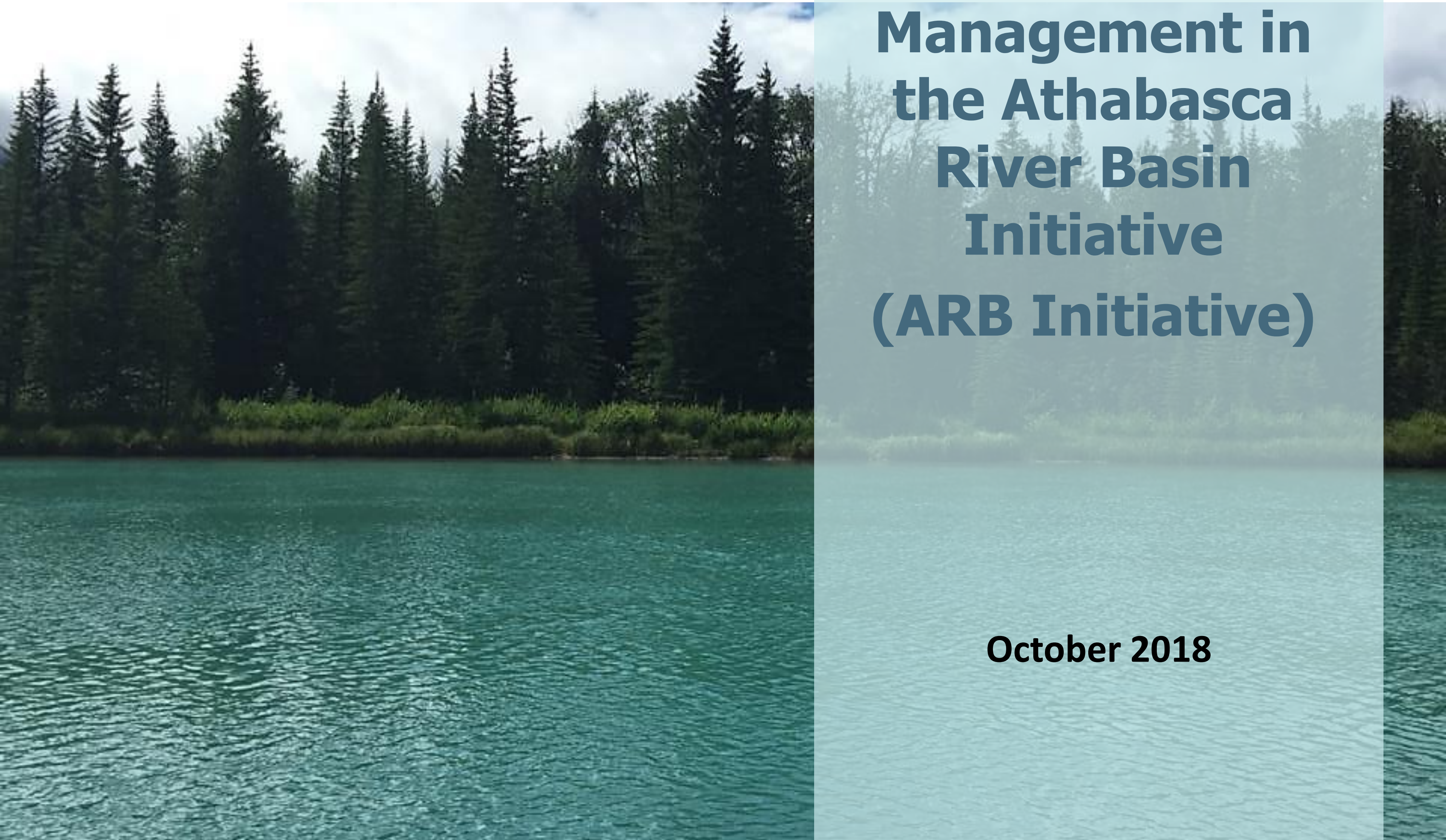
ALBERTA waterSMART

Water Management Solutions

Sustainable Water Management in the Athabasca River Basin Initiative

(ARB Initiative)



October 2018

Chatham House Rule

"When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed."

Objective of using the Chatham House Rule was for participants to be bold, innovative, speak openly.

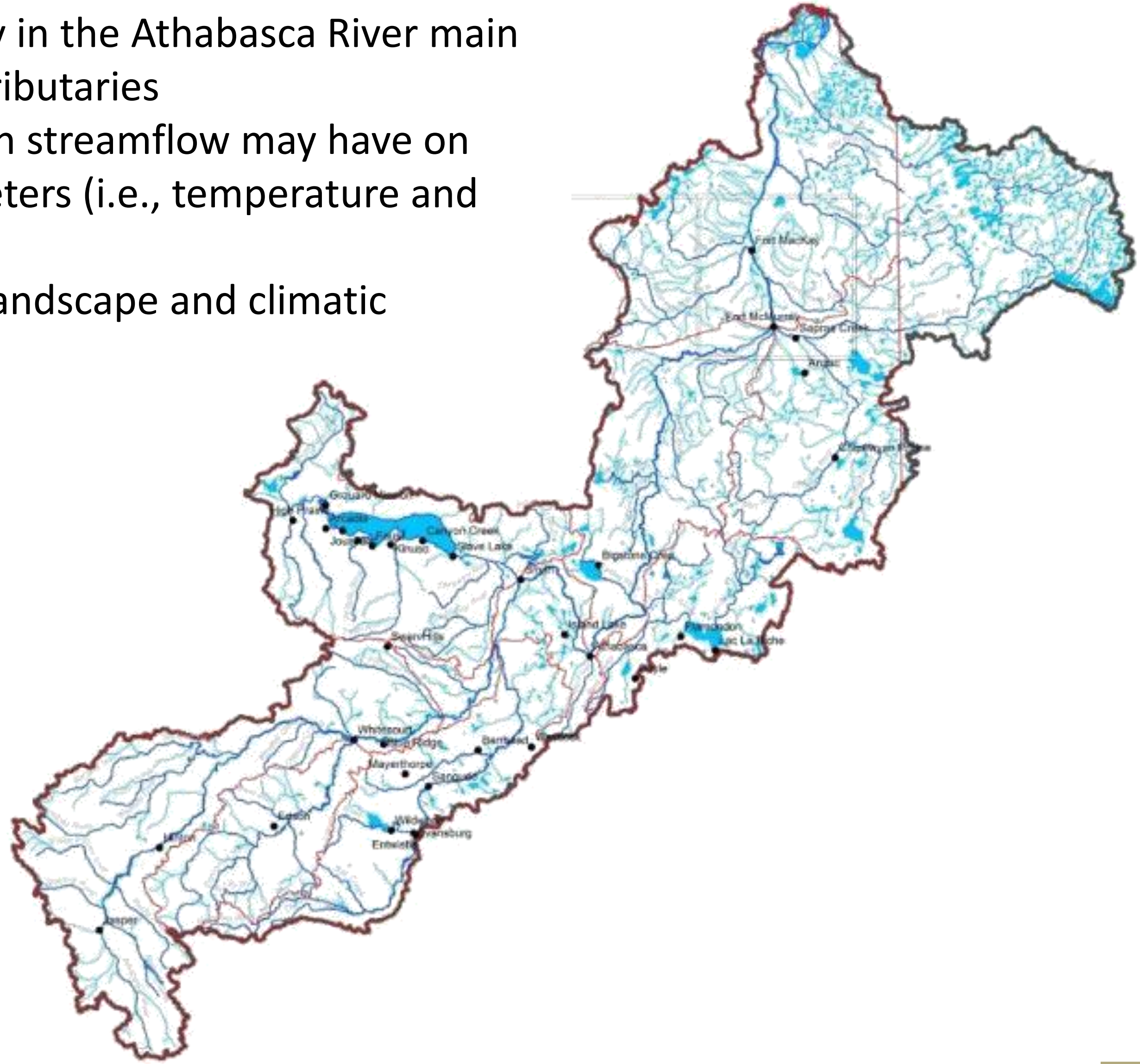
Focus on addressing the challenge, not the blame

Keep in mind…

- These slides are available and can be shared publicly.
- Materials and information presented can be shared publicly- all meeting material available on the project website (visit www.albertawatersmart.com or Google "ARB Initiative").

Scope

- Surface water quantity in the Athabasca River main stem, and the major tributaries
- Implications changes in streamflow may have on certain quality parameters (i.e., temperature and dissolved oxygen)
- Implications of basin landscape and climatic change on streamflow



ARB: A massive, diverse, complex basin

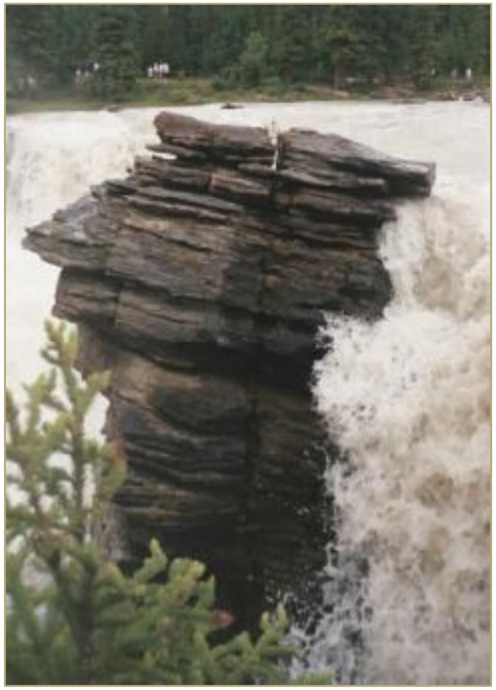
www.albertawatersmart.com

Thank you to our participants

- Alberta Agriculture and Forestry
- Alberta Energy Regulator
- Alberta Environment and Parks
- AFPA Alberta Forest Products Association
- Alberta Innovates
- Alberta Newsprint Company
- Alberta Pacific Forest Industries Inc
- Alberta Water Council
- Alberta WaterSMART Water Management Solutions
- AWA Alberta Wilderness Association
- Alexander First Nation
- Aspen Regional Water Services Commission
- ATCO Always there. Anywhere.
- Athabasca
- Athabasca University
- Athabasca Watershed Council
- Bigstone Cree Nation
- fRI Research Informing Land & Resource Management
- Conklin Integrated Environmental Services
- CPAWS Canadian Parks and Wilderness Society
- Fisheries and Oceans Canada / Pêches et Océans Canada
- Environment and Climate Change Canada / Environnement et Changement climatique Canada
- Driftpile First Nation
- Ducks Unlimited Canada
- Fort McKay First Nation
- Frog Lake First Nation
- Gift Lake Métis Settlement
- Lac La Biche County welcoming by nature.
- Lesser Slave Watershed Council
- The McKay Métis
- Métis Nation of Alberta, Region 1
- McMurray Métis
- Northern Lights Fly Fishers Trout Unlimited Edmonton
- Peavine Métis Settlement
- Regional Municipality of Wood Buffalo
- Repsol
- Shell
- Sucker Creek IR - 150A
- Suncor Energy
- Teck
- Trout Unlimited Canada
- University of Regina
- West-Central Forage Association
- West Fraser
- Westmoreland Coal Company
- Yellowhead Tribal Council

Water challenges facing the ARB

- Maintaining or improving ecosystem health
- Providing water supply certainty for development
- Minimizing the effect of the development footprint on basin hydrology
- Ensuring sufficient flow for navigation
- Limiting damage from floods or extreme events
- Maintaining or improving the health of the Peace-Athabasca Delta
- Addressing concerns around Indigenous rights
- Accessing water-related data and knowledge in the basin
- Maintaining or improving water quality
- Understanding the renewable energy potential of the basin


Water challenges facing the ARB: What we heard in Sharing Sessions

Greatest concerns are water quality, ecosystem health, water quantity

Gaps in information / community understanding regarding

- changes in water and land environment
- changes in lake levels
- fishery and wildlife health

Some community-based monitoring currently in place

- in partnership with private companies (e.g., consulting firms and oil and gas companies)
- creates more trust in data and information sharing

Concern: Navigation and transportation disruption (quantity)

- adequate water levels for water course transportation
- winter road disruption (flooded/melted) due to released reservoir water –and potentially under warmer, wetter conditions
- can impact access to food and supplies

Concern: Access to clean drinking water (quality)

- external source water supply transported into communities
- lack of trust in water supply for consumption (e.g., Fort Chipewyan: cancer amongst community perceived to be linked to water)

Concern: Fishing and trapping losses (ecosystem)

- species loss or absence of insects, birds, fish
- commercial fishery closure
- game organ meats unsafe for consumption

