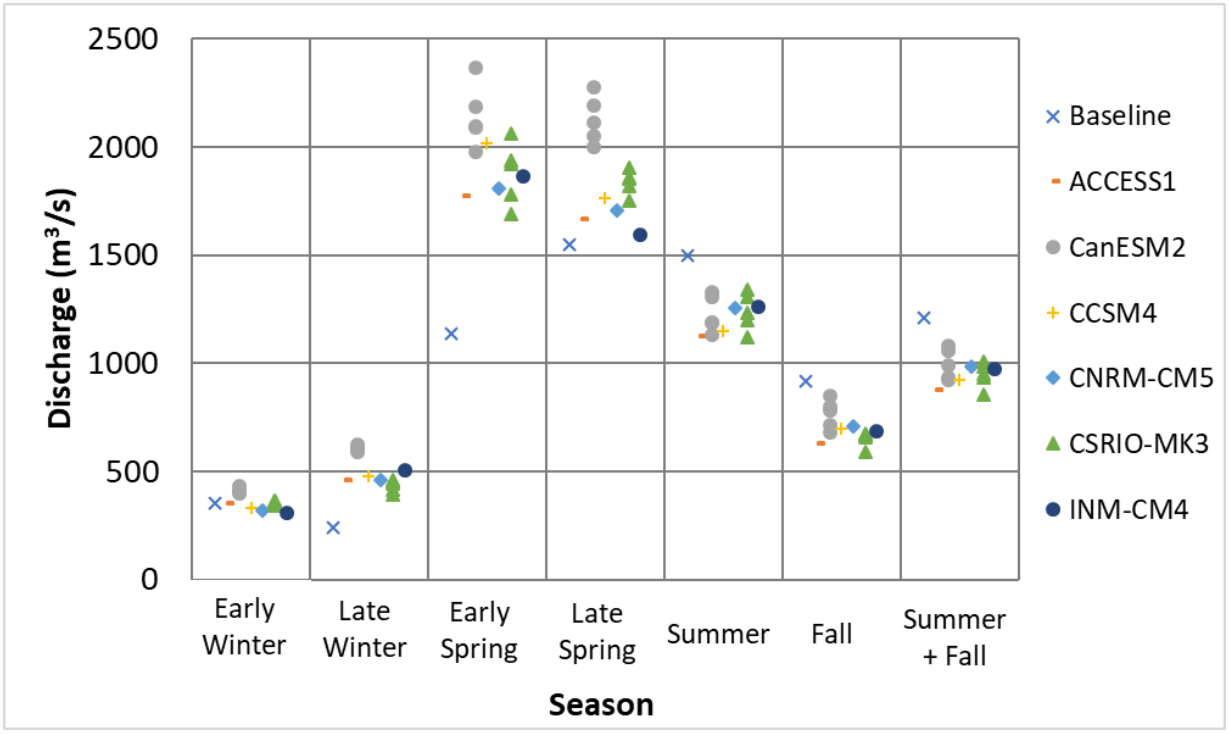
The climate modelling indicates:

- 10-year low flow is projected to range from 304-343 m^3/s, depending on the climate scenario (overall mean: 324 m^3/s); and
- 100-year low flow is projected to range from 253 to 288 m^3/s, depending on the climate scenario (overall mean: 270 m^3/s).

For both return periods, these low flows are more than 100 m^3/s below that of the baseline (reference period) which is 374 m^3/s (100-year) and 444 m^3/s (10-year). These results indicate that open-water low flow is expected to drop significantly during the life of the MLX Project. In other words, flows will more often approach or go below the AXF, including occurrences during the Summer season.

Figure 7. Seasonal mean projected water yield at the Fort McMurray location for all GCM runs in the 2050s under a) RCP4.5 and b) RCP8.5.

a) Fort McMurray 2050s RCP4.5



b) Fort McMurray 2050s RCP8.5

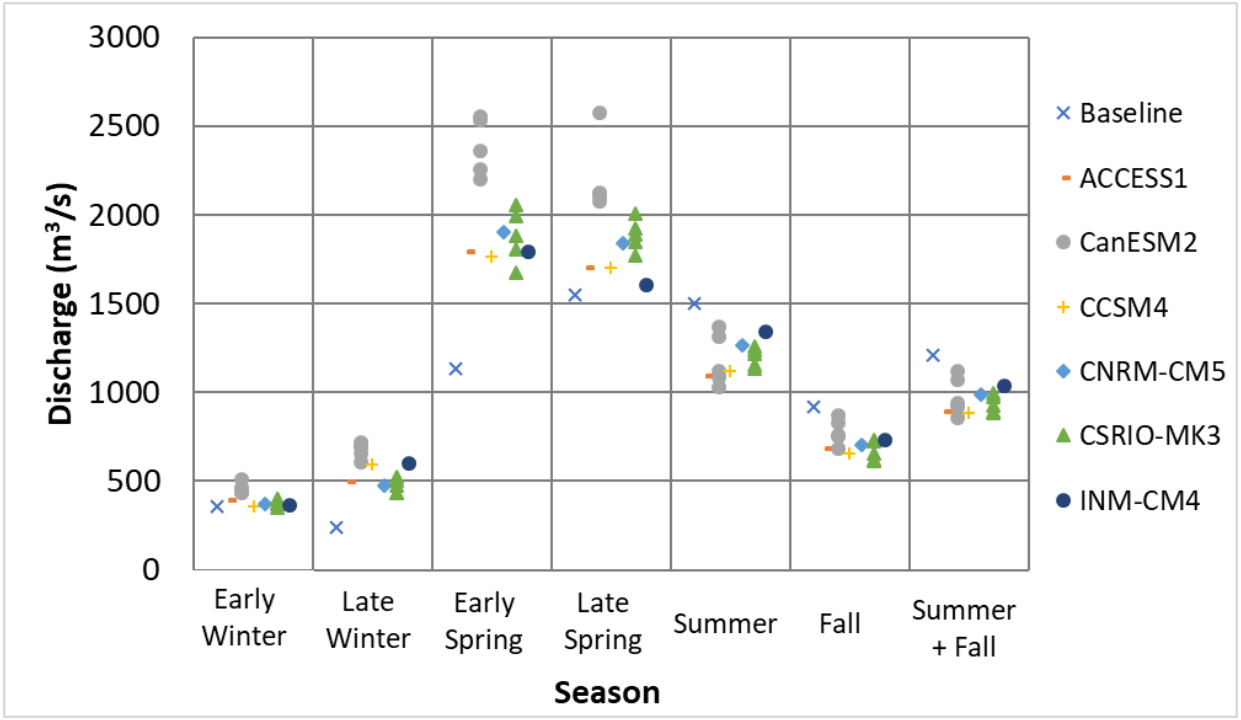
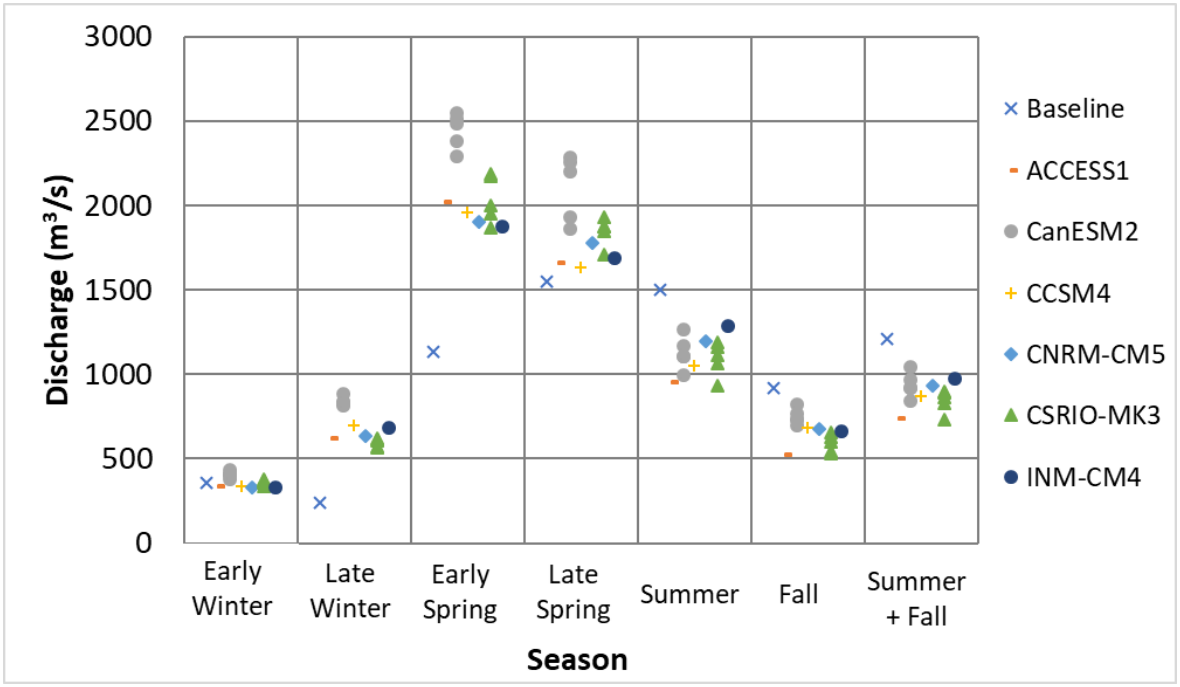


Figure 8. Seasonal mean projected water yield at the Fort McMurray location for all GCM runs in the 2080s under a) RCP4.5 and b) RCP8.5.

a) Fort McMurray 2080s RCP4.5



b) Fort McMurray 2080s RCP8.5

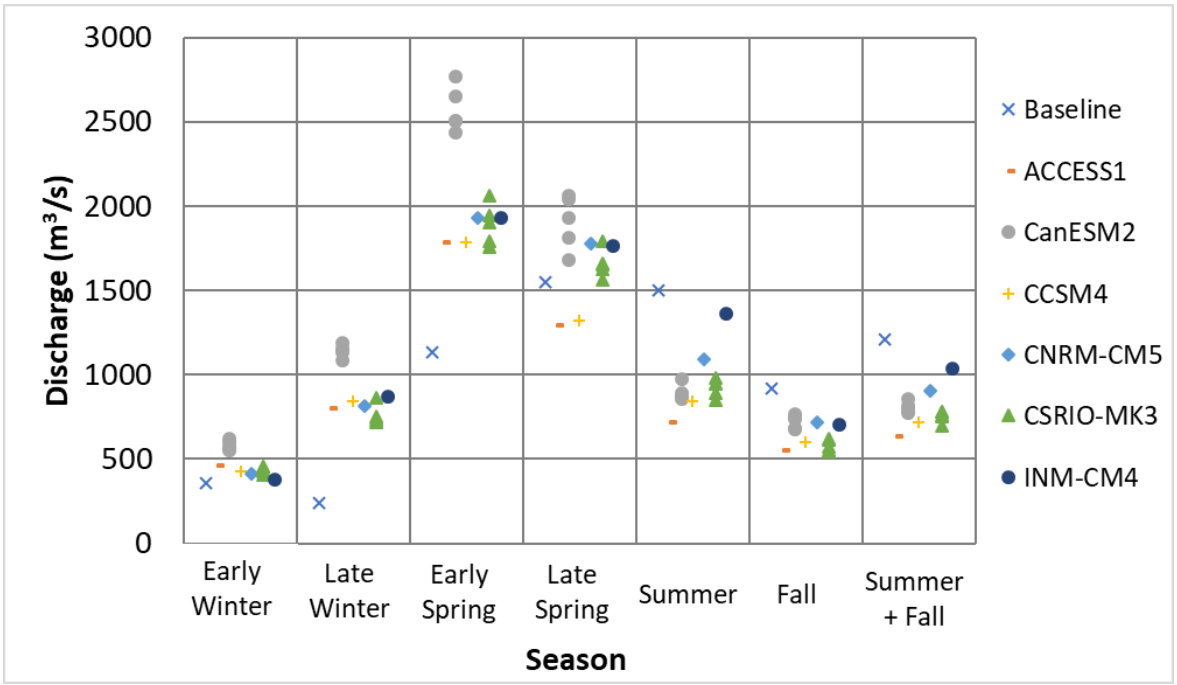


Table 1. Selected hydrograph metrics at Fort McMurray (WSC 07DA001) under two emissions pathways (RCP4.5 and RCP8.5) and for two timeframes, including the 1971-2000 baseline as reference.