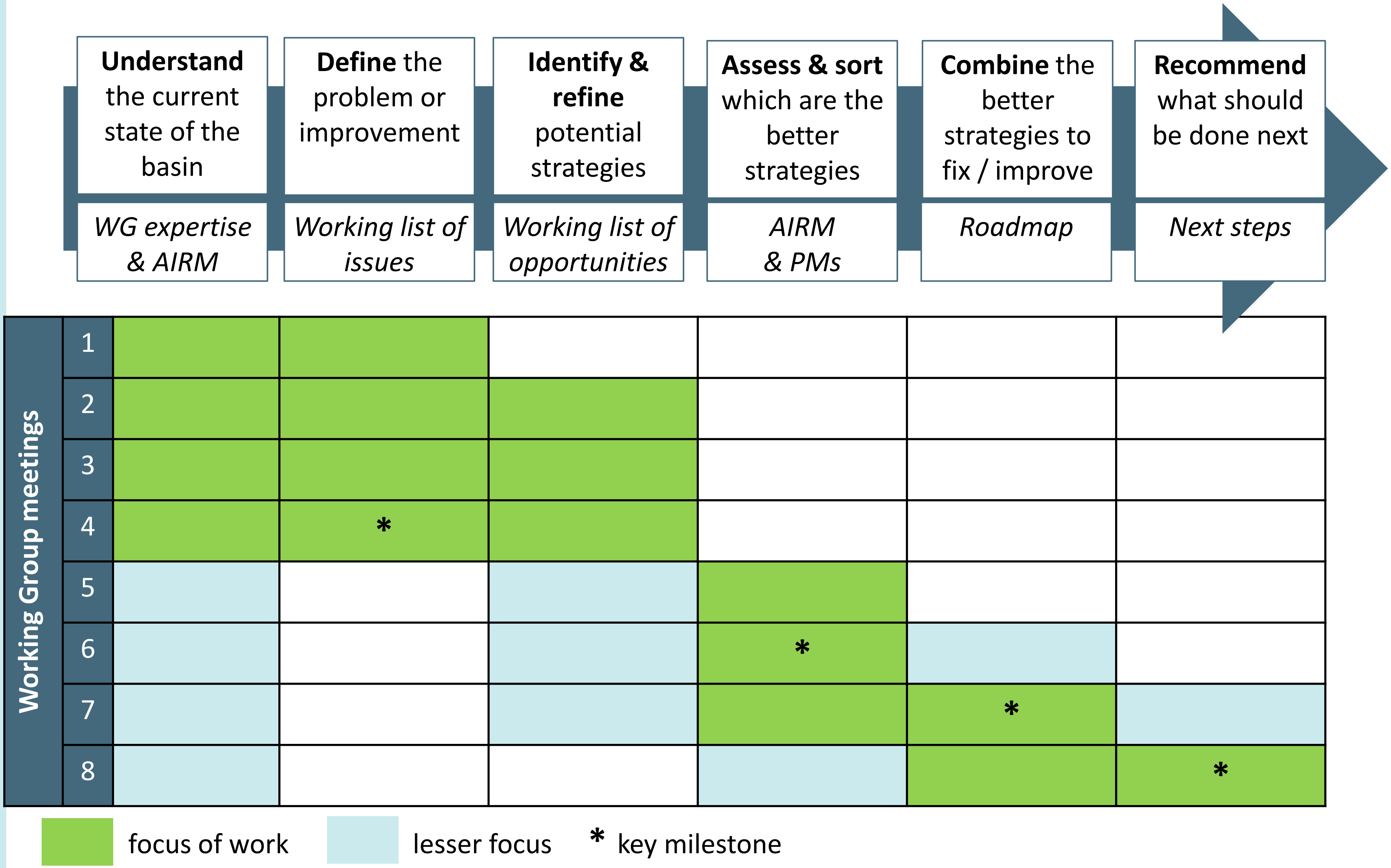
Goal: ARB Roadmap for sustainable water management

A Roadmap is:

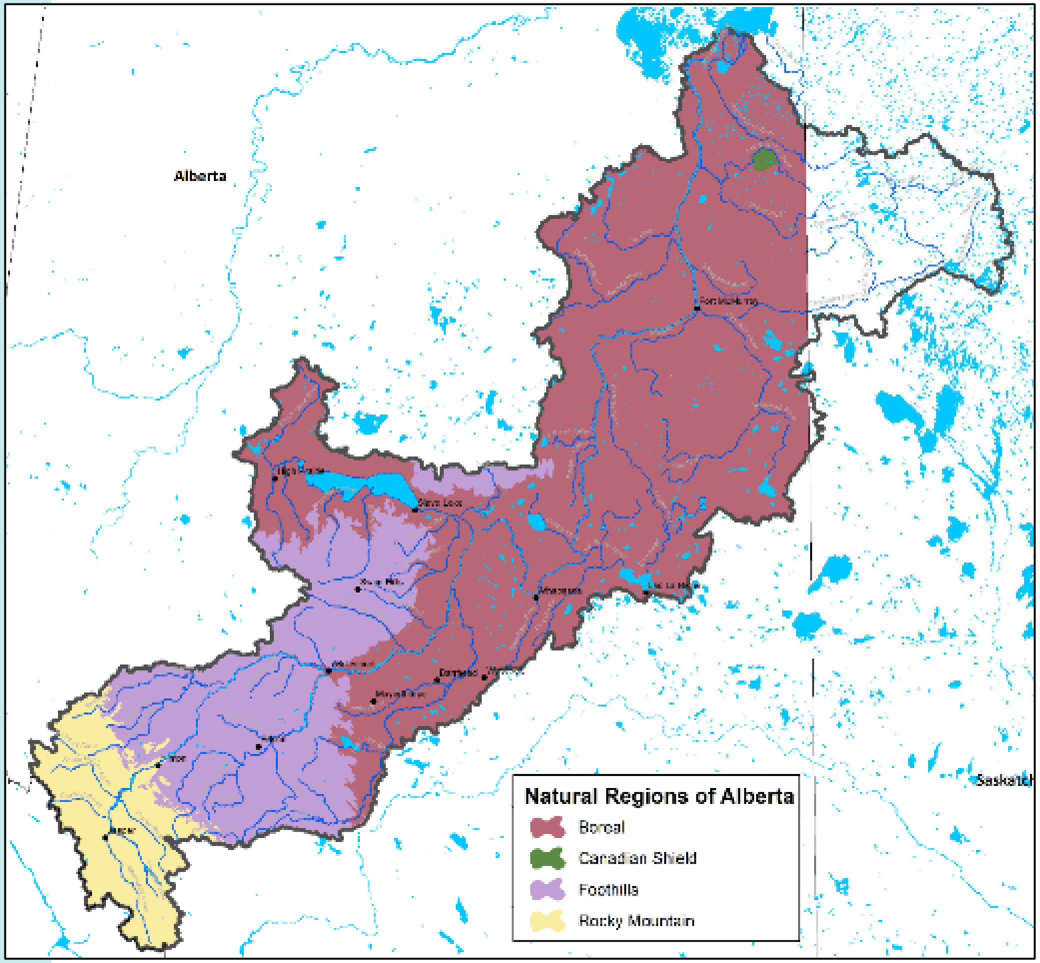
- a set of strategies with practical actions
- developed by an inclusive basin-wide working group using collaborative modelling and dialogue
- a recommended or potential path toward sustainable water management in a basin
- intended to inform future planning and management efforts as they relate to water

- **Screens** and **sorts** strategies; does not prioritize projects
- Identifies **gaps** and **recommends next steps**; does not layout an Implementation Plan
- Reflective of **collaborative findings**; not Consultation or a decision making body
- A **guiding** document; not a basin Plan

Collaborative process to develop the ARB Roadmap



Geography: Four natural regions



Drains ~165,000 km^2

Covers ~25% of Alberta

4 natural regions:

- **Rocky Mountain** steep topography, high elevations, large glaciers and high winter snowpack, widespread coniferous forest
- **Foothills** interface between the Rocky Mountains and Boreal, variable topography with undulating terrain
- **Boreal Forest** relatively flat topography, with mosaic of lakes, interspersed uplands, and extensive wetlands
- **Canadian Shield** exposed bedrock and hummocky topography, some bogs and fens

Hydrology: Generally a snowmelt dominated regime

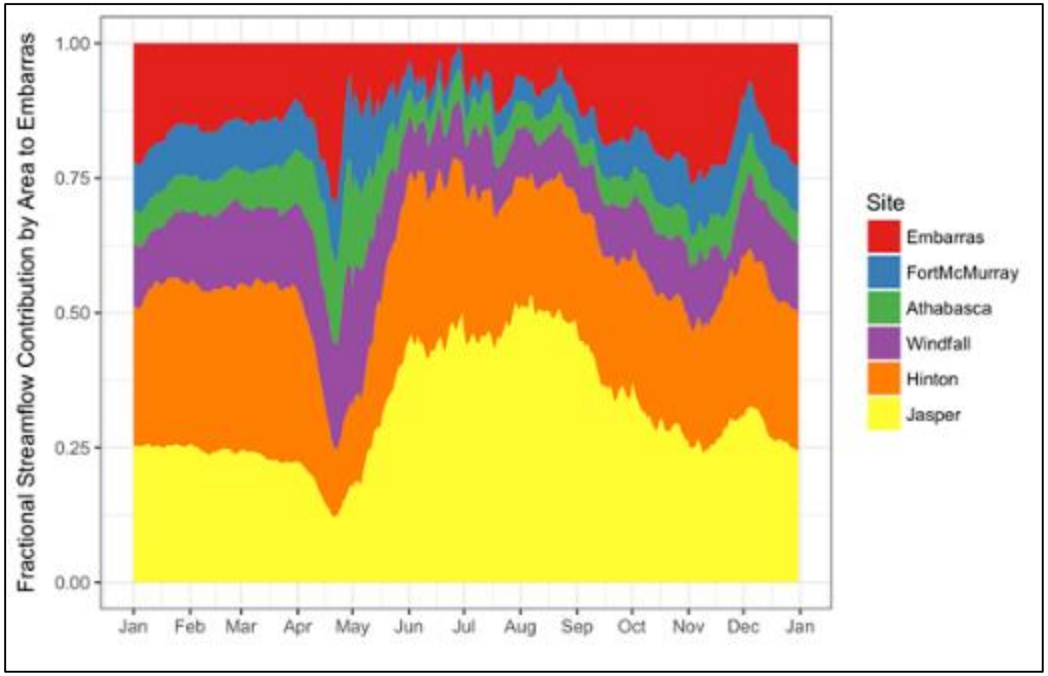
Streamflow is low during the cold winter months, peaks during the spring due to snowmelt, and tapers off into the fall as the winter snowpack becomes depleted

During the late summer and fall, streamflow periodically increases due to large summer precipitation events

The Athabasca River is supplemented during the late summer by glacier melt

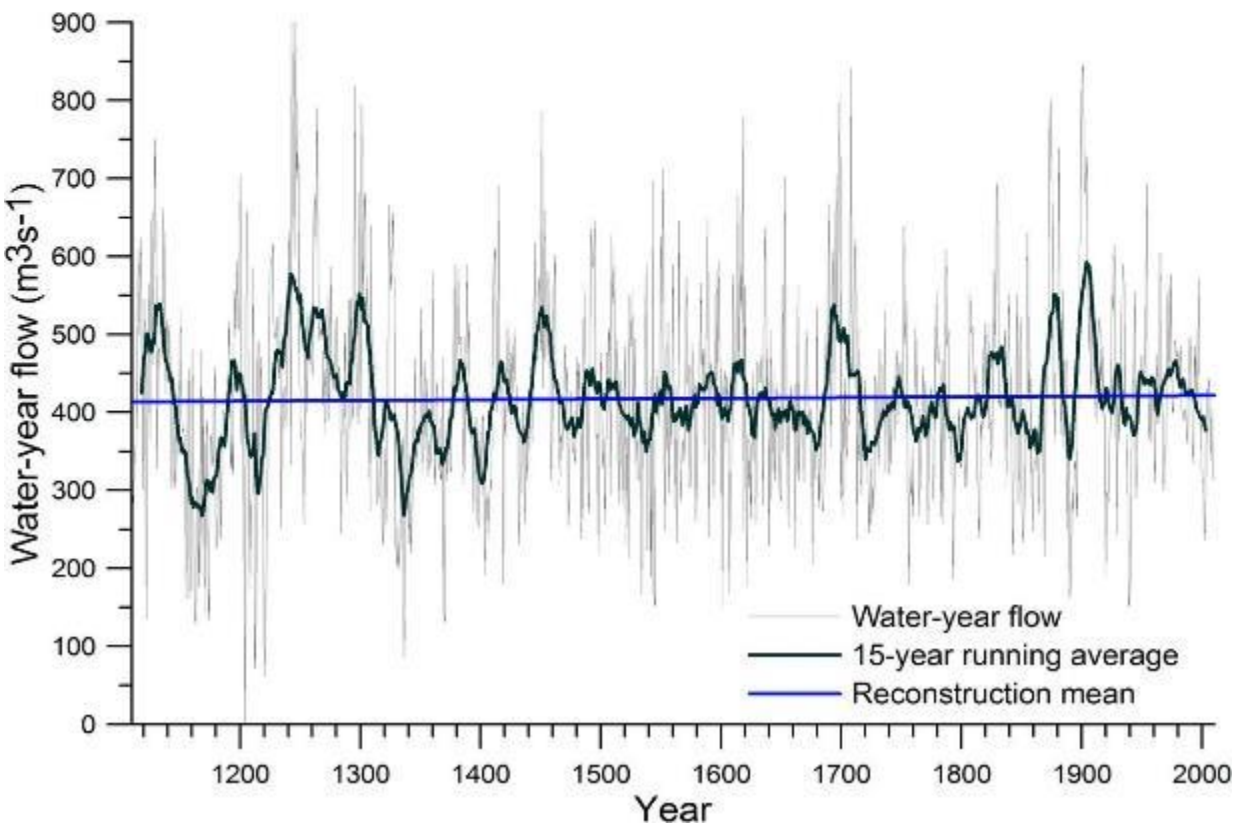
~58% of the Athabasca River streamflow by area occurs upstream of Hinton, ~38% occurs upstream of Jasper

On a per-area basis, much of the water in the Athabasca River is generated in its headwaters, at high elevations in the Rocky Mountains



Fractional streamflow contributions for various points-of-interest on the Athabasca River mainstem

Climate change

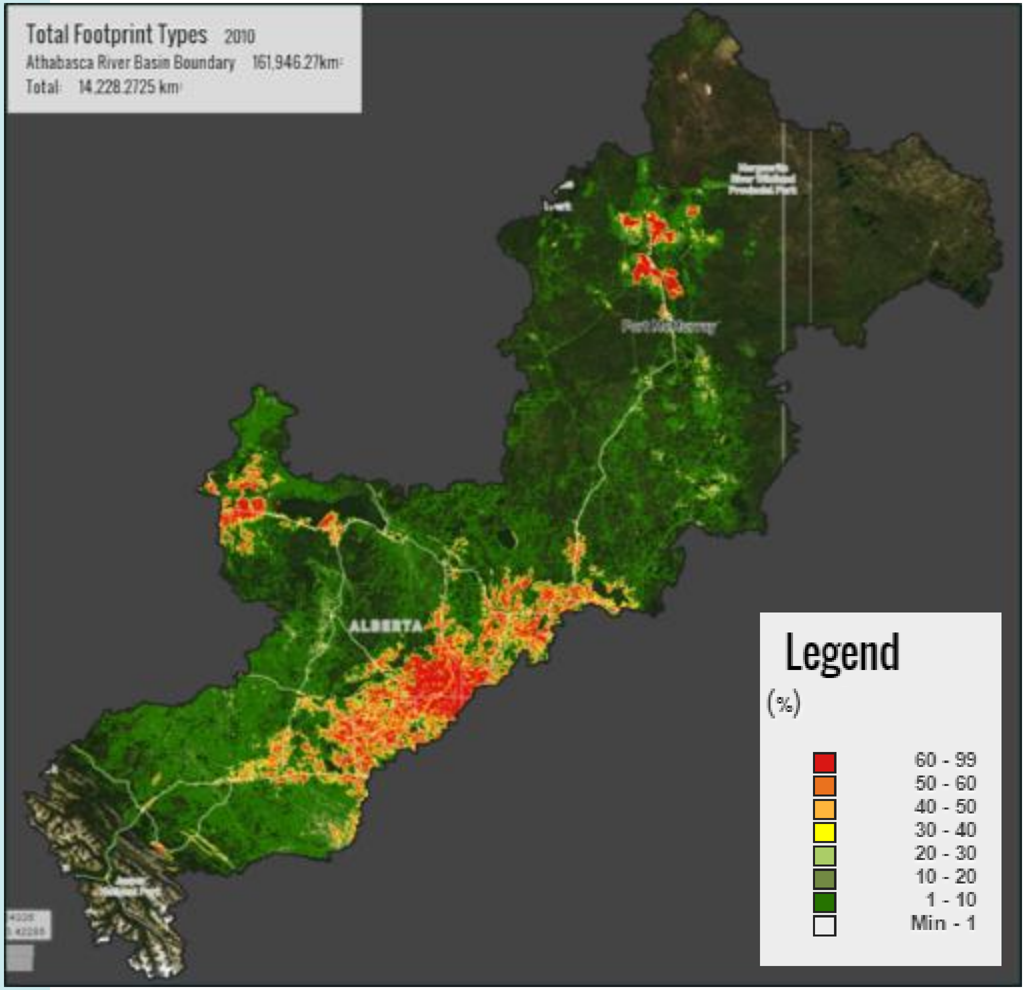


Potential future climate scenarios evaluated through this study suggest it is likely that:

- Precipitation will increase
- Air temperature will increase
- Earlier spring snowmelt
- Lower summer streamflow
- Decrease in long-term glacial contribution to streamflow

A 900-year reconstruction of annual flow using tree rings demonstrates there is higher natural variability in water availability than observed in the last 100 years

Human activity: Many land uses throughout the basin



Agriculture – largest overall land use by area

Forestry – distributed through the basin within FMA boundaries

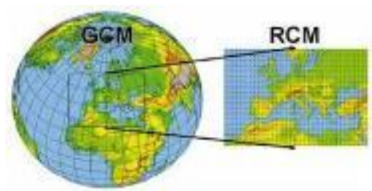
Oil & gas development – largest area footprint in the lower basin

Roads, seismic, power, rail – highest density and pressure in upper basin

Traditional uses – throughout the basin

Fact base: Athabasca Integrated River Model (AIRM)

Input: opportunities (changes in demand/water use, flow targets, infrastructure changes, land use and landscape change, changes in climate, etc.) and expertise.



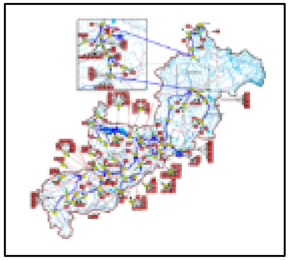
Output: future daily precipitation and air temperature

ALCES

Outputs: changes in landscape composition from various scenarios

Raven

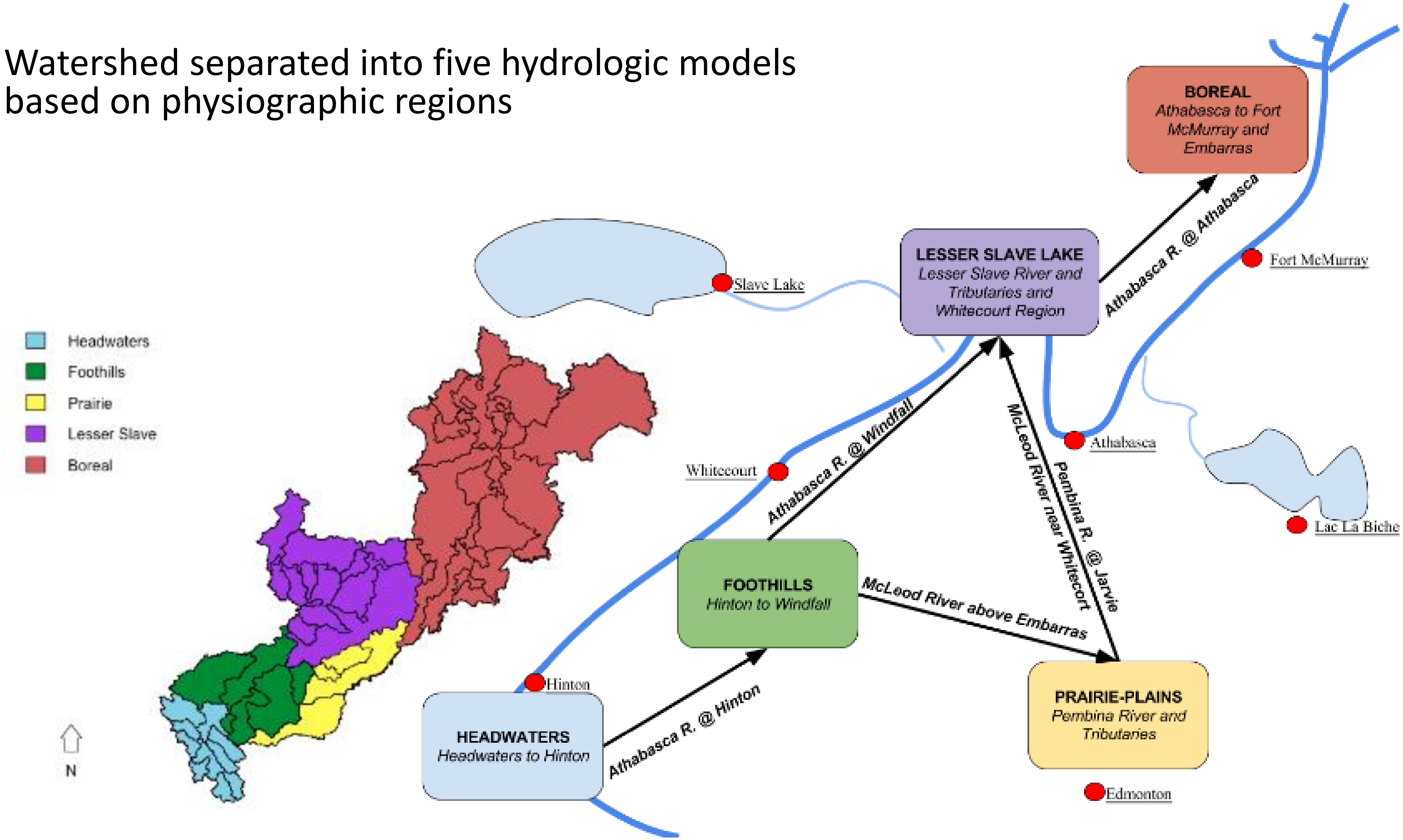
Outputs: changes to streamflow based on changes to climate and landscape, changes in snowpack, soil moisture, etc.



Outputs: Changes to streamflow and performance measures that show effects of strategies on the system

AIRM: Spatially modelled 5 physiographic regions

Watershed separated into five hydrologic models based on physiographic regions



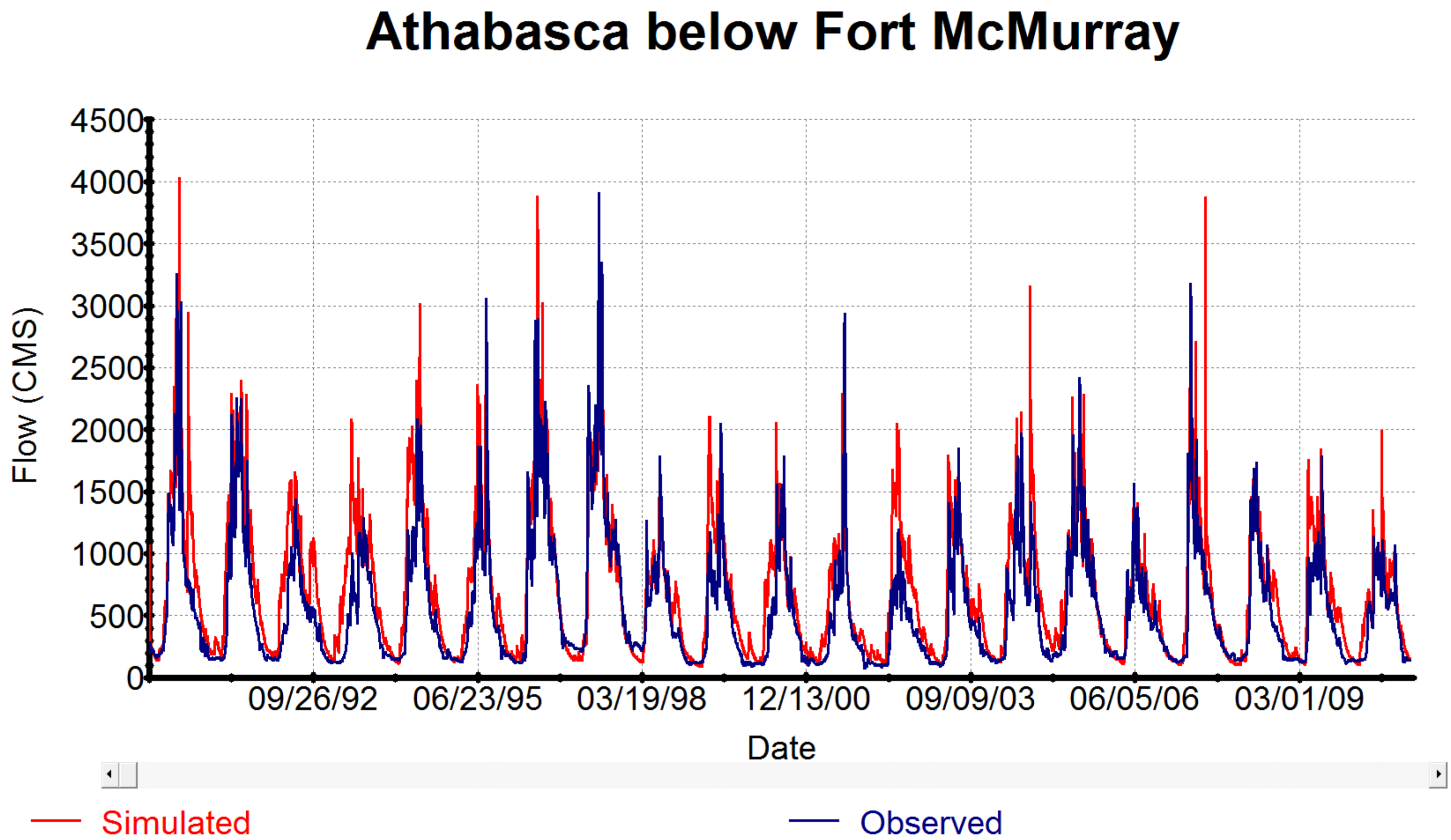
Meaningful representation of the hydrologic system to support useful discussion