Hydrograph Metric	RCP	Modelled Result (m^3/s)				
		Baseline	Mean[1]		Worst Case	
			2050s	2080s	2050s	2080s
Fall season yield	4.5	917	690	648	589	524
Summer season yield	4.5	1501	1210	1116	1118	933
Fall season yield	8.5	917	704	647	611	543
Summer season yield	8.5	1501	1200	970	1029	719
100-year 7-Day Low Flow (Fall Season)	4.5	374	272	269	232	209
10-year 7-Day Low Flow (Fall Season)	4.5	444	331	317	285	262
100-year 7-Day Low Flow (Fall Season)	8.5	374	288	253	216	180
10-year 7-Day Low Flow (Fall Season)	8.5	444	343	304	276	241
100-year 7-Day Low Flow (Summer Season)	4.5	595	403	349	293	292
100-year 7-Day Low Flow (Late Winter)	4.5	86	107	111	92	96
100-year 7-Day Low Flow (Summer Season)	8.5	595	392	324	292	211
100-year 7-Day Low Flow (Late Winter)	8.5	86	110	136	94	113

1 – Mean is the average of the 6 GCMs. Where GCMs have multiple runs, they are first averaged before being included in the GCM mean.

The incoming hydrograph has significant implications for the navigability of the lower Athabasca River and for possible opportunities for oilsands withdrawals. What is already a very difficult situation in the Fall and late-Summer seasons is projected to become far more difficult under future climates and would result in increased areas of lost access during low-flow periods. *These periods of water scarcity increase the significance and relative contribution of oilsands water withdrawals in affecting Indigenous navigability. The decline in magnitude of the open-water flows mean that there is less discretionary flow available for other activities like oilsands mining.* Syncrude has not considered this information in its EIA: that climate change on its own, without increasing water withdrawals, has the potential to worsen Indigenous navigability and when the increasing water withdrawals are also considered, a precarious picture emerges that needs assessment, in relation to Syncrude's MLX Project.

The future of navigability on the Athabasca River looks bleak: Indigenous navigability faces escalating difficulties due to the existing level of industrialization and the ongoing adjustments in the hydrograph resulting from climate change. These challenges are each expected to increase significantly in the coming decades. Leong and Donner (2015), Eum *et al.* (2017) and Dibike *et al.* (2018) describe the changing hydrograph as snow increasingly turns to rain with climate warming, leading to an earlier freshet with longer-duration lower low flows in the latter part of the open-water period. Based on long-term tree-ring data, Sauchyn *et al.* (2015) question the long-term reliability of the Athabasca River as the water source for oilsands mining. These and other studies highlight the growing conflict between oilsands withdrawals and Indigenous navigability.

3.3 Alberta's System of Rules for Prioritizing the Timing of Oilsands Water Withdrawals

3.3.1 SWQMF History and Evolution

In 2007, the GoA and DFO put in place the Phase One Water Management Framework (WMF) to establish limits to total oilsands-related water withdrawals from the lower Athabasca River (AENV & DFO 2007). Integral to the WMF development, was a commitment to subject the WMF to:

> "review and modification in Phase 2 as ecosystem knowledge improves and socio-economic considerations are taken into account…[and to]…make the required decisions by the regulatory backstop dates." (p12)

A significant process followed, led by the Cumulative Environmental Management Association and called the Phase Two Framework Committee (P2FC), which released its final report in 2010 (Ohlson *et al.* 2010) after many months of committee deliberations and considerable scientific effort. There were various problems with this process and its outcome was not supported by all committee members, yet the GoA moved forward with it to provide a selective basis for the creation of the Surface Water Quantity Management Framework (SWQMF). The SWQMF was first released as a draft in November 2013 by Alberta Environment and Sustainable Resource Development (AESRD 2013) and DFO. The final version was released in February 2015 and implemented in the fall of 2015.

Between the initial draft and final version, a second draft of the SWQMF was released on June 27, 2014 in response to technical input from ACFN and MCFN (Carver 2014a). This draft contained the first recognition by GoA of Indigenous navigability and the importance of protecting it in the lower Athabasca River. This draft introduced an index called the Aboriginal Navigation Index (ANI), however, as set out in more detail below, the ANI is ineffective in its structure and application, providing no protection to navigability. Despite objections from ACFN and MCFN (Carver 2014b), the GoA proceeded with implementing the SWQMF, maintaining the known shortcomings.

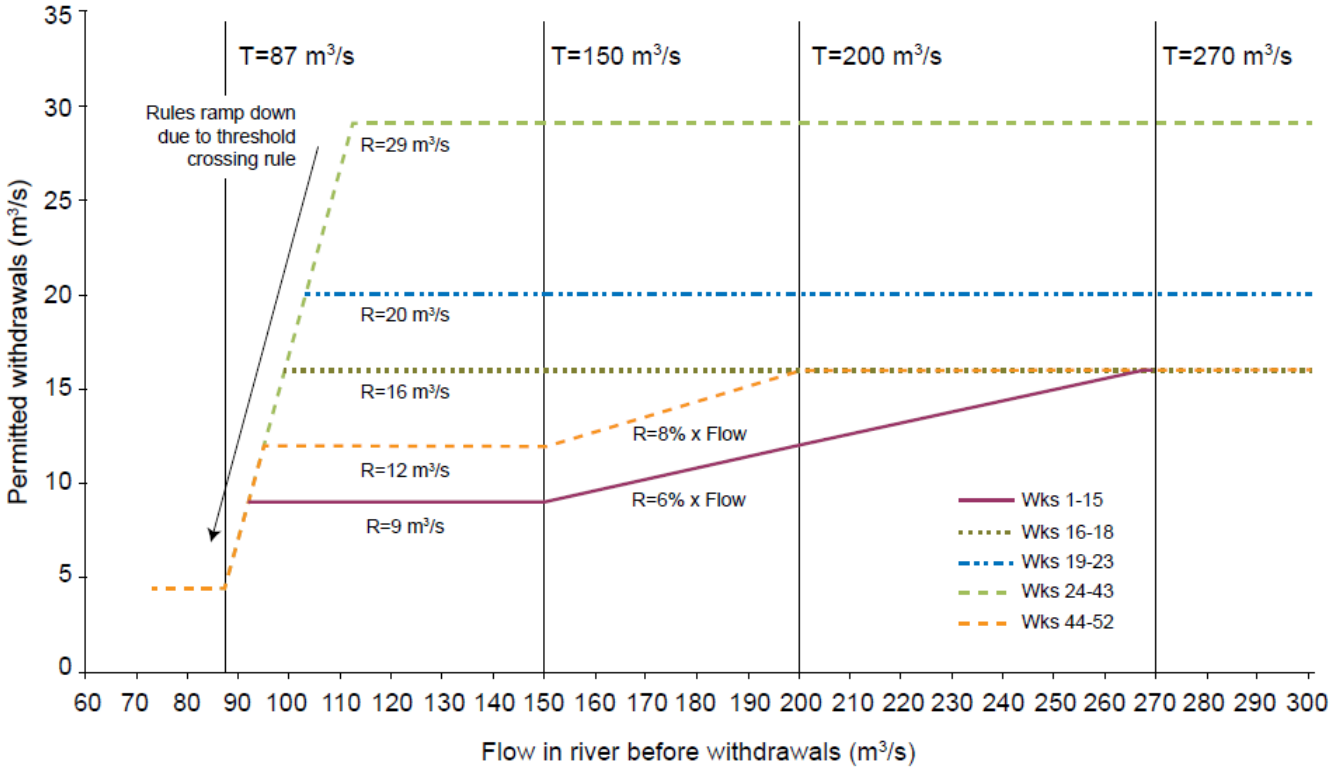
3.3.2 SWQMF Structure and Priorities

The SWQMF outlines the maximum seasonal total rate of water withdrawal (m^3/s; six seasons) that oilsands operators can withdraw collectively from the Athabasca River in relation to the river flow as measured just downstream of WSC 07DA001. (See section 3.2 for clarification about this Fort McMurray monitoring site.). These water-withdrawal rules are set up in reference to thresholds and triggers in relation to what are essentially indicators. A threshold is a limit value of an indicator beyond which a restriction comes into force or a management action may take place. A "trigger" is essentially the occurrence of an indicator reaching or crossing a threshold. The SWQMF includes weekly and adaptive-management triggers, which are explained in greater detail below. One of the adaptive-management triggers is called the Aboriginal Navigation Trigger which uses the Aboriginal Navigation Index (ANI).

Weekly Triggers

Weekly triggers (or "short-term triggers") identify withdrawal limits corresponding to discharge values in the river. The weekly triggers are structured according to six seasons. Each season has a maximum allowable water withdrawal rate and a corresponding minimum river discharge value. If the river discharge value, as measured at WSC 07DA001, drops below the relevant threshold, the trigger applies and the operators must reduce their water withdrawals accordingly. See Figure 9 below. Table 2 provides additional clarifications.

Figure 9. Total water-withdrawal limits imposed on oilsands operators expressed for each of five seasons as a function of the flow of the Athabasca River at WSC 07DA001.



Adaptive-Management Triggers (including Aboriginal Navigability Index and Trigger)

Adaptive-management triggers (or long-term triggers) alert the AER to departures from key assumptions that were used in the framework development. Those assumptions were used as input into the applied scientific work to develop some of the thresholds and withdrawal rates. They focus largely on the non-regulatory context of the SWQMF, verifying the assumptions used by the P2FC. They serve to reconfirm that boundary conditions and aspects and requirements of the framework have not drifted from what is considered acceptable. However, when triggered, the associated management actions are general in nature, simply implementing a review of factors to confirm whether the trigger event is reflecting a real concern.

Table 2. Seasonal definitions and maximum oilsands water withdrawals as provided in the Surface Water Quantity Management Framework.

Season	Weeks	Dates (day/month)	Minimum River Discharge for Maximum Oilsands Water Withdrawal	
			Max. Rate (m^3/s)	River Discharge Required (m^3/s)
Mid-Winter	1-15	1/1-15/4	16	270
Early Spring	16-18	16/4-6/5	16	98.6
Late Spring	19-23	7/5-10/6	20	102.6
Summer	24-33	11/6-19/8	29	111.6
Fall	34-43	20/8-28/10	29	111.6
Early Winter	44-52	29/10-31/12	16	200
Summer&Fall[1]	24-43	11/6-28/10	29	111.6

[1] –Under its weekly triggers, the SWQMF combines the Summer and Fall seasons into one longer season.

The second draft of the SWQMF sought to address concerns for Indigenous navigability as a non-regulatory adaptive-management trigger. A new indicator was created called the "Aboriginal Navigation Index" (ANI) which is tracked and applied in the SWQMF as an adaptive-management trigger called the "Aboriginal Navigation Trigger." The ANI is an equation that uses the following variables:

- a water flow-depth relation at Poplar Point, a single location in the Athabasca River where navigability can be restricted (SWQMF, p75) and where river bathymetry work had been conducted much earlier (CEMA 2007a 2007b) and could be used to create this index; and
- the weekly mean flow at WSC 07DA001 Fort McMurray.

The ANI calculation produces a value that is intended to indicate the state of Indigenous navigability:

- ANI = 0 when water depth at Poplar Point is one metre or less, reflecting a depth at which "navigation may be impossible with a fully loaded boat."
- ANI = 1 for flows at 1600 m^3/s (Aboriginal Base Flow; ABF) and above, "reflecting full access to traditional activities."

The ANI is calculated twice, once with oilsands water withdrawals and once without. *The difference is calculated based on a ten-week mean result for the entire fall season.* If the difference in the ten-week mean ANI values is more than 10%, a management action is triggered. This management action involves a "comprehensive assessment of factors potentially contributing to the exceedance" (SWQMF, p39) – that is, a review of information.

Priorities for Water Use

Priorities for water use embedded in the SWQMF are illustrated by the setting of weekly triggers, the selection of river values that are (or are not) given firm protection in the rules, and how effective and timely review and analysis are in protecting interests. That the concern for Indigenous navigability was lumped in with the adaptive-management triggers suggests that it was not held as a priority by the GoA, particularly given the shortcomings associated with the ANI.

An examination of the SWQMF in terms of these characteristics suggests that the priority for water use in the open-water season is industry and the priority for water use in the ice-covered season is shared between industry and fish. There is no priority given to Indigenous navigability in either of these seasons; this is spoken to only by an ineffective adaptive-management trigger - the ANI (see section 3.3.3). Even the reduction in permitted withdrawals during the ice-covered season for fish habitat offers only a scientifically-unsupported and weak protective measure for fish due to the absence of a winter cut-off flow and the use of 87 m^3/s as the lower limit for sustained significant winter withdrawals.

The AER reports that total oilsands water withdrawal rates are currently well below the limits established in the SWQMF (Islam and Leidl 2018). However, the limits are designed based on the requirements of the industry, not the requirements of Indigenous navigability or the limitations of ecosystems.

In effect, the SWQMF is a system that manages the ***timing*** of oilsands withdrawals, not a system that addresses the limits of withdrawals in relation to the requirements of the ecosystem or of Indigenous navigability. The weekly rules have been designed to meet the present and projected water requirements of an expanding oilsands industry throughout the year. Some modifications to demand timing - reductions in the winter - are made possible through the creation of storage ponds that are filled prior to the Early Winter season. Real-time (or even seasonal) feedback from the ecosystem or from those practising Indigenous navigation and land use is not used as input into decisions that could reduce the withdrawals to oilsands operators. As long as oilsands operators organize between themselves[2] to adjust the timing of their water demand according to the SWQMF schedule, they are assured that they will be permitted to withdraw the water they need for their operations *regardless of the consequences those withdrawals may have for the ecosystem or for traditional uses*. Notwithstanding the preliminary consideration given to the winter habitat flow requirements of fish, under SWQMF, Indigenous navigability and the ecosystem get what industry does not use, regardless of the potential consequences.

3.3.3 Performance of SWQMF in Relation to the Protection of Indigenous Navigability

The SWQMF includes considerable discussion about Indigenous navigability, elaborating on its importance and the measures included in the SWQMF to protect it (SWQMF, s9.3.7). The SWQMF positively reports on the science provided by Candler et al (2010):

[2] Operators are required to provide to AER a collective annual letter, indicating how they will share the allowable withdrawals such that the seasonal limits will not be exceeded. They use off-stream storage ponds to help meet their stated commitments and avoid supply disruptions.

"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" (p38).

Further, it adopts the language of Candler *et al.* (2010) in being responsive to concerns for Indigenous navigability:

"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; 1600 m^3/s) and Aboriginal Extreme Flow (AXF; 400 m^3/s)" (p37).

In addition, the SWQMF speaks of conservatism and precaution:

"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." (p39)

However, despite the positive language included in the document, the SWQMF does not provide adequate protection for Indigenous navigability because of deficiencies with the weekly triggers and the Aboriginal Navigation Trigger, a lack of transparency and accountability, and the priorities of the SWQMF.

Deficiencies with the Weekly Triggers

Various deficiencies have been identified associated with the weekly triggers:

- The weekly triggers do not provide any protection to Indigenous navigability. In the open-water season, oilsands operators are currently required to start reducing their water withdrawals when the Athabasca River discharge reaches 110 m^3/s. This threshold is significantly below the AXF (500 m^3/s), the flow at which widespread and extreme disruption of Indigenous navigability occurs. In fact, a flat rate of withdrawal is allowed through the entire transition from full access at the ABF (1600 m^3/s) to lost access at the AXF (500 m^3/s). No protection is available as navigability and access are incrementally lost.
- There are no seasonal instream-flow needs (IFNs) in place to protect navigability. An IFN for navigability would define the quantity and timing of water flows required to sustain navigability in the Athabasca River.
- The weekly triggers do not distinguish the Fall from the Summer. As a result, the SWQMF allows for highest rates of water removal (29 m^3/s) during a 20-week combined Summer/Fall season. This aggregated season represents 38.5% of the year and typically three quarters of annual open-water conditions.
- The weekly triggers have their nucleus in work carried out by the P2FC. However, that outcome did not receive consensus support either scientifically or from the participants. In addition, for a number of scientific reasons, that outcome is unreliable (see Carver 2014a, section 5.4 for details). Consider:
  - the weekly rules do not include seasonal cut-off limit thresholds (*e.g.*, an Ecosystem Base Flow or any commitments for Indigenous navigability) meaning water can be withdrawn no matter how little water may remain in the river;
  - the navigability assessments carried out by the P2FC were inappropriate for Indigenous use (see also Candler 2010, and Carver 2010);

- the P2FC outcome was subsequently altered by GoA after completion to lower the seasonal thresholds, making withdrawals more permissive;
- a serious spreadsheet error due to a staff member at Alberta Environment was discovered in the climate change projections after the process concluded casting doubt on the validity of the P2FC conclusions; and
- the P2FC outcome is inconsistent with the advice of the Canadian Science Advisory Secretariat specifically developed for the lower Athabasca River (CSAS 2010).

Deficiencies with the Aboriginal Navigation Trigger

As introduced above, calculation of the Aboriginal Navigation Index (ANI) is ostensibly the means by which the SWQMF protects Indigenous navigability. However, there is a number of shortcomings with the ANI and the management response that it triggers, as follows:

- The ANI is not based on the best available science and arbitrarily assumes that zero navigability occurs at 300 m^3/s (WSC 07DA001) and at a depth of one metre. Candler *et al.* (2010) and Carver and Maclean (2016) have shown that these thresholds are unjustified because widespread and extreme disruption of Indigenous navigability occurs at 500 m^3/s, with a water depth of 1.2 m. The GoA sets ANI to zero at 300 m^3/s and at a water depth of one metre "reflecting a depth at which navigation *may become impossible with a fully loaded boat*." (emphasis added) (GoA, p75)[3] following its own subjective view, one that is inconsistent with best available science.

- The ANI assumes watercraft need only a one-metre depth when Candler *et al.* (2010) have documented that at least a 1.2-metre depth is required.

- The ANI is based on a water flow-depth relation at only one location (Poplar Point) on the Athabasca River. Using information collected at a point in time (2007) from a single point on a sand-bed river is not representative of the range of concerns present throughout the lower Athabasca River and PAD in relation to Indigenous navigability and is likely out of date.

- The most serious declines in navigability are actually excluded from the evaluation because the ANI was designed to be set to zero for all river flows below 300 m^3/s, instead of being given appropriate negative values. Therefore, the ANI ignores – and actually removes from its tracking and evaluation – the conditions most restrictive for navigability. For example, see Islam and Leidl (2018, p24) "Week 43" which records nothing when flow dropped below 300 m^3/s. Notably, at conditions near and below the AXF when water depths are particularly low, *oilsands water withdrawals are disproportionately damaging to Indigenous navigability – the tracking system is thus designed to exclude these most damaging periods due to oilsands withdrawals*.

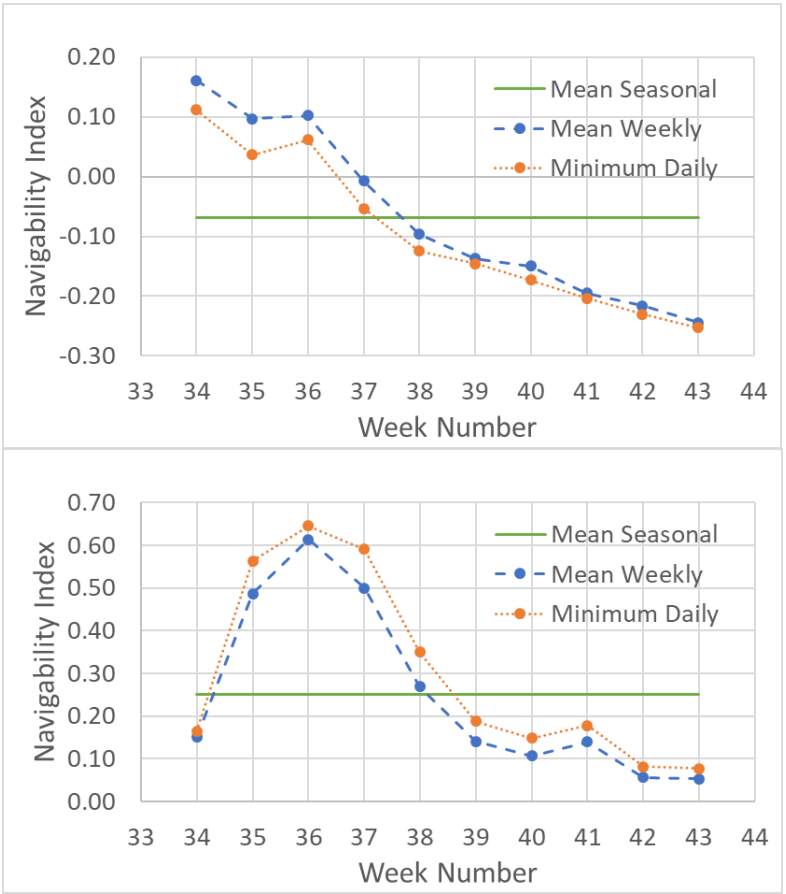
- The ANI trigger that is included in the SWQMF is concerned only with the incremental effect of oilsands, (*i.e.*. the added effect due to oilsands withdrawals above and beyond whatever may be happening due to other reasons).

[3] GoA also maintains that at "a flow of 400 m^3/s (AXF)… [n]avigation 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."