Model calibration and verification

- Each model is calibrated using 2-4 sub basin streamflow records, from 2003 - 2013, and verified from 1986 – 2012
- In each model, calibrated parameters include:
  - Precipitation and air temperature lapse rates, snow melt factors, vegetation interception, soil routing
- Calibration is done by maximizing the daily Nash-Sutcliffe (NSE)
- Model evaluation done using monthly NSE and Percent Bias (PBIAS)
- Evaluated air temperature, precipitation, snow water equivalent

AIRM: Compared to ARB observations

Daily NSE = 0.66



AIRM: Data sources, calibration and verification

Hydrometric Data

- 51 Water Survey of Canada Gauges used for Daily Discharge (m3/s)

Climate Data

- Daily Precipitation and Temperature from 7 Environment Canada Stations
  - *Mica, Cariboo Lodge, Jasper, Hinton, Whitecourt, Slave Lake, Fort McMurray*
- 28 Synthetic climate stations,
  - *Derived by scaling nearest EC Station and PRISM monthly data*
- 27 Snow Survey sites used for modelled SWE verification
  - *AB Environment and Parks, BC River Forecast Centre, AB Climate Information Service*
- 25 Environment Canada Climate Stations used for modelled Temperature and Precipitation verification (independent from model)

Spatial Data (ALCES Online)

- Land-use (Deciduous/Cut/Coniferous Forest, Wetland, Grassland, Alpine, Glacier, Disturbed, Mine, Lake)
- Digital Elevation Model (25 m resolution)

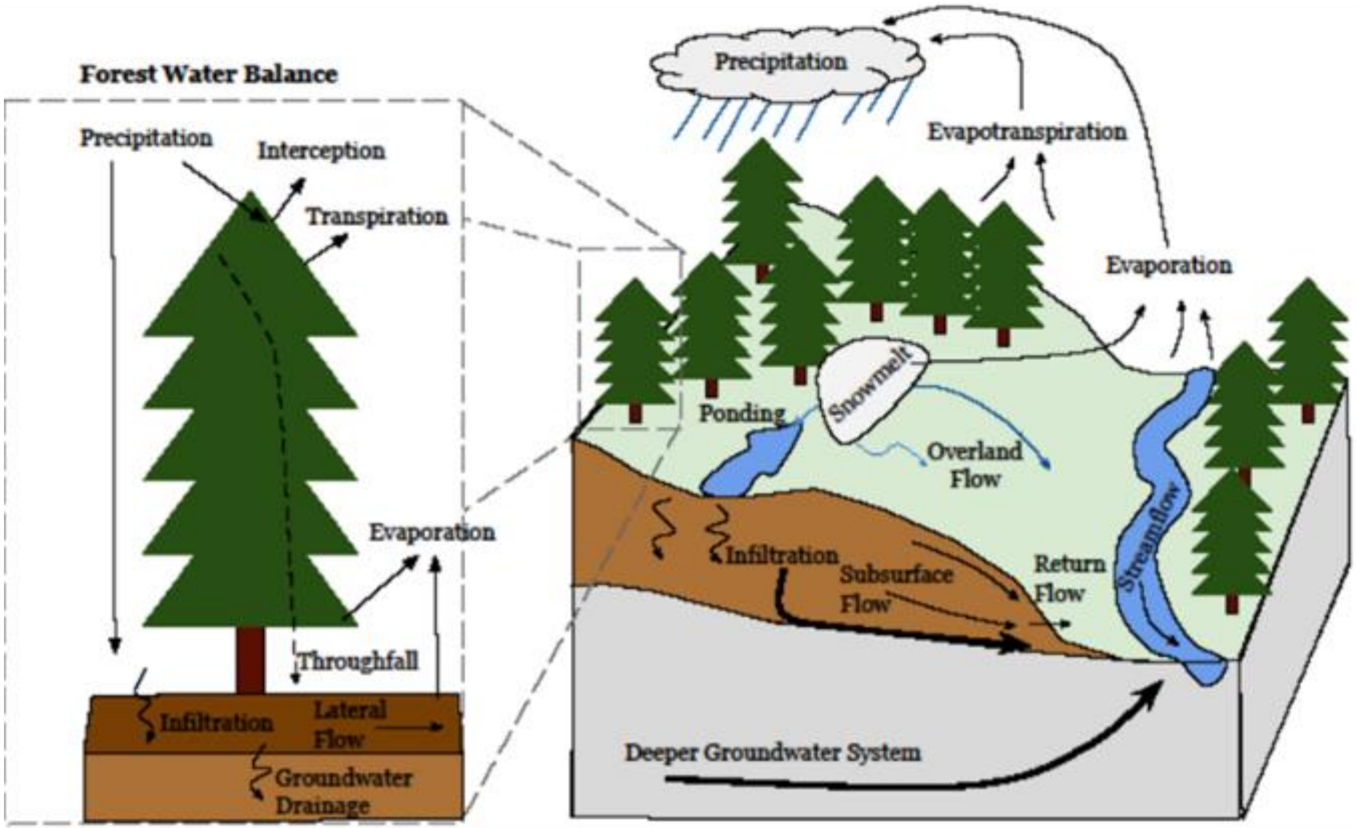
Each model is calibrated using 2-4 sub basin streamflow records, from 2003 - 2013, and verified from 1986 – 2012.
In each model, calibrated parameters include: Precipitation and air temperature lapse rates, snow melt factors, vegetation interception, soil routing.
Calibration is done by maximizing the daily Nash-Sutcliffe (NSE).
Model evaluation done using monthly NSE and Percent Bias (PBIAS).
Evaluated air temperature, precipitation, snow water equivalent.

What AIRM does…

- Three 'components' to the model
  - Mass balance model (simulates water demand and availability)
  - Hydrological model (simulates hydrological processes)
  - Landscape model (simulates changes in landscape)
- Simulates surface water quantity at a daily time step
- The model is driven by operating 'rules' that can be changed
- The mainstem of the Athabasca River is modelled, as are many larger tributaries
- Water quality as it relates to quantity will be simulated (e.g. DO, temperature)
- Changes to surface water quantity due to landscape changes and changes in climate can be modelled

Modelling 101

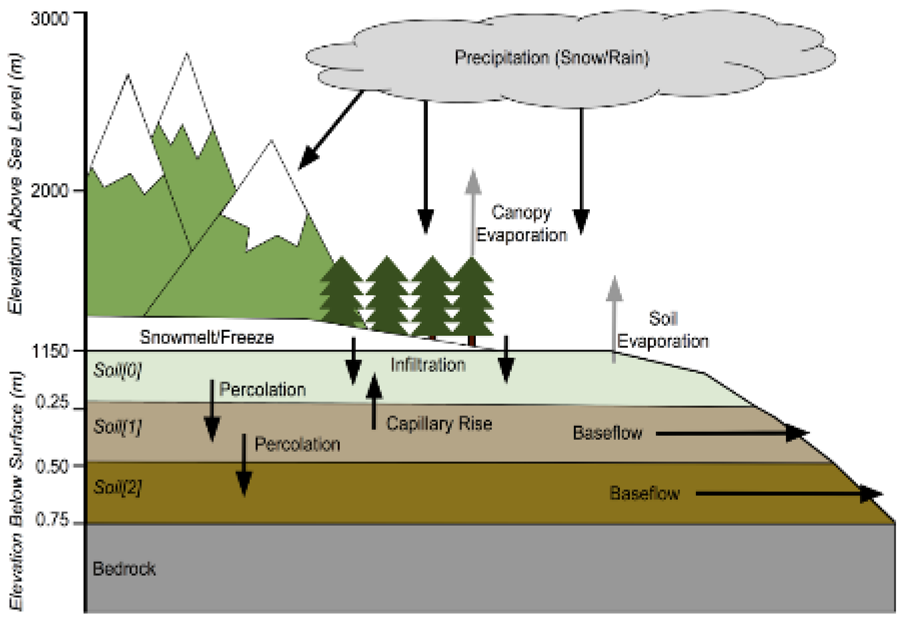
- The integrated model is a representation of a large complex system

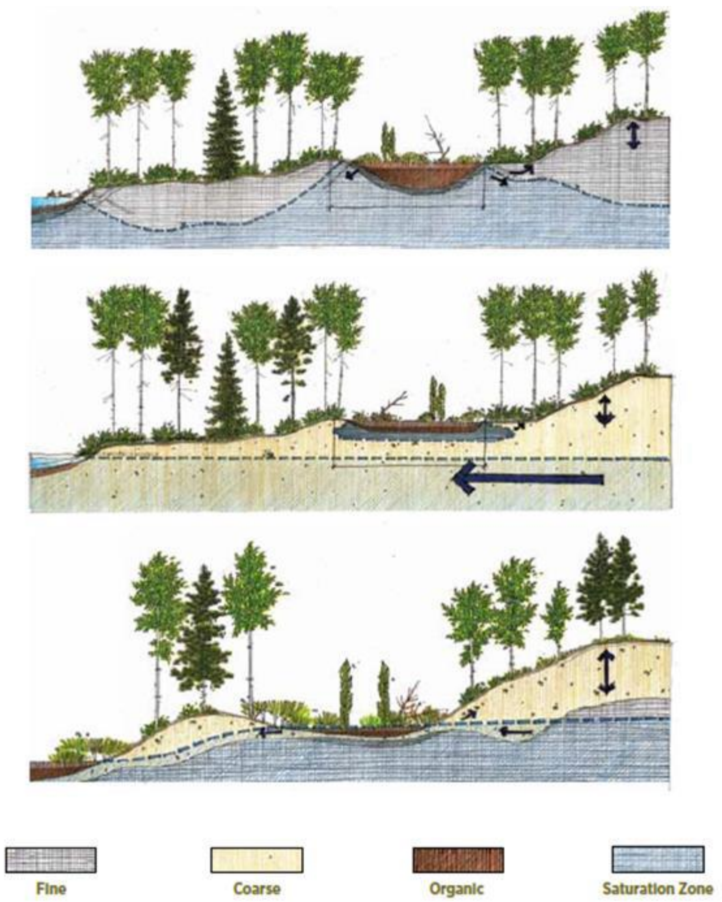


- No model is 100% correct – the intent is to have a model that is <u>correct enough</u> to facilitate informed discussions
- The model is a scale appropriate tool for the Working Group to understand the current system and explore how it might change