- In order to trigger any type of management action, the ANI requires a 10% reduction in the seasonal mean due to water withdrawals. As a result, management responses occur only under severely compromised navigability conditions.
- If a management action is triggered, "the management response associated with this trigger will initially focus on a comprehensive assessment of the factors potentially contributing to the exceedance" (SWQMF p39). This management response does not take any steps to change the conditions under GoA's regulatory control (*i.e.,*, oilsands withdrawals) that contributed to the exceedance.
- The ANI is not tracked from year to year to inform management of water withdrawals, thus patterns of change in this index through time have no influence on management.
- The ANI disregards declines occurring on a weekly (and daily) basis in favour of 10-week seasonal means, thereby masking significant variability and lost navigability within the season. See examples in Figure 10 that illustrate the extent that lost navigability is also lost from consideration using the current ANI's exclusive focus on mean index values averaged over the entire Fall season.

Figure 10. Variation in daily and mean weekly ANI in 1999 (upper) and 2016 (lower).

Note how information about severe navigability decline can be lost when only a seasonal mean is computed. Under the ANI, only the mean seasonal values (green) are relevant; the weekly (blue) and daily (orange) show the extent of navigability loss that is ignored by the ANI. Daily and mean weekly index values should be considered because they provide more precise information about the state of Indigenous navigability.



Lack of Transparency and Accountability in SWQMF Reporting

The SWQMF lacks key transparency measures that would enable the public to verify performance and effectiveness in safeguarding traditional-use values. Consider:

- The reporting of industry water withdrawals appears to be done without independent verification.
- Reported water withdrawals are not publicly available and appear to be available only upon request.
- GoA does not provide an independent scientific "check" of the flows downstream of oilsands operations as would be provided by hydrometric data.

Priority Water Allocation under the SWQMF Is Detrimental to Indigenous Navigability

In addition, due to the priority of water use accorded to oilsands operators, the SWQMF protections for fish require a trade-off at the expense of Indigenous navigability. In order to provide some protection to fish, the SWQMF requires operators to reduce withdrawals during the Early Winter and Mid-Winter seasons to limit flow declines during the time of year when river flows are the lowest and habitat the most limiting to fish survival. However, to ensure operators have enough water during these periods of reduced withdrawals, SWQMF permits maximum water withdrawals in the Fall to allow operators to fill up water storage ponds for use during the winter period. The fall is a critical hunting period for ACFN and MCFN and the fall hunt is dependent on the ability to safely and efficiently navigate waterways. In this way, the SWQMF *actually encourages the deterioration of Indigenous navigability during the critically important fall hunting season* and there are no SWQMF restrictions or protections to address this impact.

Indeed, SWQMF Fall season (Sept/Oct) discharge of the Athabasca River has already shown a recent marked decline as illustrated earlier in Figure 6. The mean hydrograph prior to 1998 sustained flows at and above the AXF throughout the fall hunting season (which generally takes place during weeks 36-43). In the past two decades, the mean hydrograph for this period has seen discharge drop well below the AXF during the hunting season. It is projected that this component of the Athabasca River hydrograph will decline further in magnitude under future climates (Leong and Donner 2015; Eum *et al.* 2017; also, see section 3.2). This raises concern for the further erosion of Indigenous navigability during the Fall and late Summer seasons. Rather than creating steps to alleviate it, SWQMF's internal makeup serves to *amplify* this growing threat to Indigenous navigability posed by climate change, pointing to a potential escalation of this problem under SWQMF.

In conclusion, the examination of SWQMF's structure, priorities and purported protective mechanisms indicates that Indigenous navigability, although identified in the SWQMF as a key element of Indigenous land use, is actually given no protection by the SWQMF.

3.4 Alberta's Response to Communicated Concerns from ACFN and MCFN

ACFN and MCFN have communicated extensively with GoA concerning the need for it to modify its rules governing oilsands water withdrawals so as to provide protection to Indigenous navigability. As introduced in section 3.3.1, the P2FC was used by GoA as a partial and selective foundation for the present SWQMF. In the five years between the 2010 P2FC release and the 2015 SWQMF release, ACFN and MCFN communicated repeatedly and substantively with GoA concerning deficiencies in its maintenance and protection of Indigenous navigability through successive versions of its water withdrawal rules. Consider:

- In 2010, ACFN and MCFN provided a detailed technical review of GoA's selected P2FC outcome and in relation to its protection of Indigenous navigability and the aquatic ecosystem of the lower Athabasca River. That report included 14 recommendations which appear to not have been responded to by GoA (or by DFO to whom they were also provided).
- AESRD hosted a workshop with ACFN and MCFN members on Feb 14, 2014 to discuss GoA's initial released draft of its new water withdrawal rules. That meeting resulted in a set of notes taken from the discussion (AESRD 2014a).
- In response to a subsequent SWQMF draft, ACFN and MCFN submitted a major technical review to GoA (and DFO) on May 28, 2014 (Carver 2014a). That review detailed GoA's gaps in protecting Indigenous navigability and included detailed reference to sources of concern within the P2FC process and outcome. It also provided nine recommendations to assist in addressing the gaps including one each for creating a weekly and adaptive-management trigger to support and protect Indigenous navigability.
- GoA responded to ACFN and MCFN (Carver 2014a) with a revised draft dated June 13, 2014 (AESRD 2014b) that included detailed *recognition* of the concern for navigability (through inclusion of the new and problematic ANI – see section 3.3.3) *but provided no measures to deliver protection*. GoA also provided tabulated commentary on the nine recommendations contained within Carver (2014a) and provided comments on them.

Repeated communications from ACFN and MCFN (*e.g.*, Carver 2014b, 2014c) subsequent to the June-13-2014 draft (AESRD 2014b) and including a technical meeting in Edmonton yielded no change to the draft's content. Although the GoA was aware of its deficiencies, the content related to Indigenous navigability was included in the final Framework in early 2015 and was implemented that fall, thereby assuring that no protection would be given to Indigenous navigability. Consistent with this weak science and GoA's apparent lack of commitment to protect and maintain Indigenous navigability, in an email dated October 5, 2014 (AESRD 2014c), Mr. Thorsten Hebben confirmed GoA's support for the incorrect 300-m^3/s and one-metre thresholds and noted that the SWQMF is focused on incremental impacts due to oilsands withdrawals and is not engaged with tracking long-term trends in Indigenous navigability.

On December 12, 2014 Stacey Smythe of AESRD indicated to MCFN that the SWQMF was now "within the Government approval process" and that "any additional incoming comments regarding the SWQMF will be held for consideration in the future". She indicated that the "intent of ESRD remains to have the SWQMF fully addressed in Cabinet by January 2015, and to begin supporting the Framework implementation upon the approval." Since that letter, she has also stated in a letter to Melody Lepine (Director of MCFN Government and Industry Relations):

> "During the implementation of the Framework, Alberta will be seeking additional input from MCFN. In the future, we are anticipating an augmentation to the existing information through the Community-based Monitoring system managed by Mikisew Cree First Nation and the Athabasca Chipewyan First Nation to inform updates of the preliminary Navigation Index."

This was four years ago; there has been no update to the index since that time, despite new published information from the ACFN/MCFN CBM program including the data from Carver and Maclean (2016) and Appendix A of the present report, both of which have been previously made available to GoA.

The GoA has indicated that it is unwilling to consider changes to the SWQMF until it has been in place for five years. It has not explained how this time period can be reconciled with comments in SWQMF about the new ANI that "[t]he indicator will be preliminary and subject to continuous improvement, as more knowledge around navigation becomes available" (SWQMF, p37).

4.0 AMENDING ALBERTA'S SWQMF RULES TO DELIVER PROTECTION FOR INDIGENOUS NAVIGABILITY

As described in section 3, the SWQMF does not manage oilsands water withdrawals from the lower Athabasca River in a manner that protects the longstanding and scientifically-described navigability requirements of Indigenous peoples who depend on travel and territorial access using this major waterway. Existing mines and new mine applications depend on the GoA to put in place appropriate rules and effective measures to protect Indigenous navigability and access that may be affected by oilsands water withdrawals. Whereas Syncrude may implicitly assume that compliance with the SWQMF is sufficient to mitigate MLX Project impacts, a closer examination shows that this is an unreliable assumption. As explained in section 4.1, a mine's compliance with the SWQMF does not mitigate its impacts. In response, the subsequent sections 4.2-4.5 consider how the SWQMF can be amended to provide adequate protection for Indigenous navigability while balancing oilsands water withdrawal requirements.

4.1 SWQMF Compliance Does Not Mitigate MLX Project Impacts

Syncrude relies on its compliance with the *Water Management Framework* (AENV & DFO 2007) to provide assurance that MLX Project effects on Indigenous navigability will be negligible (Syncrude 2014, p1114). This is inappropriate because the *Water Management Framework* is no longer applicable in Alberta; the SWQMF has been in place since 2015, giving Syncrude sufficient time to update its EIA. (Syncrude's Project update provided in October 2018 did not mention or address this inconsistency.) Assuming that Syncrude will comply with the current regulatory framework, it is important to note that while the SWQMF is more demanding that the Water Management Framework, it delivers no protection to Indigenous navigability, as elaborated in detail in section 3.3.3.

Therefore, Syncrude's compliance with the SWQMF cannot be used as a basis for concluding that the MLX Project will have a low or negligible effect on the environmental flow requirements of the lower Athabasca River (including the key river function of minimum Indigenous navigability). In fact, to preserve water availability for oilsands operators in the winter, the SWQMF actually encourages water withdrawals to occur during SWQMF's Fall season. This is the time Indigenous navigability is critically needed for the fall hunting season and is already demonstrably jeopardized by existing rules and current and future hydrograph conditions (Carver and Maclean 2016).

Thus, Syncrude's compliance with either the *Water Management Framework* or the SWQMF implies that MLX Project winter water demands will be met at the expense of Indigenous navigability and may, in fact, exacerbate existing problems with Indigenous navigability on the lower Athabasca River and increase loss of Indigenous access to territory.

4.2 Protection of Indigenous Navigability through Weekly Triggers

The SWQMF could protect Indigenous navigability if it were amended appropriately. It is the SWQMF's weekly triggers, the short-term rules dictating limits to industrial water withdrawals, that are the mechanisms most able to provide timely and strong protection of river values such as Indigenous navigability. Section 3.1 has described the requirements of Indigenous navigability and provided updated results from recent field monitoring and research. There is an ample body of scientific knowledge available

to create accurate and meaningful weekly triggers to protect Indigenous navigability. The SWQMF's Fall and late Summer seasons (June 11 – October 28) are the periods when Indigenous navigability is most in need of protection. As discussed in section 3.1, the AXF identifies the discharge (measured at WSC 07DA001) below which there is widespread and extreme disruption of Indigenous navigability and access. The preliminary AXF value of 400 m^3/s (Candler *et al.* 2010) has subsequently been revised by ACFN/MCFN to 500 m^3/s based on five (now seven) years of CBM data (Carver and Maclean 2016). Using the AXF (500 m^3/s) as a basis, the weekly triggers required to protect Indigenous navigability are as follows:

1) A cut-off threshold at 500 m^3/s. Once the Athabasca River discharge reaches 500 m^3/s at WSC 07DA001, all operators would be required to cease water withdrawals, no exemptions allowed.

2) A reduction threshold at 700 m^3/s. Once the Athabasca River discharge reaches 700 m3/s at WSC 07DA001, all operators must step down their withdrawals so that total oilsands water withdrawals are no greater than 20 m^3/s. This precautionary signal assists operators to adjust their operations in anticipation of the cutoff at 500 m^3/s and to lessen the impact of industrial withdrawals on Indigenous navigability in the transition toward the AXF. This threshold is consistent with that of the short-term trigger currently in place for the Late Spring season.