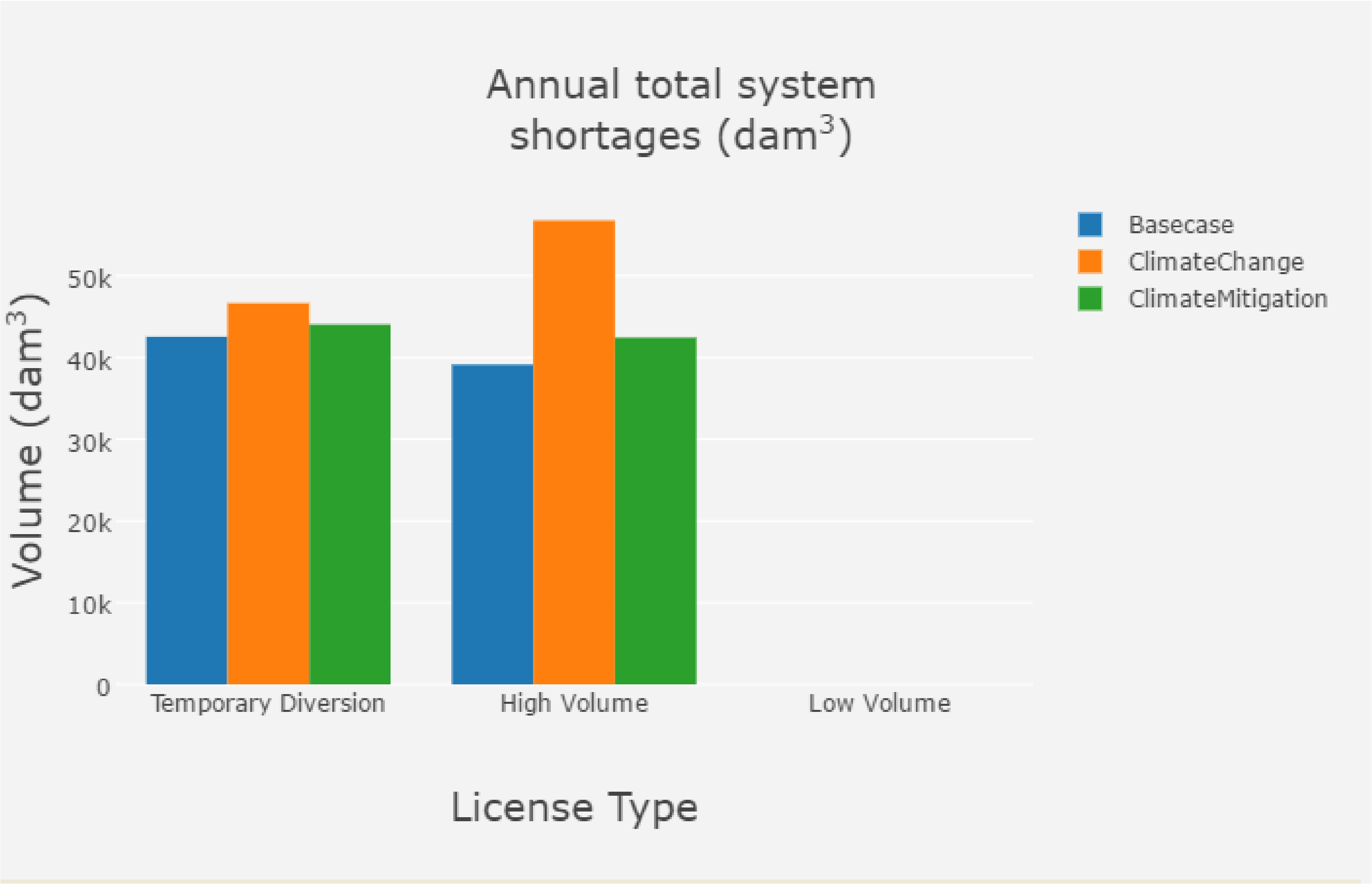
Model description

- Aiming to represent hydrologic processes correctly
- Meaningful representation of the system to support useful discussion

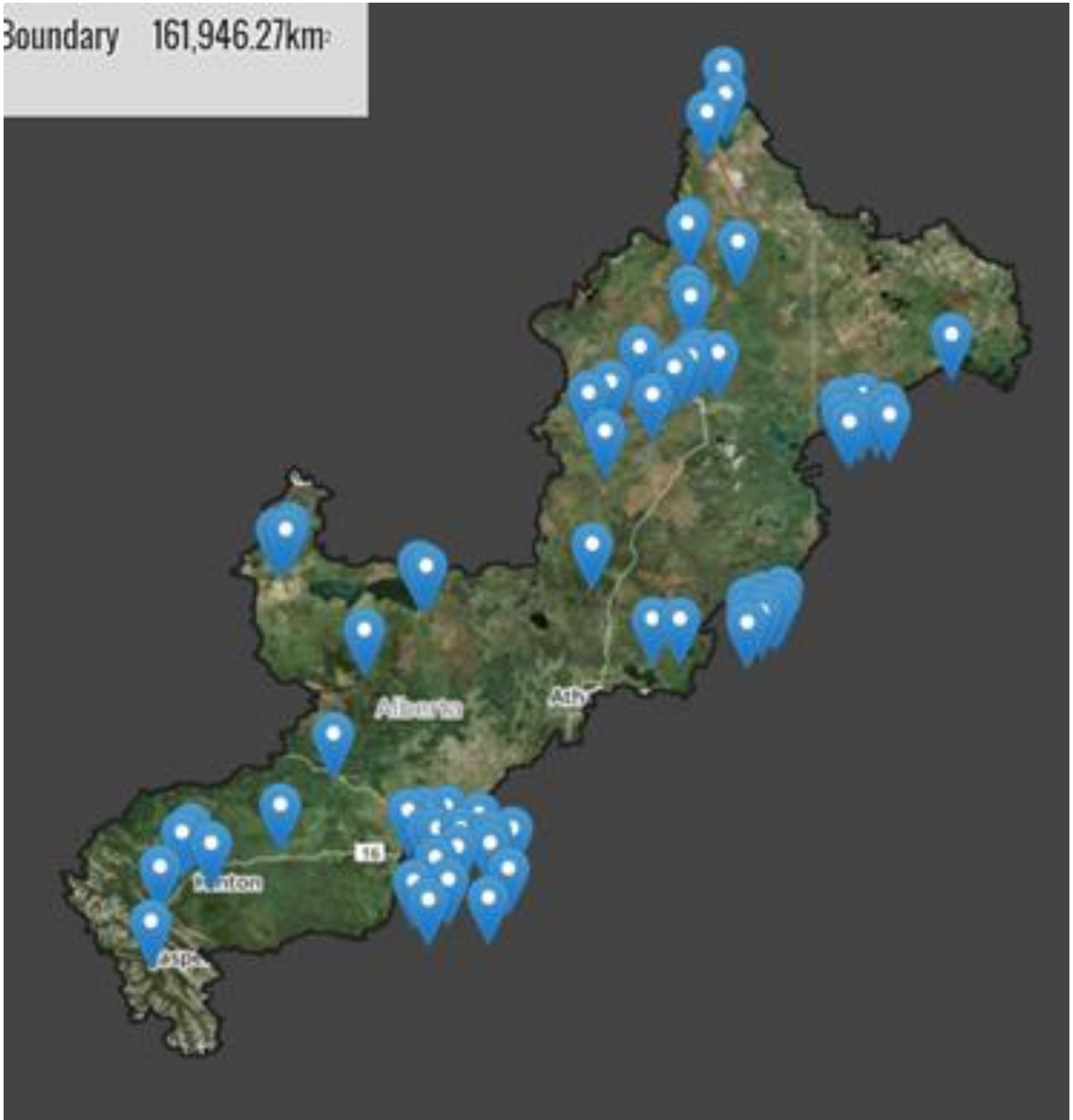




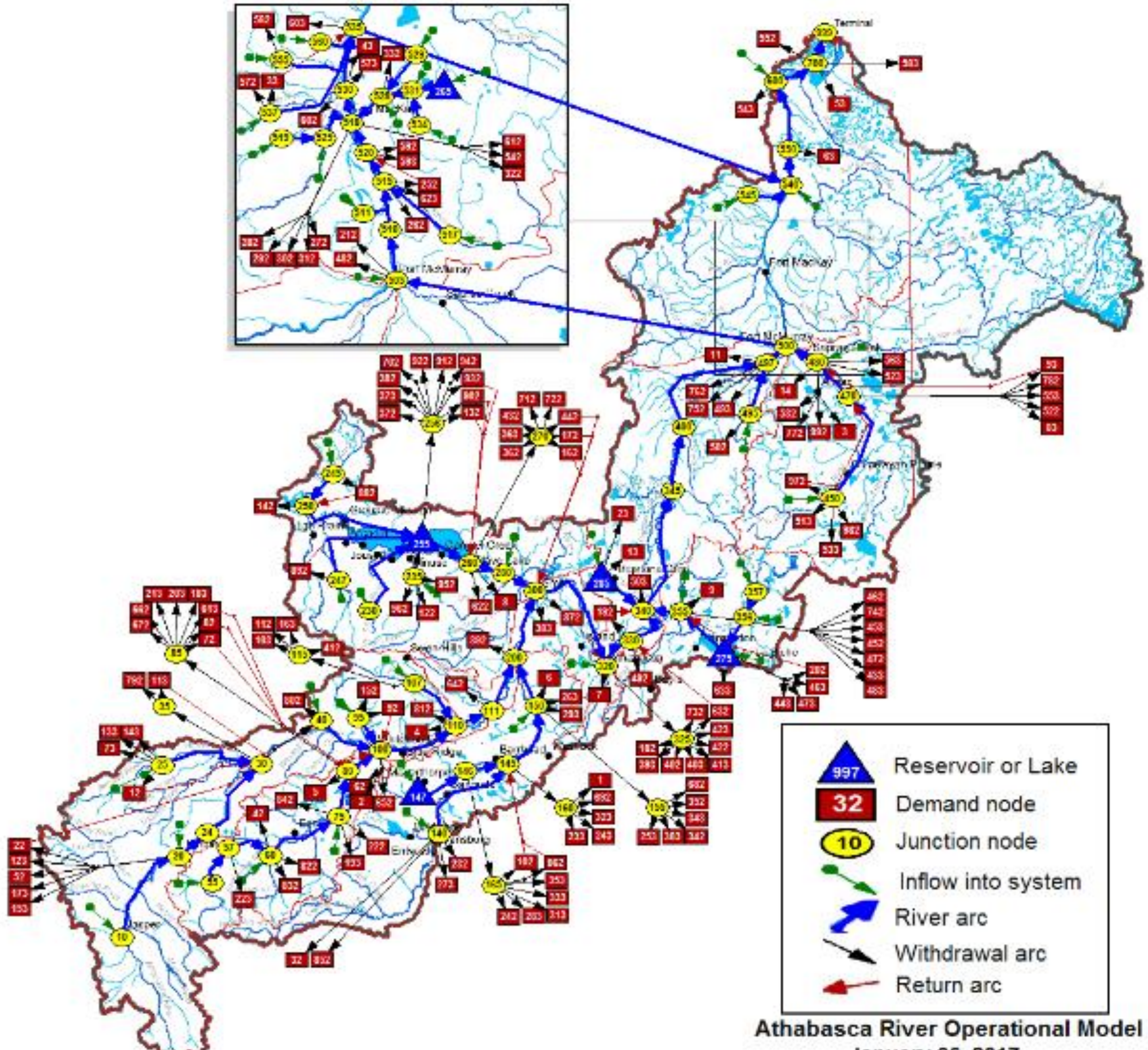
What can be looked at in the model…



Some of the opportunities for the Roadmap



AIRM: Operational rules reflecting management decisions



Athabasca River Operational Model
January 06, 2017

What can be looked at in the model…

Operational changes to existing infrastructure

Investment in new water infrastructure

Investment in natural infrastructure

Demand management

Planning and preparedness

Policy and practices

Performance Measures used to explore opportunities….

Performance Measure (PM)	Associated water challenge
Change in seasonal system shortages (m^3/s)	Provide water supply certainty for municipalities and development
Change in seasonal streamflow as a percentage of naturalized streamflow	Minimize the effect of development footprint on basin hydrology
Change in walleye recruitment reduction	Maintain or improve ecosystem health
Change in annual instream flow needs violations	Maintain or improve ecosystem health
Change in number of days over 1:100 flood thresholds	Limit damage from floods
Change in number of days meeting Aboriginal Extreme Flow	Ensure sufficient flow for navigation

PMs are proxies to show whether the strategies were having their intended impact and no unintended consequences.

Strategies for sustainable water management in the ARB

1. **Effluent reuse**: Enable reuse of industrial or municipal effluent to reduce reliance on freshwater

2. **Water conservation**: Continue to achieve water conservation and efficiency improvements as communities develop

3. **On-stream storage**: Explore new on-stream multi-purpose storage options

4. **Off-stream storage**: Develop new and existing off-stream storage sites to meet multiple basin water management objectives

5. **Existing infrastructure**: Alter existing water storage infrastructure and operations to meet multiple basin water management objectives

6. **Environmental flows**: Establish instream flow needs or similar targets for all tributaries in the basin as a precautionary water management measure

7. **Navigational flows**: Implement minimum flows to improve navigation in the lower Athabasca basin

8. **Land conservation**: Increase the quantity and improve the condition of conserved and restored land across the basin

9. **Forestry practices**: Support practices in Forest Management Agreements that minimize hydrologic change

10. **Wetlands**: Avoid further wetland loss and functional impairment and promote more wetland restoration, education, and best management practices focused on minimizing impacts

11. **Linear connectivity**: Reclaim or deactivate linear features and reduce future linear disturbances in watersheds

12. **Extraction industry reclamation**: Continue to set and meet high standards of reclamation of extraction footprint to maintain or improve hydrological functions in a watershed

**** Numbering does not indicate priority or ranking of the strategies*

Strategy overview: Effluent reuse

Enable reuse of industrial or municipal effluent to reduce reliance on freshwater

Overview

Take return flows (treated effluent) from industrial, municipal, or commercial operations and reuse that water for other industrial purposes. This strategy:

- would support development without needing to withdraw additional fresh water
- would reduce treated effluent release back into the river
- has potential when applied at local levels throughout the basin

What's already happening with this strategy

- ANC may be considering supplying companies with effluent water for the use of hydraulic fracturing
- RMWB is looking into the option of sending treated wastewater to industrial users
- Industry to industry reuse is taking place between the Suncor base mine and the Suncor Firebag SAGD operation

How it was simulated in the model

- Return flows from the industrial and commercial demands in the upper ARB were simulated to flow to off-stream storage instead of a return flow to the river. TDLs in the upper ARB would then draw from this off-stream storage instead of taking freshwater. The maximum storage is set at 100,000 dam^3 with volumes in excess of storage flow back to the mainstem Athabasca River. Water may also be drawn from this storage to meet the downstream SWQMF.

Key modelling results and discussion: Effluent reuse

Period and Location	_Dry_Reuse	_Hist_Reuse	_Wet_Reuse
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	0.0 Days	0.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	0.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	-24.0 Days	-5.0 Days	-1.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	-88.0 Days	-33.0 Days	-19.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	1.59%	1.40%	0.63%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.02%	0.01%	0.02%
Spring - at the Mouth	0.02%	0.00%	0.00%
Fall - at the Mouth	0.03%	0.02%	0.03%
Winter - at the Mouth	0.34%	0.02%	0.03%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	0.0 m^3/s	-0.0 m3/s	0.0 m3/s
Winter - whole system	-0.35 m3/s	0.0 m3/s	-0.02 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Benefits and tradeoffs: Effluent reuse

Benefits

- This strategy simply changes the source of TDL water withdrawals from fresh water to wastewater, thereby allowing more fresh water to remain in the river reducing the number of IFN violations in some sub-basins
- This strategy shows a slight impact on flow at a basin scale, but has visible benefits on smaller rivers
- This strategy may have substantial benefits to water quality (e.g. reduced nutrient loading and other constituents on tributaries and the mainstem), though this cannot be demonstrated through the modelling
- Stored effluent could provide a backup water source when freshwater systems are stressed or not available

Trade-offs

- There is a slight negative impact on walleye recruitment, this impact is seen when the off-stream storage is initially filling
- Developing infrastructure to distribute wastewater for reuse may not necessarily result in net environmental benefit
- Reusing treated wastewater, which is usually returned to the river as per the return flows in licenses, may impact the quantity of water available for downstream water users

Implementation: Effluent reuse

Challenges

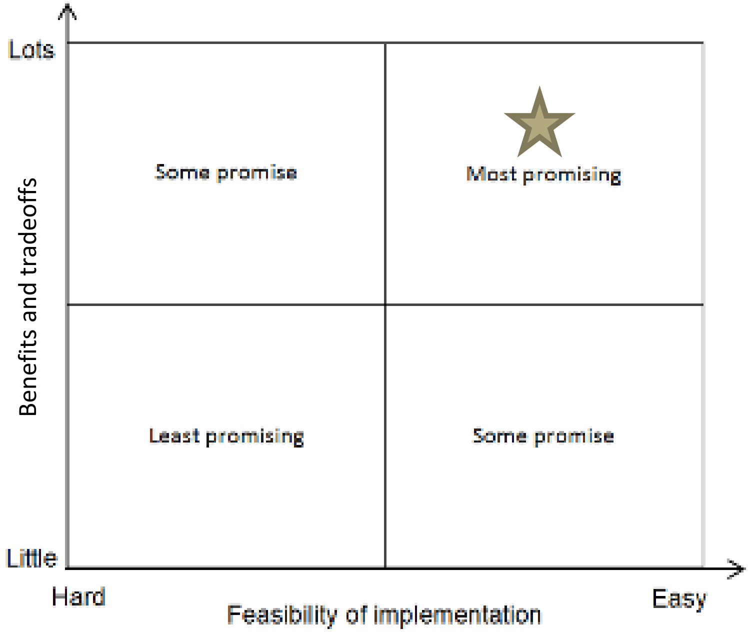
- This strategy is more feasible to implement at a local level with a network of smaller storage facilities, thus minimizing transportation distances
- For this strategy to be implemented there is a need to ensure acceptable quality of the water for reuse depending on the end use

Actions

- Continue to develop and implement a basin-wide or province-wide water reuse policy. Such a policy should change, clarify, or create clear direction for decisions on water reuse
- Create incentives for water reuse (e.g. an opportunity for a company to report through a sustainability index)

Screening assessment

- This strategy was identified as a most promising strategy
- Ease of implementation of this strategy is contingent on a water reuse policy being developed and implemented to allow users to begin the reuse process. This may start with many small water exchanges that develop over time into a larger water reuse network.



Strategy overview: Water conservation

Continue to achieve water conservation and efficiency improvements as communities develop

Overview

Promote conservation and efficiency practices for municipal, industrial, and commercial water use; supporting future regional development without increasing demand for fresh water.

What's already happening with this strategy

- The Draft Water Conservation Policy was released in October 2016 and outlines the conservation of fresh water for oil and gas development
- The Water for Life Strategy outlines conservation, efficiency, and productivity (CEP) outcomes and actions for specific sectors
- The Alberta Water Council produced recommendations for CEP planning, and outlined a planning process to be followed by the seven major water using sectors in Alberta

How it was simulated in the model

- All municipal, industrial, and commercial demands throughout the basin were reduced by 10%

Key modelling results and discussion: Water conservation

Period and Location	Dry – Water conservation	Historic – Water conservation	Wet – Water conservation
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	1.0 Days	0.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	2.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	0.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	-3.0 Days	0.0 Days	-2.0 Days
Annual - Mouth of the McLeod River	-54.0 Days	-20.0 Days	-17.0 Days
Annual - Mouth of the Clearwater River	-20.0 Days	-3.0 Days	-3.0 Days
Annual - Mouth of the Lesser Slave river	-40.0 Days	-34.0 Days	-48.0 Days
Annual - Mouth of the Pembina River	-8.0 Days	-6.0 Days	-5.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	-7.62%	-7.50%	-7.62%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.10%	0.05%	0.07%
Spring - at the Mouth	0.16%	0.08%	0.08%
Fall - at the Mouth	0.13%	0.06%	0.09%
Winter - at the Mouth	0.25%	0.17%	0.20%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	-0.88 m3/s	-0.01 m3/s	-0.02 m3/s
Winter - whole system	-3.21 m3/s	-0.0 m3/s	-0.06 m3/s
Fall - whole system	-0.02 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Benefits and tradeoffs: Water conservation

Benefits

- Benefits incurred from this strategy would be seen across all PMs and would be proportional to the degree of conservation practiced
- This strategy improves walleye recruitment and reduces IFN violations, improvement in these two PMs indicate healthier aquatic systems
- These is a reduction in shortages for water users because water users are not asking for as much water

Trade-offs

- A great deal of effort and expense may be required to implement conservation programs and initiatives throughout the basin. All sectors have been working towards CEP plans of 30% conservation targets, a 10% target, as modelled, beyond this may be impossible
- Reductions beyond 30% may provide diminishing returns, some sectors may experience more difficulties than others

Implementation: Water conservation

Challenges

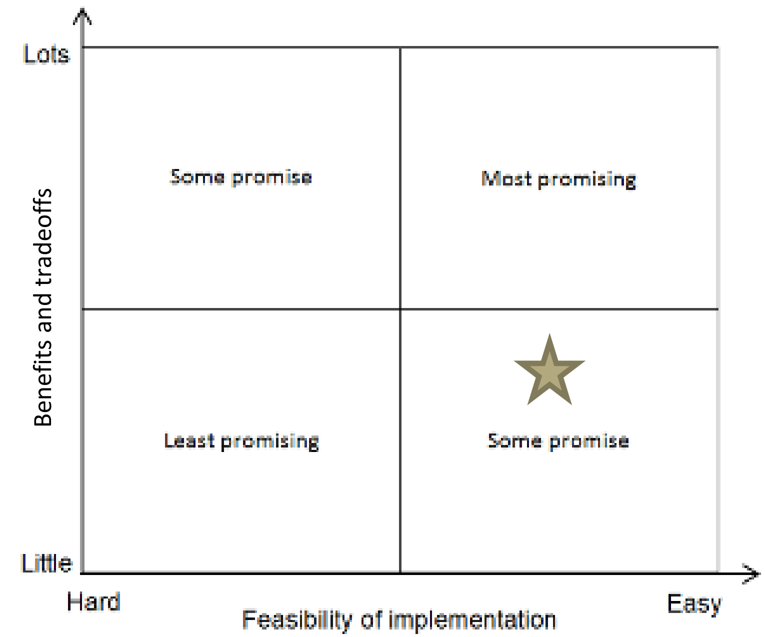
- Achieving effective outreach to residents, industry, and business owners
- The cost of new technologies to achieve further water conservation could be very high

Actions

- Outreach and education programs should be implemented for all municipalities and for all industrial and commercial developments. Awareness and education are vital for the combined success of conservation as a strategy.
- Encourage and support water conservation through incentive programs, such as:
    - Enforce stricter water use regulations and imposing higher water rates
    - Establish legislation that encourages water reuse
    - Review the progress on the CEP plans more frequently, perhaps every year

Screening assessment

- This strategy was identified as having some promise
- This strategy was noted to be highly feasible and to yield moderate net benefits for the basin. This strategy is also socially feasible and much is already being done to advance water conservation goals.



Strategy overview: On-stream storage

Explore new on-stream multi-purpose storage options

Overview:

Explore on-stream storage options within the ARB, which would serve multiple purposes, including but not limited to:

- Storage for flow augmentation to meet downstream minimum flows e.g., flows for aquatic health, riparian health, and/or navigation
- Water supply for licensed demands
- Flood mitigation
- Hydropower generation as a renewable energy source

What's already happening with this strategy:

- A report completed in 2010 for AUC by Hatch identified a number of potential hydropower sites in Alberta, with 17 potential sites identified in the ARB
- Alberta's Climate Leadership Plan established aggressive targets for renewable energy
- Applications have been made for two on-stream run-of-river hydropower sites on the mainstem of the Athabasca River; the two proposed sites are the Pelican Renewable Generating Station Project and Sundog Renewable Generating Station Project upstream of Fort McMurray

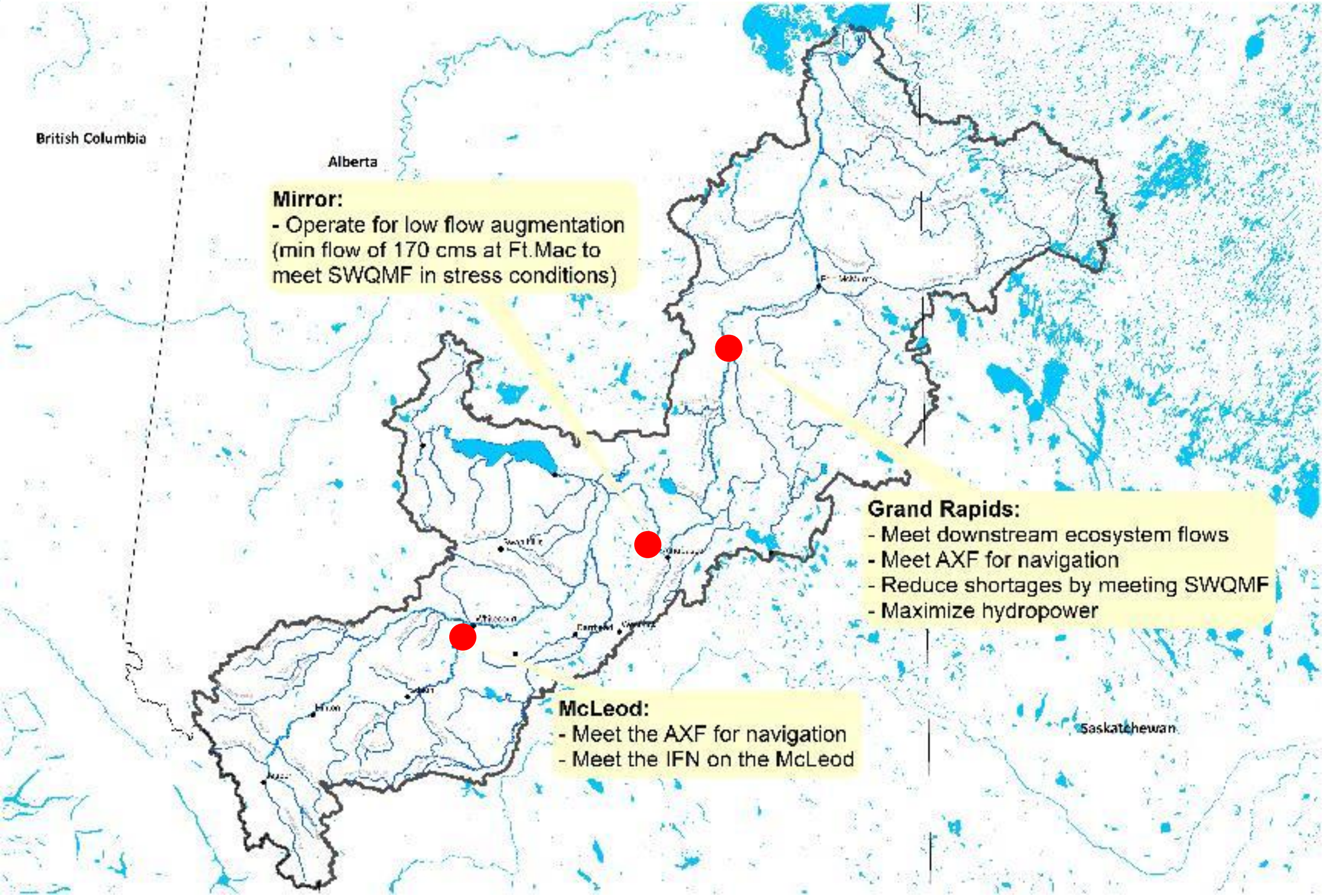
Strategy overview: On-stream storage

How it was simulated in the model

The following model runs were simulated in AIRM to explore the effects of on-stream storage at different locations in the basin:

- On-stream tributary facility - McLeod site
  - This reservoir would have a maximum storage of 694,000 dam^3 and would operate to meet downstream flows for navigation and IFN flows on the McLeod River. The reservoir would only release water when it is needed for these purposes The McLeod reservoir could also be simulated to operate for hydropower purposes only.
- On-stream mainstem facility - Mirror site
  - This reservoir would have a maximum storage of 1,899,600 dam^3 and would operate for low flow augmentation and hydropower production. The Mirror reservoir could also be simulated to operate for hydropower purposes only.
- On-stream mainstem downstream facility - Grand Rapids site
  - This reservoir would have a maximum storage of 407,000 dam^3 and would operate to meet the following objectives in priority order: 1) meet downstream ecosystem flows, 2) meet navigational flow requirements, 3) reduce shortages, and 4) maximize hydropower. The Grand Rapids reservoir could also be simulated to operate for hydropower purposes only.