4.3 Revised Adaptive Management Trigger, Using a Reconfigured Index to Meaningfully Reflect and Effectively Protect Navigability

A revised adaptive management trigger is also required to protect Indigenous navigability over the longer-term. As discussed above, the Aboriginal Navigation Trigger is ineffective because it is based on an Index that is incorrect and misleading, and if triggered, the management response fails to compel any meaningful corrective action to address the cause of the problem.

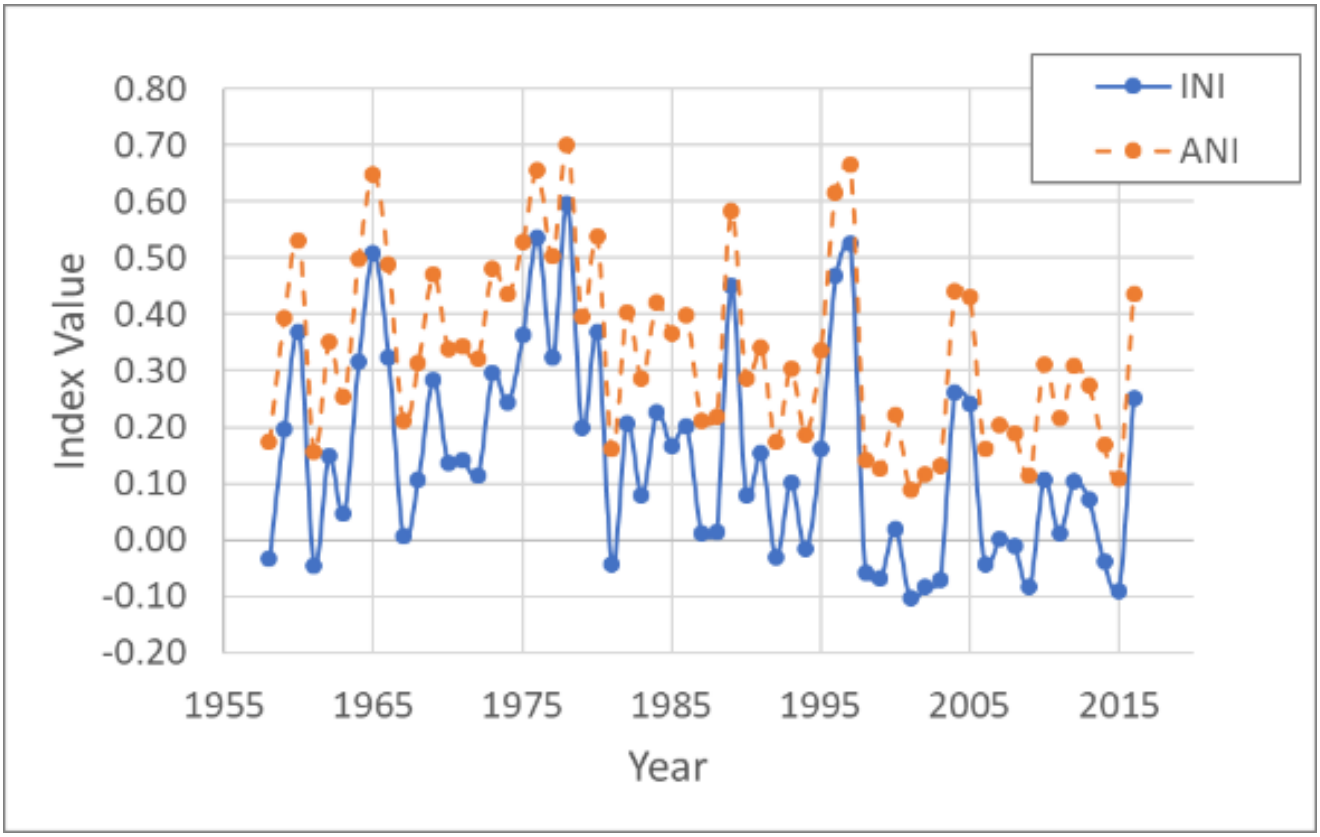
The shortcomings of the ANI and the associated trigger can be addressed by creating a reconfigured index and a revised trigger. The new index could be renamed the "Indigenous Navigability Index" (INI) to help distinguish it from the GoA's version and to more appropriately emphasize navigability rather than navigation. The zero point of navigability for the INI should be set at the AXF, a discharge of 500 m^3/s (measured at WSC 07DA001), corresponding with the findings of Carver and Maclean (2016) and Candler *et al.* (2010). The INI would also retain negative values.

Using INI = 1 at the ABF and INI = 0[4] at the AXF, a simple linear relation could be used. For INI < 0, loss of navigability occurs; these negative values could be defined using Indigenous knowledge in terms of reductions in functionality of river-based access and transportation at a majority of the restricted sites and site types, and include factors such as load restrictions, watercraft limitations, speed constraints, etc. Note the increased effectiveness and accuracy of the INI over the ANI as illustrated in Figure 11 which shows the historic trend in ANI (orange) compared to the recalculation of the historic ANI as the INI (blue). The INI's formulation and tracking through time illustrates clearly the occurrences of lost access and navigability in the lower Athabasca River.

[4] Discharge refers to the river flow as measured at WSC 07DA001. This formulation yields 0 at 500 m^3/s (consistent with Carver and Maclean 2016) and 1 at 1600 m^3/s (consistent with Candler *et al.* 2010 as the point at which access to Territory is effectively complete). These two points are used to yield a simple linear relation between discharge and INI.

Figure 11. Mean Fall-season Aboriginal Navigation Index and proposed Indigenous Navigability Index from 1956-2016.

Using INI (blue) shows the number of years with below-zero values, indicative of widespread and extreme disruption of Indigenous navigability and loss of access. The ANI (orange) remains positive despite the lost access. Also, note the long-term declining trend in the index since 1976.



The revised navigability trigger should focus on the real condition and trends of Indigenous navigability, rather than only the incremental or additional effect due to oilsands withdrawals. If the prevailing conditions decline, potentially jeopardizing functional navigability, GoA's management of oilsands water withdrawals should be responsive to the tracked changes. The reconfigured navigability index (as described above) would assist the trigger in being effective. Daily and weekly declines in navigability should be tracked and responses provided.

4.4 Monitoring of Water Depth, Navigability Limitations and River Discharge

Monitoring is a cornerstone of an effective, transparent and accountable resource management system. It is vital to know the condition of the system and be able to evaluate the indicators on which that condition is determined if appropriate management responses are to be enacted. Three monitoring areas require greater attention in the SWQMF:

Water-Depth. Since 2010, the ACFN and MCFN have been monitoring water depth at locations distributed throughout their territories in the region downstream of the oilsands. Initial analysis has been provided by Carver and Maclean (2016). These data sets emphasize pinch points and assist in better understanding the effects of river discharge on navigability limitations and in describing spatial variability in water depth across territories. This information is critical to tracking and understanding changes to Indigenous navigability. Although the SWQMF indicates that it intends to use this on-the-ground information, in fact this information critical to tracking and understanding changes in Indigenous navigability is not supported or utilized by SWQMF.

Navigability Limitations. Navigability in the lower Athabasca River and PAD is dynamic, changing with discharge, river-bed morphology, sedimentation, *etc*. Some PAD zones are also affected by the flow regime of the Peace River and other factors. It is ACFN, MCFN and other Indigenous land users who can provide the best raw field data on navigability of the areas because they are actively out on the land and waterways, experiencing its changing condition and able to most effectively report on short-term and long-term patterns in navigability.

Athabasca River Discharge. Currently, SWQMF relies entirely on discharge measurements taken upstream of the oilsands mining area. SWQMF should include downstream flow data to assist in understanding navigability conditions in the lower river and to confirm assumptions about water availability below the oilsands intakes. (Measurement of flow rates below 1600 m^3/s should be emphasized because these are where navigability constraints escalate.) Flow is currently measured downstream of the oilsands region however, AEP [Alberta Environment and Parks] will not use that information in SWQMF because "downstream stations cannot achieve the same accuracy as the 07DA001 station." (Thorsten Hebben 2014). While this is true if the full range of potential river discharge is being monitored (because the Fort McMurray site has a good cross-section control), if the focus is on measuring low discharge only, the two could be equivalent.

4.5 Transparency, Reporting and Verification of Performance and Outcomes

Annual reporting of the "State of Indigenous Navigability" should be prepared and publicly released before the start of each subsequent open-water season. Data used in SWQMF or referred to in the report should be made public. Field data such as CBM and imagery should be used to verify performance and outcome claims. Such a report would provide the opportunity for cross-checking the measured flow at Fort McMurray with the measured flow at the Eymundson RAMP hydrometric station (or with another appropriate station downstream of the oilsands that is set up to reliably measure lower flow rates relevant to managing for minimum Indigenous navigability).

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In conclusion, summary responses are given here to the three questions posed at the report's outset.

1. Does Alberta's Surface Water Quantity Management Framework (SWQMF) adequately protect and/or maintain Indigenous navigability of the lower Athabasca River? Explain.

The SWQMF is clear that Indigenous navigability of the lower Athabasca River is of value and should be tracked and protected. Peer-reviewed scientific publications point to projected declines in flow during the latter part of the open-water season, now reinforced by new research undertaken by MCFN and reviewed in section 2.3 of the present report. As a lead participant in the P2FC science process which was instrumental in the creation of the SWQMF, GoA is also aware of the changing hydrograph of the lower Athabasca River resulting from climate change - both now and into the coming decades – that increasingly threatens Indigenous navigability. In its SWQMF, GoA recognizes the leading science describing the minimum requirements of Indigenous navigability and affirms the framing and concepts provided in that science. Whereas GoA applies the threshold *concepts* of that science that it recognizes as sound and legitimate, it subjectively – and without evidence - eases the actual threshold *values* in SWQMF in such a way that the management actions deliver no protection to Indigenous navigability.

In addition, the SWQMF actually encourages added oilsands pressure on Indigenous navigability during the Fall season due to the configuration of its weekly rules. By reducing permitted withdrawals during the winter season, and increasing permitted withdrawals during the open-water period, the SWQMF effectively compels oilsands operators to store water in the latter part of the open-water season to enable them to limit their water withdrawals during the ice-covered season. However, these Fall and late-Summer periods are also the same time when Indigenous navigability is most needed to support the fall hunting season, and are already in greatest jeopardy due to the observed declining hydrograph. This is discussed further below in reference to question #3.

In light of these findings, it is concluded that the SWQMF does not adequately protect or maintain Indigenous navigability on the lower Athabasca River.

2. Would Syncrude's compliance with the SWQMF mitigate and/or avoid impacts to Indigenous navigability on the lower Athabasca River? Explain.

Compliance with the SWQMF does not provide an indication of the effects that the MLX Project may have on Indigenous navigability because that is determined by the efficacy of SWQMF performance itself. This report has shown how the SWQMF rules influence operators to reduce their winter withdrawals in favour of increased withdrawals during the open-water season, and particularly during the Fall and late Summer in the period prior to freeze-up. This regulatory design is in place to help support winter fish survival during the annual low-flow period. These Fall and late-Summer periods are also the same time when Indigenous navigability is most needed to support the fall hunting season. SWQMF includes no weekly rules to limit water withdrawals in support of Indigenous navigability. Thus, not only do the rules not provide any explicit protection, they actually compel operators to withdraw water more heavily during the time when it

is most needed to support traditional uses. Further, it is understood that the changing climate is bringing about an increase in the magnitude of winter low flows *while Fall and late-Summer low flows are decreasing*. This shift is projected to continue into future decades.

Thus, it is concluded that Syncrude's compliance with SWQMF (nor with the 2007 Water Management Framework) does nothing to protect Indigenous navigability or avoid or mitigate MLX Project impacts. In addition, Syncrude has not provided an assessment of the impacts of its Project on Indigenous navigability. If the MLX Project is approved, if Syncrude wishes to avoid contributing to the further decline of Indigenous navigability, Syncrude will have to go beyond SWQMF compliance and avoid withdrawing water when open-water flows go below the (revised) AXF of 500 m^3/s. As part of the EIA process for the MLX Project, it should also provide an assessment to AER of the impacts of its water withdrawals on Indigenous navigability.

3. What changes are required to improve the SWQMF's regulation of oil sands water withdrawals from the lower Athabasca River so that it minimizes and/or avoids the impact of those withdrawals on Indigenous navigability?

If SWQMF is to protect Indigenous navigability from impacts of oilsands water withdrawals, it will need to be amended so that its rules limit withdrawals in a manner that recognizes the requirements of Indigenous navigability. Such recognition is particularly pertinent in SWQMF's Fall and late Summer seasons. Protective weekly triggers are needed during those seasons to limit oilsands withdrawals when river flow declines below 700 m^3/s and then shut off withdrawals (without exemption) when the flow drops below the AXF of 500 m^3/s.

The Aboriginal Navigation Index also needs to be reconfigured so that it is meaningful and applied in such a way that it is effective in supporting the tracking and interventions required to protect Indigenous navigability. This would involve establishing its "zero point" (datum) at the AXF (500 m^3/s) and including its negative values (when river flow drops below the AXF) to appropriately inform tracking and annual reporting. SWQMF should also recognize and track weekly (and potentially daily) index values, in addition to the seasonal mean values that are currently its exclusive reporting focus (Islam and Leidl 2018). With a reconfigured "Indigenous Navigability Index" (INI) in place, long-term trends in this index need to be tracked so that management interventions can be proactively enacted to assure continued protection including measures designed to both better understand navigability needs and to lessen oilsands demands.

Greater transparency and accountability are also suggested through frequent public reporting of industry withdrawals and AER decisions under the SWQMF rules. A strengthened monitoring regime is needed of river flow downstream of the oilsands intakes as well as water-depth at critical pinch points, building on the well-established Indigenous-led CBM program. This CBM field information should be integrated effectively into SWQMF's decision-making regime through a collaborative and active process of adaptive management.

Given the ongoing expansion of the oilsands, and the projected increase in oilsands water demand particularly in relation to filling the End Pit Lakes (EPLs), these changes to SWQMF may be insufficient to avoid conflict in the future. Seasonal Athabasca River flows are expected to continue to decline during the latter half of the open-water period due to climate change. At some point, there may be no surplus water available for oilsands purposes during long periods in the open water season, particularly during dry years.

Either the industry will have to redesign its operations (*e.g.*, avoid creating EPLs) or GoA will have to scale back the extent of mines being considered for approval. Otherwise, GoA will be unable to confirm that oilsands expansion will not continue to undermine Indigenous navigability.

5.2 Recommendations

This study has determined that the SWQMF does not deliver protection for Indigenous navigability in the lower Athabasca River. Syncrude's EIA materials suggest the MLX Project may impact flows in the Athabasca River that can significantly contribute to lost Indigenous navigability now and into the future. The findings have also shown that Syncrude's EIA materials do not assess the potential effects of its proposed MLX Project on Indigenous navigability of this river and assume that compliance with the now outdated water management rules (AENV and DFO 2007) addresses the potential effects of Syncrude's water withdrawals and other impacts on water flow within the Athabasca River. Due to the nature of the SWQMF's structure and priorities, Syncrude cannot assure regulators that its compliance with SWQMF will not detrimentally affect Indigenous navigability. If the MLX Project is approved, mitigations will be required. In addition, changes to SWQMF are needed either as part of the mitigations or to address the potentially unrecognized impacts associated with existing oilsands mines operating in compliance with SWQMF.

In support of these findings and implications, this study provides 11 recommendations for consideration by the Alberta Energy Regulator Review Panel.

A. Amendments to Surface Water Quantity Management Framework

1) Create new SWQMF weekly triggers.

Include two effective weekly triggers to protect open-water Indigenous navigability. Require a full cut-off at the AXF (500 m^3/s at WSC 07DA001) reflecting the flow required for full Indigenous navigability. Include a second weekly trigger at 700 m^3/s requiring operators to lower their withdrawals to a total maximum of 20 m^3/s as a precautionary limit to assist them in adjusting their operations and to moderate impacts to Indigenous navigability in the transition toward reaching the AXF.

2) Remove 4.4-m^3/s low-flow exemption.

Revise the current exemption permitting withdrawals of 4.4 m^3/s at any flow so that it does not apply to the open-water season. The exemption was established to address concerns present during the winter that are inapplicable during the open-water season.

3) Reconfigure SWQMF's Aboriginal Navigation Index.

Reconfigure the Aboriginal Navigation Index so that it is zero at the AXF (500 m^3/s, measured at WSC 07DA001). Retain negative values of the index. Consider renaming it the Indigenous Navigability Index (INI).

4) Amend SWQMF's Aboriginal Navigation Trigger.

Redesign the SWQMF's Aboriginal Navigation Trigger to be a proactive and effective advanced-warning system in support of Indigenous navigability. In it, include:

- considerations of long-term (multi-annual) and short-term (daily, weekly, seasonal) changes in navigability;

- explicit effective management interventions should navigability loss occur due to oilsands withdrawals; and
- close collaboration with ACFN and MCFN and other Indigenous groups to identify and verify issues requiring management action.

5) Incorporate downstream flow monitoring data into SWQMF decision-making.

Apply data from existing or new hydrometric monitoring stations downstream of the oilsands region into the SWQMF to verify available water for Indigenous navigability and to improve understanding of navigability dynamics. Focus discharge measurements on flow rates below the ABF (1600 m^3/s).

6) Support CBM and incorporate updates to thresholds into SWQMF.

Provide long-term support to Indigenous-led community-based monitoring (CBM) and work closely with First Nations, under an active adaptive management approach, to incorporate CBM data and Indigenous knowledge concerning Indigenous navigability and its thresholds into SWQMF decision making.

7) Expand public reporting on the State of Indigenous Navigability.

Report publicly on the State of Indigenous Navigability and including field information, hydrometric data, verified weekly operator water-withdrawal records, trigger responses, and progress under adaptive management.

B. Revisions to Syncrude's Effects Assessment of MLX Project on Indigenous Navigability

8) Improve understanding of river bathymetry.

Syncrude to gather river bathymetry data emphasizing sections of the lower Athabasca River between the Syncrude MLX Project and the Peace-Athabasca Delta that are valued for Indigenous use and expected to experience navigability limitations under low-flow conditions. Work closely with affected Indigenous communities to optimize selection of reaches chosen.

9) Provide effects assessment on Indigenous navigability.

Syncrude to provide an assessment of MLX Project effects on Indigenous navigability through examination of multiple limiting locations and in consideration of the types of river habitats, access situations, transport requirement *etc.* needed for Indigenous-use purposes.

C. Long-Term Oilsands and Water-Use Planning

10) Re-assess projected expansion of oilsands mining in light of requirements of Indigenous navigability.

Government of Alberta to revisit proposed build-out of the oilsands industry in light of its potential incompatibility with traditional-use practices in relation to Indigenous navigability. Focus assessment on the implications of climate change and seasonal river flow projections in light of the Government of Alberta's obligations in maintaining Indigenous navigability and access to Indigenous lands.

11) Examine changes to oilsands water use to reduce conflict with Indigenous navigability.

In light of the water-resource requirements needed to sustain Indigenous navigability, examine conventional oilsands design and practice to discover opportunities to reduce impacts to Indigenous navigability. Potential opportunities that should be coordinated across the oilsands industry include explicit scheduling of the timing of filling of End Pit Lakes, re-examination of capacity requirements for off-stream water storage, and revisions to oilsands water licenses in order to reduce the rates of water withdrawals permitted under water licenses and to avoid seasonal conflict with the needs of Indigenous navigability.

6.0 DUTY AS EXPERT WITNESS

In connection with the Syncrude MLX Project hearing proceeding before the Alberta Energy Regulator, I prepared this report for Athabasca Chipewyan First Nation and Mikisew Cree First Nation entitled "Indigenous Navigability of the Lower Athabasca River: Alberta's SWQMF & Syncrude's Proposed Mildred Lake Extension Project".

As the author of this report, I confirm that I prepared it cognizant of my duties to assist the Regulator and not to act as an advocate for any particular party. I am aware that my duty to the Regulator prevails over any obligation I may owe any other party, including ACFN and MCFN. Further, I have prepared this report in compliance with the following duties:

1. To provide evidence that is fair, objective and non-partisan;
2. To provide evidence that is related only to matters within my areas of expertise; and
3. To provide such additional assistance as the Regulator may reasonable require to determine a matter in issue.

Prepared by:

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December 14, 2018

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7.0 REFERENCES

Alberta Environment and Department of Fisheries and Oceans (AENV&DFO) 2007. *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River*, 37 p.

Alberta Environment and Sustainable Resource Development (AESRD) 2013. *Surface Water Quantity Management Framework for the Lower Athabasca River*. 47 p, including three appendices.

Alberta Environment and Sustainable Resource Development (AESRD) 2014a. *Draft Surface Water Quantity Management Framework for the Lower Athabasca River, Draft Tailings Management Framework for the Oil Sands Region, Summary Notes from February 14, 2014 Workshop*. Fort McMurray, Alberta, 9 p.

Alberta Environment and Sustainable Resource Development (AESRD) 2014b. *Surface Water Quantity Management Framework.* Letter from Stacey Smythe, Aboriginal Engagement and Planning Unit, Edmonton, 2 p.

Alberta Environment and Sustainable Resource Development (AESRD) 2014c. *Surface Water Quantity Management Framework.* Email from Thorsten Hebben (October 15 2014 4:45pm) to Sebastien Fekete (MCFN), 2 p.

Beltaos S 2007. The role of waves in ice-jam flooding of the Peace-Athabasca Delta. *Hydrological Processes* 21:2548-2559.

Canadian Science Advisory Secretariat 2010. *Science Evaluation of Instream Flow Needs (IFN) for the Lower Athabasca River*. September 2010, 22 p. Available at: http://www.dfo-mpo.gc.ca/CSAS/Csas/publications/sar-as/2010/2010_055_e.pdf

Candler C 2010. *Review of the Athabasca River Phase II Framework Committee (P2FC) Report, January 2010 – Aboriginal Knowledge, Use, Interest and Rights*. Technical Memorandum to the ACFN and MCFN, the Firelight Group.

Candler C, R Olson and S DeRoy 2010. *As Long as the Rivers Flow*, Prepared for the ACFN and MCFN, November 26 2010. Parkland Institute, University of Alberta. Available at: https://s3-us-west-2.amazonaws.com/parkland-research-pdfs/aslongastheriversflow_summary.pdf

Carver M 2018. *Assessment of Impacts to Water Quantity, Indigenous Access and Traditional Use due to Teck's Frontier Mine*. Report prepared for the Mikisew Cree First Nation for submission to the Joint Review Panel for the Frontier Mine, August 31, 96 p.

Carver M and B McLean 2016. *Community-Based Water-Depth Monitoring in the Peace-Athabasca Delta: Insights and Evaluation*. Report prepared for the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation, July 2016, 54 p.