Strategy overview: On-stream storage



Key modelling results and discussion: On-stream storage tributary (multipurpose storage)

Period and Location	Dry - McLeod	Historic - McLeod	Wet - McLeod
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	43.0 Days	59.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-2.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	-1904.0 Days	-1701.0 Days	-1640.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	0.38%	2.54%	0.05%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.26%	0.37%	0.68%
Spring - at the Mouth	1.16%	1.10%	0.77%
Fall - at the Mouth	0.25%	0.66%	0.56%
Winter - at the Mouth	0.35%	0.32%	0.65%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	-0.01 m3/s	-0.0 m3/s	0.0 m3/s
Winter - whole system	-0.0 m3/s	0.0 m3/s	-0.01 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Key modelling results and discussion: On-stream storage tributary (hydro)

Period and Location	Dry – McLeod hydro	Historic – McLeod hydro	Wet – McLeod hydro
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	1.0 Days	1.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-1.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	15.0 Days	-7.0 Days	32.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	6.67%	13.75%	6.67%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	-0.77%	-0.69%	-0.55%
Spring - at the Mouth	1.11%	0.99%	0.61%
Fall - at the Mouth	0.00%	0.00%	0.00%
Winter - at the Mouth	0.00%	0.00%	0.00%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Winter - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Key modelling results and discussion: On-stream storage mainstem (multipurpose storage)

Period and Location	Dry - Mirror	Historic - Mirror	Wet - Mirror
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	-28.0 Days	-4.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-3.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	107.54%	211.42%	106.98%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	-11.52%	-13.42%	-7.95%
Spring - at the Mouth	20.49%	16.95%	0.41%
Fall - at the Mouth	8.53%	8.43%	6.16%
Winter - at the Mouth	50.03%	29.01%	6.66%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	-0.79 m3/s	-0.0 m3/s	0.0 m3/s
Winter - whole system	-2.98 m3/s	0.0 m3/s	-0.02 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Key modelling results and discussion: On-stream storage mainstem (hydro)

Period and Location	Dry – Mirror hydro	Historic – Mirror hydro	Wet – Mirror hydro
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	2.0 Days	2.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-1.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	8.25%	16.88%	8.25%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	-2.57%	-2.93%	-1.54%
Spring - at the Mouth	1.03%	1.08%	0.85%
Fall - at the Mouth	0.00%	0.00%	0.00%
Winter - at the Mouth	-1.06%	-1.02%	-1.04%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Winter - whole system	0.24 m3/s	0.01 m3/s	0.24 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Key modelling results and discussion: On-stream storage mainstem downstream (multipurpose storage)

Period and Location	Dry – Grand Rapids	Historic – Grand Rapids	Wet – Grand Rapids
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	43.0 Days	59.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-1.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	14.85%	10.96%	4.44%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	-1.79%	-1.44%	-1.22%
Spring - at the Mouth	16.18%	4.48%	1.17%
Fall - at the Mouth	0.00%	-0.02%	0.00%
Winter - at the Mouth	75.90%	0.00%	0.04%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	-0.79 m3/s	-0.0 m3/s	0.0 m3/s
Winter - whole system	-2.94 m3/s	0.0 m3/s	-0.02 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Key modelling results and discussion: On-stream storage mainstem downstream (hydro)

Period and Location	Dry - Grand Rapids hydro	Historic – Grand Rapids hydro	Wet – Grand Rapids hydro
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	1.0 Days	0.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-1.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	4.44%	9.38%	4.44%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	-1.79%	-1.44%	-1.22%
Spring - at the Mouth	3.31%	2.99%	1.17%
Fall - at the Mouth	0.00%	0.00%	0.00%
Winter - at the Mouth	0.00%	0.00%	0.00%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	-0.02 m3/s	-0.0 m3/s	0.0 m3/s
Winter - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Benefits and tradeoffs: On-stream storage

Benefits

- There are potentially large benefits to the basin from on-stream dams and reservoirs; the nature of the benefits would depend on what objectives the storage facility is built and operated to meet
- On-stream storage would allow for storage of water at high flow times and releases at low flow times, therefore potentially helping to meet navigational flows more often, reducing shortages to licenced demands, and reducing IFN violations (if storage were on the major tributaries)
- Flow stabilization or augmentation may offer potential for managing ice-jamming
- On-stream storage could result in fewer flood days through communities under wet conditions by capturing and storing peak flows

Trade-offs

- The potential benefits from on-stream storage would result from the facility changing the natural flow regime of the river; such changes can introduce significant trade-offs
- A major trade-off is the potential impact on fisheries; as modelled, this strategy has negative impacts on walleye recruitment during the summer fry period (as walleye rely on naturalized summer flows for recruitment)
- On-stream storage could have impacts on other environmental factors and traditional communities, for example, inhibiting fish passage, altering riparian health, and changing the natural sedimentation of the river
- On-stream storage may have negative effects on Indigenous communities, land uses and sites
- Other cultural and recreational uses of the river, such as canoeing, may be negatively impacted by this strategy; however, in some instances these same uses have seen benefits from flow augmentation from storage

Implementation: On-stream storage

Challenges

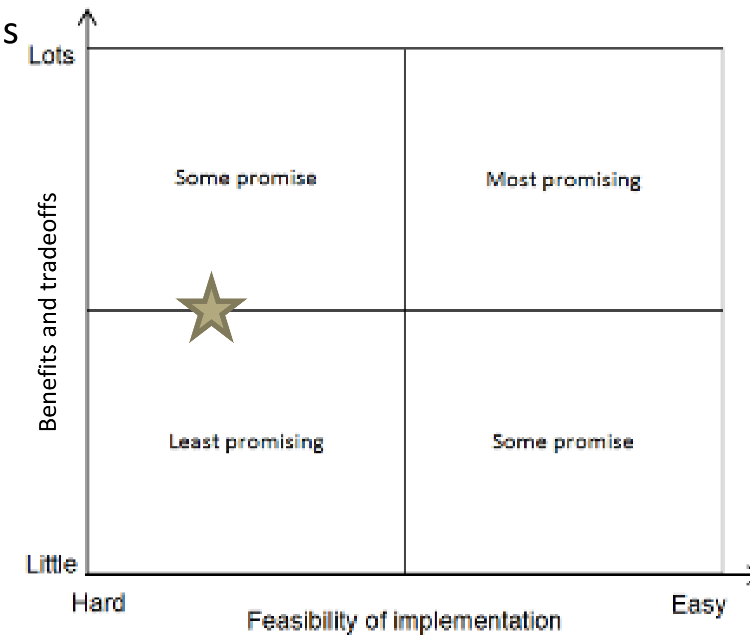
- Large on-stream storage infrastructure projects are extremely costly to develop, build and operate
- A wide range of environmental concerns will need to be identified and addressed for an on-stream storage project to proceed, e.g. flows to the Peace-Athabasca Delta, sediment transport, fish migration, and ice-jamming; these should be managed through federal and provincial environmental assessment and mitigation measures

Actions

- Develop basin purposes for any potential on-stream storage facility; should a project be advanced, it would meet basin objectives in addition to energy generation
- Perform site selection, project feasibility and environmental assessments in the context of defined basin purposes
- Align with best practice guidelines through upfront engagement and consultation, and conduct them in accordance with federal and provincial regulations

Screening assessment

- This strategy was identified as being least promising to having some promise
- The strategy was considered to have low feasibility (contingent on site selection, feasibility studies, EAs, adequate engagement, and adequate financial support), with high potential benefit, but also high tradeoffs



Strategy overview: Off-stream storage

Develop new and existing off-stream storage sites to meet multiple basin water management objectives

Overview:

Develop new off stream storage sites to meet multiple basin water management objectives, such as enhancing industrial water supply, flow regulation for aquatic health, improved riparian health or navigation, and hydropower generation

What's already happening with this strategy:

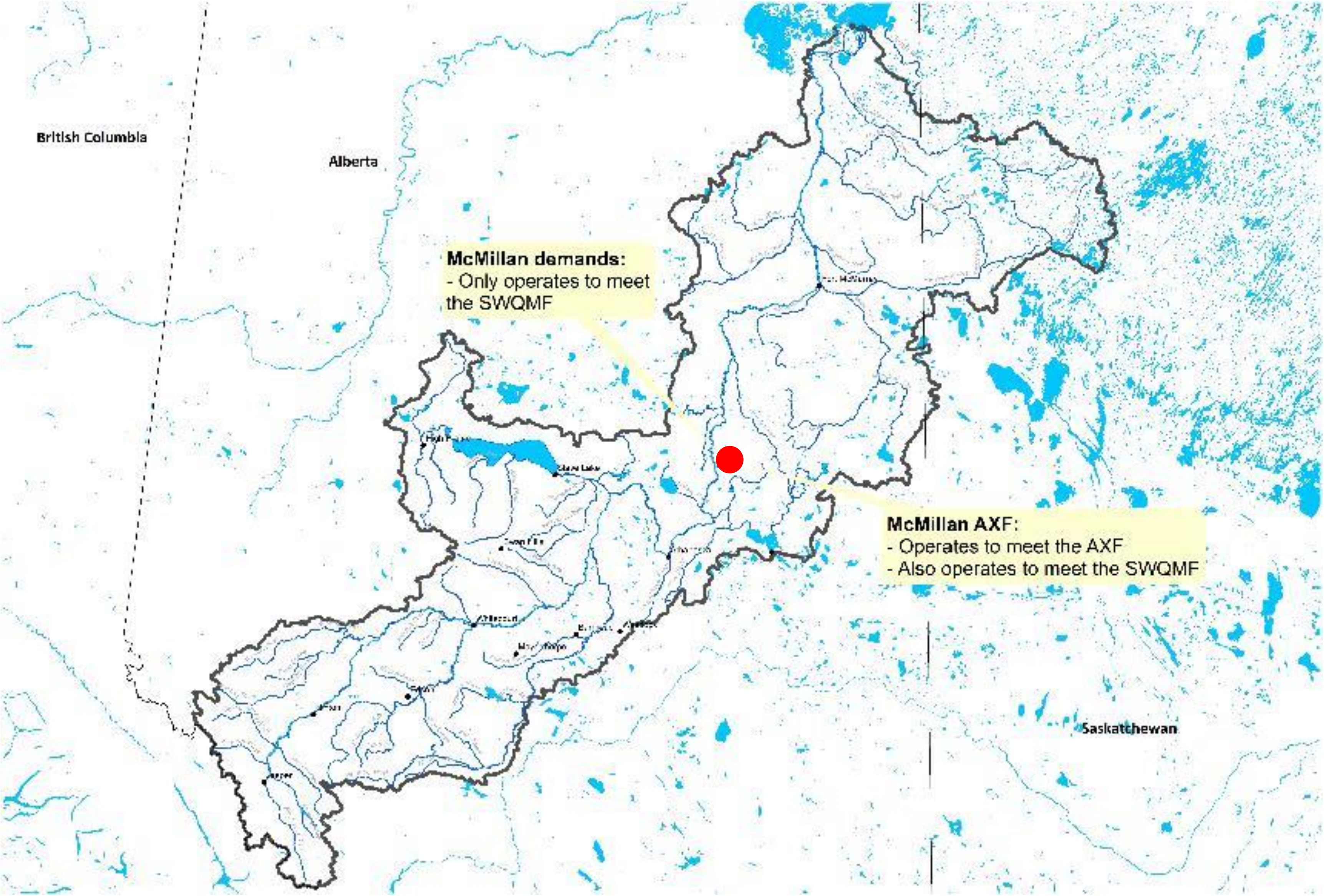
- Several oil sands sites have off-stream water storage. For example, Imperial Oil's Kearl site has storage capacity for make-up water for a 30-day period. These sites allow operators to not divert water during low flow periods; however, they were not built and designed to meet multiple basin water management objectives

How it was simulated in the model

Two model runs were done to test this strategy:

- McMillan demands: assumes both a maximum and initial storage of 100,000 dam^3 in McMillan Lake. Water would only be pumped out of the lake when necessary to meet downstream licence demands.
- McMillan AXF: assumes both a maximum and initial storage of 100,000 dam^3 in the lake. Water would be pumped out of the lake to 1) meet the AXF navigation flow target downstream, and 2) meet any downstream licence demands.