Carver M 2014a. *Surface Water Quantity Management Framework for the Lower Athabasca River* (Government of Alberta & Dept of Fisheries and Oceans) Technical Review. Report prepared for the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation, May 28, 2014, 57 p.

Carver M 2014b. *Surface Water Quantity Management Framework for the Athabasca River* (GoA & DFO 2014) Review of Draft 2. Report prepared for the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation, August 5, 2014, 5 p.

Carver M 2014c. *October 5, 2014 email response to August-5-2014 review of SWQMF second draft.* Review Letter to Mr. Thorsten C Hebben from Aqua Environmental Associates on behalf of ACFN and MCFN, Dec. 11, 2014, 4 p.

Carver M 2010. *Review of the P2FC Phase 2 Water Management Framework Outcome – Hydrology, Geomorphology, Decision Framework*. Report prepared for the Athabasca-Chipewyan and Mikisew Cree First Nations, Aqua Environmental Associates, Nelson BC, 41 p.

Clarke GKC, AH Jarosch, F Anslow and others. 2015. Projected deglaciation of western Canada in the twenty-first century. *Nature Geoscience* 8:372-377.

Cumulative Environmental Management Association (CEMA) 2007a. *Winter Bathymetric Surveys on Reach 3 of the Lower Athabasca River* (Poplar Point).

Cumulative Environmental Management Association (CEMA) 2007b. *Winter Lower Athabasca River Habitat Surveys – 2007 Winter Flow Simulations at Poplar Point* (Reach #3).

Dibike Y, H Eum and T Prowse 2018. Modelling the Athabasca watershed snow response to a changing climate. *Journal of Hydrology: Regional Studies* 15:134-148.

Eum H, Y Dibike and T Prowse 2017. Climate-induced alteration of hydrologic indicators in the Athabasca River basin, Alberta, Canada. *Journal of Hydrology* 544:327-342.

Golder Associates Ltd. (Golder) 2004. *Athabasca River Instream Flow Needs Scoping Study*. Prepared for the Cumulative Environmental Management Association, Surface Water Working Group, Instream Flow Needs Subgroup. Calgary Alberta, April 2004.

Government of Alberta (GoA) 2015. *Surface Water Quantity Management Framework for the Lower Athabasca River*. February 2015, 79 p. Available at: http://aep.alberta.ca/land/programs-and-services/land-and-resource-planning/regional-planning/lower-athabasca/documents/LARP-SurfaceWaterQuantity-Feb2015.pdf

Hebben T 2014. *Surface Water Quantity Management Framework*. Email from Thorsten Hebben (Water Policy Branch, Alberta Environment and Sustainable Resource Development) to Sebastien Fekete (MCFN Government and Industry Relations), October 15, 2014 4:45pm, 1 p.

Islam Z and C Leidl 2018. *2015 and 2016 Status of Surface Water Quantity for the Lower Athabasca Region, Alberta, Reporting on the Surface Water Quantity Management Framework*. Government of Alberta, Environment and Parks (April 2018). ISBN 978-1-4601-3580-8, 25 p. Available at: https://open.alberta.ca/publications/9781460135808.

Leong DNS and SD Donner 2015. Climate change impacts on streamflow availability for the Athabasca Oil Sands. *Climatic Change* 133:651-663.

Ohlson D, G Long and T Hatfield 2010. *Phase 2 Framework Committee Report*. Final report of the Phase 2 Framework Committee, 125 p plus appendices.

Sauchyn DJ, J St. Jacques and BH Luckman 2015. Long-term reliability of the Athabasca River (Alberta, Canada) as the water source for oil sands mining. *Proceedings of the National Academy of Sciences* 112(41):12621-12626.

Stahl K, RD Moore, JM Shea, D Hutchinson and AJ Cannon 2008. Coupled modelling of glacier and streamflow response to future climate scenarios. *Water Resources Research* 44:W02422.

Syncrude Canada Ltd. (Syncrude) 2018. *Mildred Lake Extension Project Proceeding ID 361. Applications 1820856, 00263298-005, 00363203-001, 00000026-034, MSL0352, MSL170423 and MSL170430*. Hearing Submission of Syncrude Canada Ltd, October 4, 2018, 96 p.

Syncrude Canada Ltd (Syncrude) 2014. *Environmental Impact Assessment for the Mildred Lake Extension Project.* Three volumes. 3477 p.

Trillium Engineering and Hydrographics Inc. (Trillium) 2004. *Open Water survey of the Athabasca River at Bitumount (Reach #4)*. CEMA. Project Number: 03-560, Lower Athabasca River Habitat Surveys.

Trillium Engineering and Hydrographics Inc. (Trillium) 2005a. *Summer Survey of the Athabasca River at Embarras (Reach #2)*. CEMA. Project Number: 04-568 Lower Athabasca River Habitat Surveys.

Trillium Engineering and Hydrographics Inc. (Trillium) 2005b. *Summer Survey of the Athabasca River at Poplar Point (Reach #3)*. CEMA. Project Number: 04-568 Lower Athabasca River Habitat Surveys.

Trillium Engineering and Hydrographics Inc. (Trillium) 2005c. *Summer Survey of the Athabasca river at Northlands (Reach #5)*. CEMA. Project Number: 04-568 Lower Athabasca River Habitat Surveys.

UNESCO World Heritage Centre (WHC) and International Union for Conservation of Nature (IUCN) 2017. *Reactive Monitoring Mission to Wood Buffalo National Park, Canada (September 25 to October 4, 2016)*, Mission Report January 2017, 78 p.

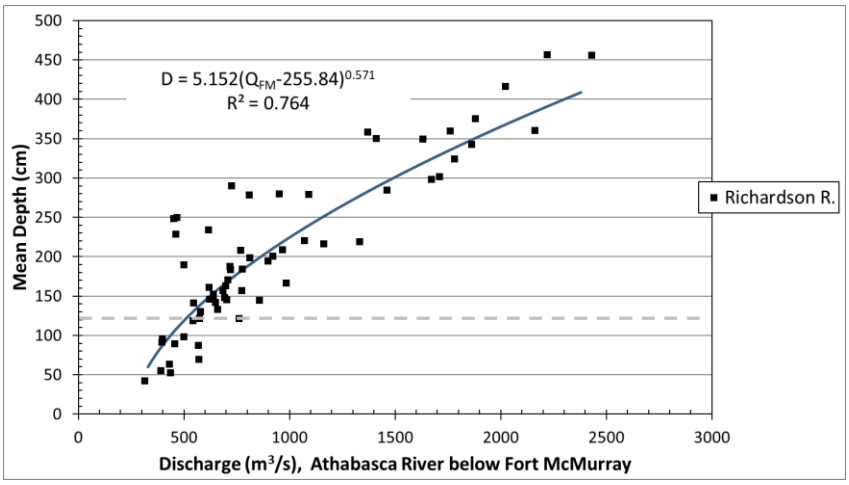
van Vuuren DP, J Edmonds, M Kainuma, K Riahi, A Thomson, K Hibbard, GC Hurtt, T Kram, V Krey, J-F Lamarque, T Masui, M Meinshausen, N Nakicenovic, SJ Smith and SK Rose 2011. The representative concentration pathways: an overview. *Climatic Change* 109:5-31.

Wang T, A Hamann, D Spittlehouse and TN Murdock 2012. ClimateWNA – High-resolution spatial climate data for western North America. *Journal of Applied Meteorology and Climatology* 61:16-29.

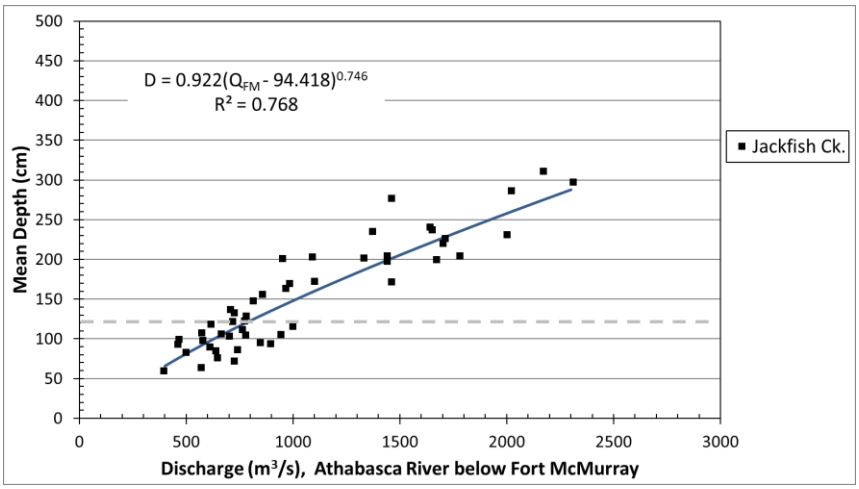
APPENDIX A. UPDATED CBM WATER-DEPTH RELATIONS AT SITES IN THE SOUTHERN PAD (2011-2017)

Figure A1. Updated power functions relating depth at three CBM sites in the southern PAD to the discharge of the Athabasca River at Fort McMurray: a) Richardson River b) Jackfish Creek and c) Embarras River near Athabasca River.

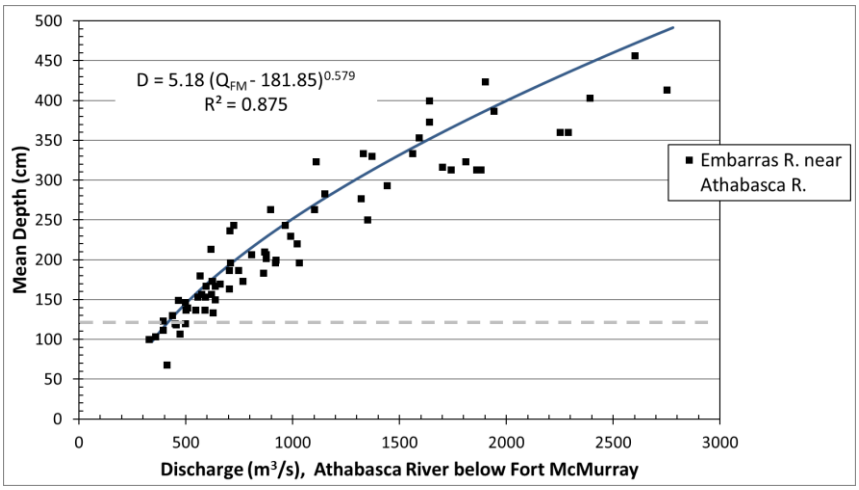
a)



b)



c)

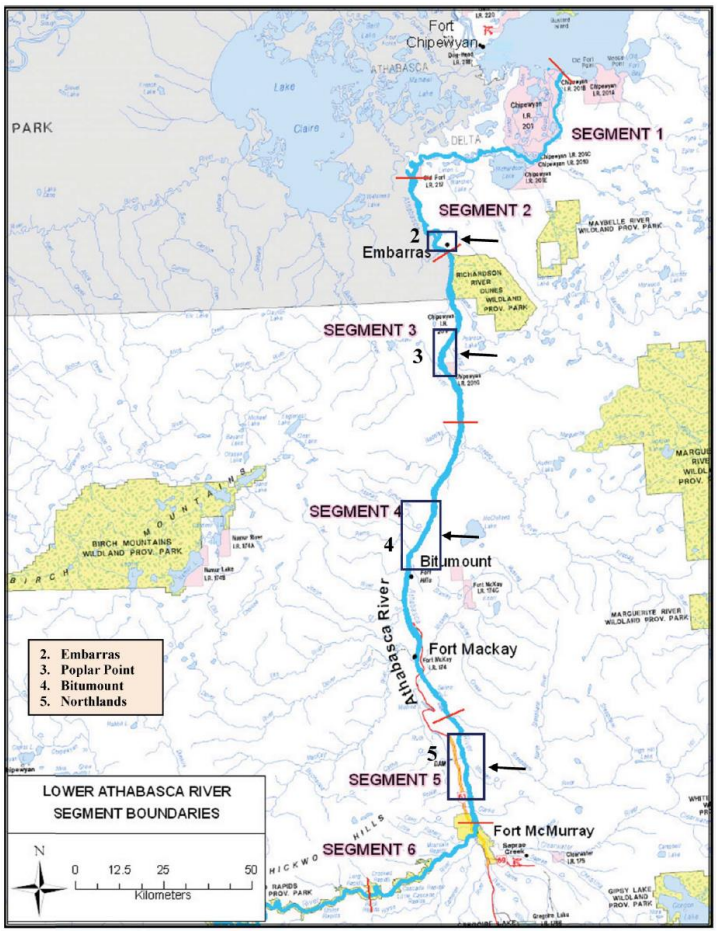


APPENDIX B. RIVER-DEPTH MODELLING USING RIVER2D

The River2D model is public-domain software[5], developed and tested collaboratively by the Department of Fisheries and Oceans (DFO), the University of Alberta, the USA Geological Survey and the Alberta Government (Fisheries Division). River2D generates bed topography from raw field data then determines water depths iteratively through a succession of modified bed topographies. River2D is also used to visualize results. In support of its DFO application to the lower Athabasca River, Golder (2004) has established five major segments between Fort McMurray and the PAD as shown in Figure B1, plus one additional reach within the PAD. Within each segment, a representative study site has been identified, as shown in Figure B2. DFO has analyzed these four reaches in the field during 2004-2005 (Trillium 2004, 2005a, 2005b, 2005c) and with River2D. Together, they account for 30 km of the 213 km of river. The associated River2D model outputs are used to identify river depths corresponding to the river discharges determined with the watershed model.

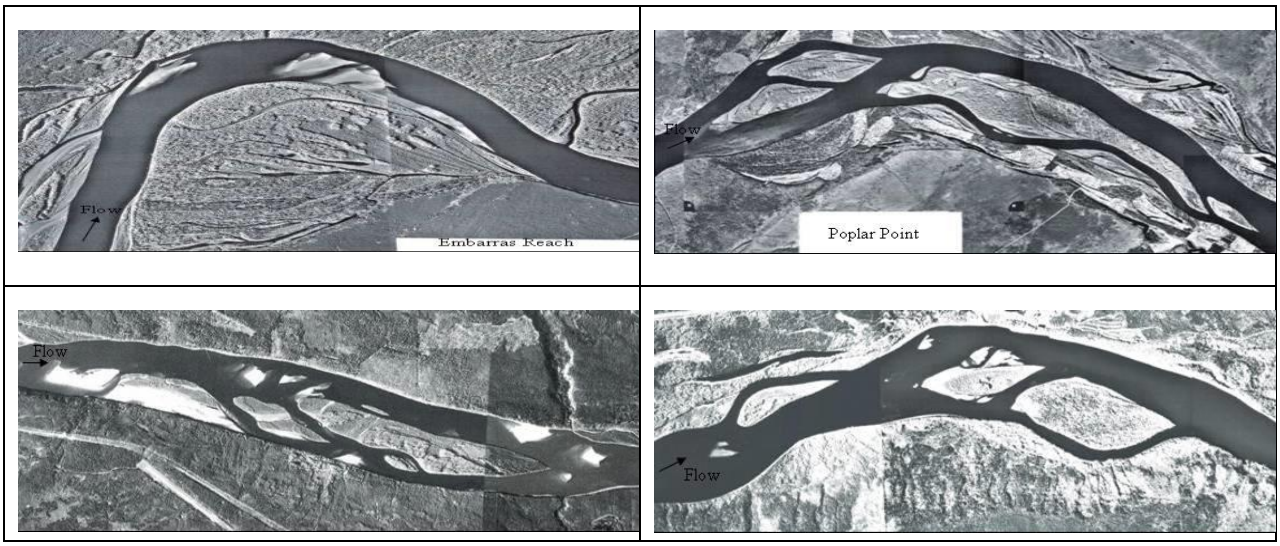
The timing of the field work carried out in support of this model application corresponds well to the period relevant to the data gathered in Candler *et al.* (2010) which can be expected to emphasize the decade 2000-2010.

Figure B1. Delineated segments of the lower Athabasca River used in River2D modelling.



[5] www.river2D.ca

Figure B2. Four reaches along the lower Athabasca River analyzed using River2D: a) Segment 2 - Embarras b) Segment 3 - Poplar Point c) Segment 4 – Bitumount d) Segment 5 – Northlands.



APPENDIX C. INTEGRATED MODELLING OF CLIMATE AND RIVER DISCHARGE

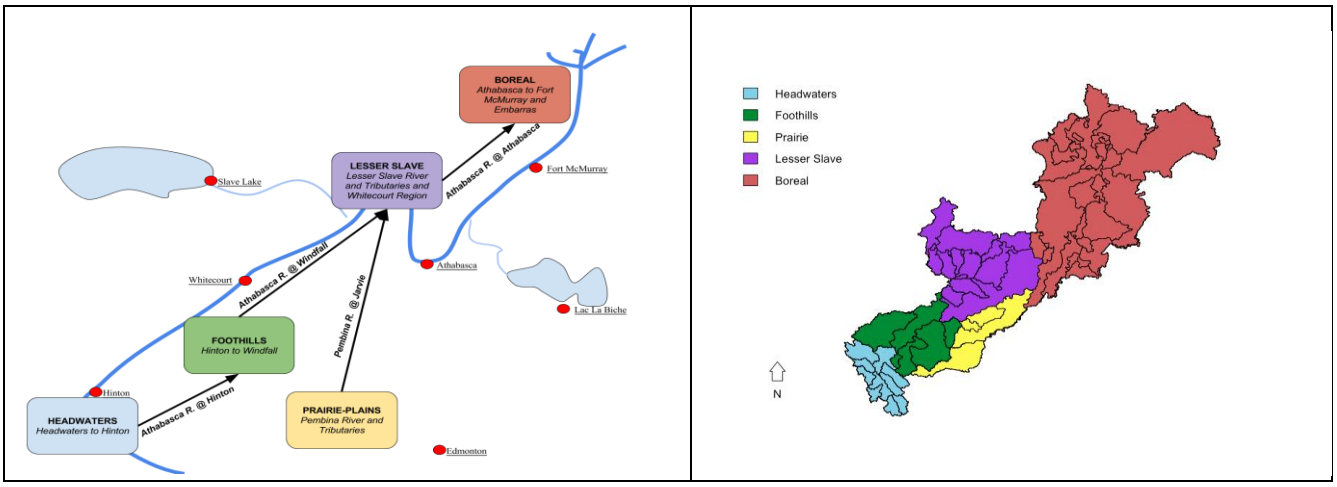
The modelling sequence begins with characterization of the future climate which is here bracketed using outputs from multiple GCMs and appropriate emissions pathways. Projected climates from six GCMs are forced with two Representative Concentration Pathways (RCP4.5 and RCP8.5 – see van Vuuren *et al.* 2011). The six GCMs are as follows:

- CanESM2 – Canadian Earth System Model generation 2 – Environment Canada (5 runs)
- ACCESS1 – Australian Community Climate and Earth System Simulator – Monash University, Victoria, Australia (1 run)
- CCSM4 – The Community Climate System Model – NCAR (1 run)
- CNRM-CM5 – Centre National de Recherche Meteorologiques – Meteo-France (1 run)
- CSRIO-MK3 – Commonwealth Scientific and Industrial Research Organization Mark 3.0 – The Centre for Australian Weather and Climate Research (5 runs)
- INM–CM4 – Institute for Numerical Mathematics Climate Model Version 4 – Russian Institute for Numerical Mathematics Climate (1 run)

Each RCP applied (4.5 and 8.5) represents a set of assumptions that would result in, respectively, a 4.5- and 8.5-W/m^2 increase in radiative forcing by 2100 relative to pre-industrial values. Under RCP4.5, greenhouse gas emissions are predicted to rise until the 2040s, then decline, while under RCP8.5, they continue to rise through the 21st century. The data for these 28 climate scenarios (2011–2100) are obtained from ClimateWNA (Wang *et al.* 2012) and are from the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). AR5 provides the most recent data provided by the IPCC. All 28 scenarios are carried through in the analysis. Where mean results are provided, model outputs based on multiple runs are averaged prior to being combined with those with only one run. (Results based on the mean of all runs can be found in Carver 2018.) The 1971-2000 baseline is the reference point against which projected changes in climate are measured.

These climate futures become inputs to a watershed model for the Athabasca River basin (ARB) to determine the corresponding river flows. The collaborative Athabasca Integrated River Model (AIRM) project (AWS 2018) integrates land use, climate, and hydrology using the RAVEN modelling platform by simulating watershed hydrologic processes to generate daily streamflow in the ARB. RAVEN is a semi-distributed hydrologic model including elements of the HBV-EC hydrologic model which is a Canadian version of the original Scandinavian HBV watershed model, applied extensively to model mountain streamflow in Alberta and British Columbia. The AIRM splits the Athabasca watershed into five individual sub-models based on physiographic regions with different hydrologic behavior: headwaters, foothills, prairie, lesser slave, and boreal plain (Figure C1). Hydrologic Response Units for each sub-basin are delineated using elevation bands, aspect and nine land-use types.

Figure C1. Physiographic model components within the Athabasca River basin.



To fit simulated streamflow to observed values, parameters in each of the sub-models are individually calibrated. Parameter calibration is achieved by first identifying sensitive parameters and then grouping and calibrating process-related parameters following Stahl et al (2008). Parameter calibration is evaluated using two hydrometric gauges with good long-term records and available data (2003-2013). Once calibration is complete for each sub-model, performance is evaluated for each model using available streamflow measurements from all gauges outside the calibration period (1986-2003). Model verification is supplemented by comparing simulated snow-water equivalent, monthly precipitation and daily air temperature to independent climate stations and snow survey sites. The watershed model is also calibrated using data from 33 climate stations distributed across the ARB for the period of 1971–2015. This 45-year period provides the data used in establishing the baseline for the study (selected as 1971-2000).

Once calibrated, AIRM simulates daily streamflow at hydrometric points of interest throughout the ARB and hydro-climatic variables (snowmelt, precipitation, evaporation, etc.) at any point of interest, averaged across sub-basins and/or regions. The model requires only daily climate data (air temperature and precipitation) and land cover and elevation data. Glacier change is simulated by modifying glacier coverage at a decadal timestep following the results from simulations performed by Clarke *et al.* (2015) using the CanESM2 GCM. In the Athabasca River basin, glacier coverage decreases (Figure C2) from approximately 270 km^2 in 2010 to ~150 km^2 in 2050 and less than 50 km^2 in 2100. Glacier retreat is projected to be greater under RCP4.5 until 2050, while from 2050 to 2100 glacier retreat is significantly more severe under RCP8.5.

Figure C2. Glacier retreat in the Athabasca River Basin as derived from simulations by Clarke *et al.* (2015).