Strategy overview: Off-stream storage



Key modelling results and discussion: Off-stream storage (SWQMF)

Period and Location	Dry – McMillan demands	Historic – McMillan demands	Wet – McMillan demands
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	-8.0 Days	0.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	0.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	0.00%	0.00%	0.00%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.00%	0.00%	0.00%
Spring - at the Mouth	-13.45%	0.00%	0.00%
Fall - at the Mouth	0.00%	0.00%	0.00%
Winter - at the Mouth	36.91%	0.00%	0.04%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	-0.13 m3/s	0.0 m3/s	0.0 m3/s
Winter - whole system	-2.09 m3/s	0.0 m3/s	-0.02 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Key modelling results and discussion: Off-stream storage (water use for AXF)

Period and Location	Dry – McMillan AXF	Historic – McMillan AXF	Wet – McMillan AXF
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	32.0 Days	51.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	0.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	0.96%	1.17%	0.00%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.00%	0.00%	0.00%
Spring - at the Mouth	-12.45%	1.02%	0.00%
Fall - at the Mouth	0.03%	0.49%	0.00%
Winter - at the Mouth	36.91%	0.01%	0.04%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	-0.14 m3/s	-0.0 m3/s	0.0 m3/s
Winter - whole system	-2.09 m3/s	0.0 m3/s	-0.02 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Benefits and tradeoffs: Off-stream storage

Benefits

- The benefits to the basin from off-stream reservoirs would depend on what objectives the storage facility is built and operated to meet. Some possible benefits include:
  - Potential reduction in shortages to water users
  - More days meeting desired navigational flow targets
  - Higher winter streamflow
  - Hydropower generation may be possible depending on how the facility is built

Trade-offs

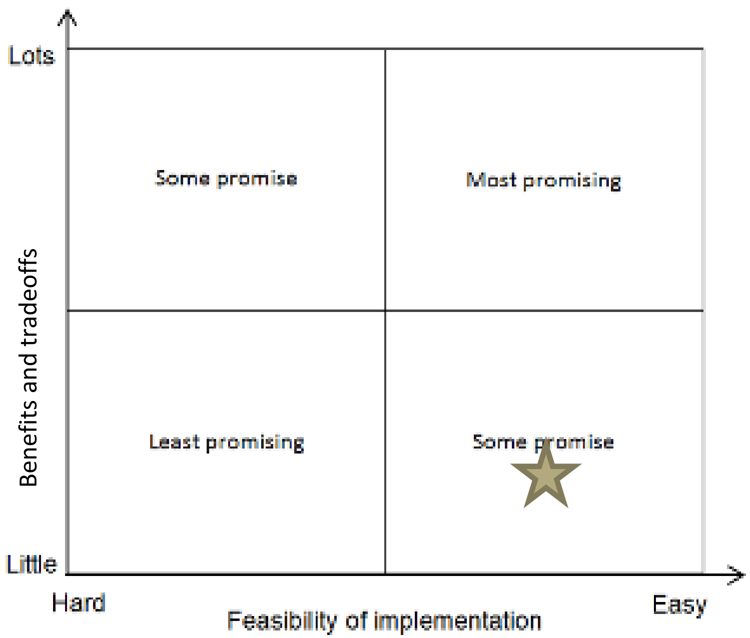
- The potential benefits from off-stream storage would result in part from a diversion changing the natural flow regime of the source river. Changes to the natural flow regime can introduce significant trade-offs including negative impacts to walleye recruitment due to diversions to refill the storage during the summer fry window
- Off-stream storage may create water temperature and water quality concerns depending on the site selected and operating parameters

Implementation: Off-stream storage

Challenges
- None identified

Actions
- Develop basin purposes for any potential off-stream storage facility
- Undertake feasibility and engineering studies for specific sites to see if this strategy is viable
- Conduct an EA to identify negative consequences to the environment or Indigenous values in the area

Screening assessment
- This strategy was identified as a strategy having some promise
- This strategy is moderately feasible to implement; the benefits would be low to moderate for the basin as a whole. It is categorized as a strategy of moderate promise.



Strategy overview: Existing infrastructure

Alter existing water storage infrastructure and/or operations to meet multiple basin water management objectives

Overview:

Alter existing water storage operations on the Paddle River Dam and alter the weir infrastructure on Lesser Slave Lake. These modifications would help meet multiple objectives in the basin, including storage for flow augmentation, licence use, flood mitigation, and restoring natural flow regimes downstream

What's already happening with this strategy:

- Paddle River Dam, which is currently used for flood control and recreation
- Weir on Lesser Slave Lake, which is currently used to reduce fluctuating lake levels and diminish flood risk

How it was simulated in the model

- Alterations to the dam and the weir were modelled together in the same strategy. Paddle River Dam operations were modified so that downstream demands would be able to pull water out of the reservoir during low flow periods when needed. The weir Lesser Slave Lake was raised by 30 cm to simulate increased storage on the lake
- Two variations of this strategy were run
    - Meet the downstream minimum flows for the SWQMF
    - Meet a downstream minimum flow of 15 m^3/s on Lesser Slave River

Key modelling results and discussion: Existing infrastructure (meeting the SWQMF)

Period and Location	Dry – Existing infrastructure	Historic – Existing infrastructure	Wet – Existing infrastructure
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	-9.0 Days	-4.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	2.0 Days	137.0 Days	502.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-6.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	-606.0 Days	3327.0 Days	1315.0 Days
Annual - Mouth of the Pembina River	55.0 Days	30.0 Days	3.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	0.00%	0.00%	0.00%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	-0.74%	0.06%	0.03%
Spring - at the Mouth	-1.02%	-0.14%	-0.18%
Fall - at the Mouth	-0.68%	-0.23%	-0.16%
Winter - at the Mouth	0.08%	-0.40%	-0.62%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	-0.8 m3/s	-0.01 m3/s	-0.0 m3/s
Winter - whole system	-2.93 m3/s	0.0 m3/s	-0.02 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Key modelling results and discussion: Existing infrastructure (not meeting the SWQMF)

Period and Location	Dry – Existing infrastructure without SWQMF	Historic – Existing infrastructure without SWQMF	Wet – Existing infrastructure without SWQMF
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	-6.0 Days	-4.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	-1.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	29.0 Days	134.0 Days	495.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-6.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	-262.0 Days	3262.0 Days	1325.0 Days
Annual - Mouth of the Pembina River	55.0 Days	30.0 Days	3.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	-0.12%	-0.06%	0.00%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.13%	0.06%	0.03%
Spring - at the Mouth	1.21%	0.40%	-0.02%
Fall - at the Mouth	-0.43%	-0.23%	-0.16%
Winter - at the Mouth	0.80%	-0.07%	-0.51%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	14.69 m3/s	5.55 m3/s	0.4 m3/s
Winter - whole system	15.73 m3/s	3.16 m3/s	0.67 m3/s
Fall - whole system	0.02 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Benefits and tradeoffs: Existing infrastructure

Benefits

- The benefits to the basin would depend on what objectives the revised operations of the existing infrastructure intended to meet.
- This strategy shows increased walleye recruitment due to higher than naturalized summer flows, overall this suggested improved aquatic health

Trade-offs

- Increased flooding hazard on the Lesser Slave River and Lesser Slave Lake due to higher peak flows and increased lake elevation
- Decreased water quality may be expected as increased erosion and sedimentation could result from higher peak flows
- Lower winter flows would also be expected on Lesser Slave River creating more IFN violations, and could potentially increase shortages to water users

Implementation: Existing infrastructure

Challenges

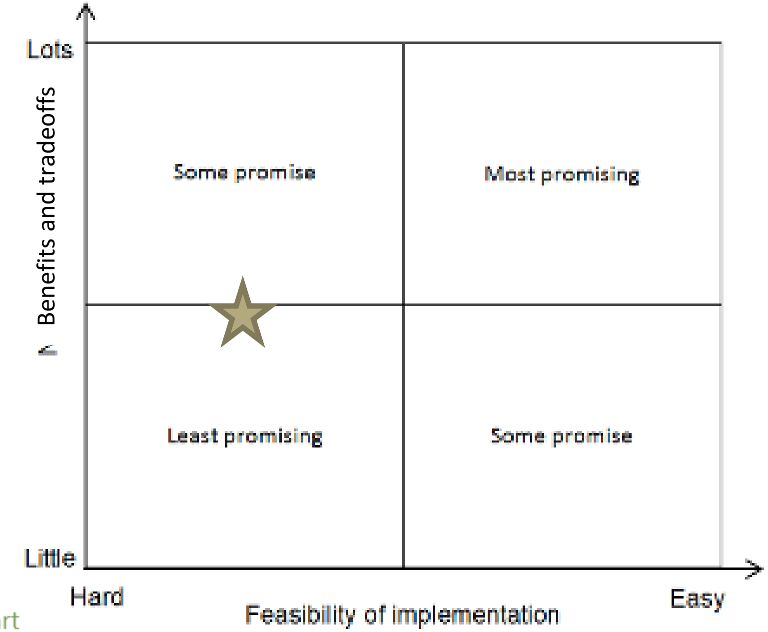
- There are negative social and recreational impacts associated with an increase in the water level on Lesser Slave Lake and the Paddle River Reservoir
- The operational changes proposed in this strategy may not be feasible or useful given the low benefits seen with this strategy

Actions

- Develop and implement a lake management plan for the Lesser Slave Lake region; this plan should create clear management objectives for lake levels, water allocations, and downstream flows on Lesser Slave Lake to optimize aquatic health, flood mitigation, and recreational and navigational opportunities

Screening assessment

- This strategy was identified as a least promising strategy
- As it was modelled, the effect of modifying existing infrastructure and operations in the basin may not be socially or ecologically feasible due to increased flooding risk and increased IFN violations



Strategy overview: Environmental flows

Establish IFNs or similar targets for all tributaries in the basin as a precautionary water management measure

Overview:

Set IFN or similar flow targets on some larger tributaries in the basin as a precautionary water management measure using the existing Alberta Desktop Method. This is intended to proactively manage ecosystem health.

What's already happening with this strategy:

- The Lower Athabasca Region Surface Water Quantity Management Framework (SWQMF)
- All new TDLs issued are subject to IFNs as calculated using the Alberta Desktop Method
- A modified desktop method is currently being developed to guide water allocations so that ecosystem health can be maintained
- Water sharing agreements between oil sands operators

How it was simulated in the model

- The Alberta Desktop Method was applied to five tributaries in the model (McLeod, Pembina, Lesser Slave, Lac La Biche, and Clearwater) to set an IFN minimum flow target at the mouth of each tributary. The Alberta Desktop Method is the greater of either a 15% reduction in naturalized flow or the Q80 of weekly naturalized flow. Upstream demands were shorted in order to meet the IFN whenever necessary.

Key modelling results and discussion: Environmental flows

Period & Location	Dry – Environmental flows	Historic – Environmental flows	Wet – Environmental flows
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	3.0 Days	0.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	0.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	-30.0 Days	-16.0 Days	-20.0 Days
Annual - Mouth of the McLeod River	-470.0 Days	-177.0 Days	-156.0 Days
Annual - Mouth of the Clearwater River	-189.0 Days	-37.0 Days	-56.0 Days
Annual - Mouth of the Lesser Slave River	-2661.0 Days	-1481.0 Days	-1953.0 Days
Annual - Mouth of the Pembina River	-577.0 Days	-504.0 Days	-328.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	-13.50%	-7.15%	-7.85%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.70%	0.24%	0.34%
Spring - at the Mouth	1.91%	0.73%	0.69%
Fall - at the Mouth	1.23%	0.31%	0.47%
Winter - at the Mouth	2.48%	1.01%	1.18%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	18.88 m3/s	5.88 m3/s	13.59 m3/s
Winter - whole system	28.38 m3/s	7.09 m3/s	13.66 m3/s
Fall - whole system	23.02 m3/s	5.45 m3/s	10.31 m3/s
Summer - whole system	16.32 m3/s	5.54 m3/s	11.28 m3/s

Benefits and tradeoffs: Environmental flows

Benefits

- This strategy results in decreased IFN violations throughout the basin, and would also increase seasonal naturalized streamflow
- This strategy results in increased walleye recruitment, suggesting an improvement to fishery health
- Under dry conditions, this strategy results in a slight increase in the number of days that navigational flows are met

Trade-offs

- This strategy has significant increases in water shortages to all users over all seasons as licences are shorted in order to meet IFNs

Implementation: Environmental flows

Challenges

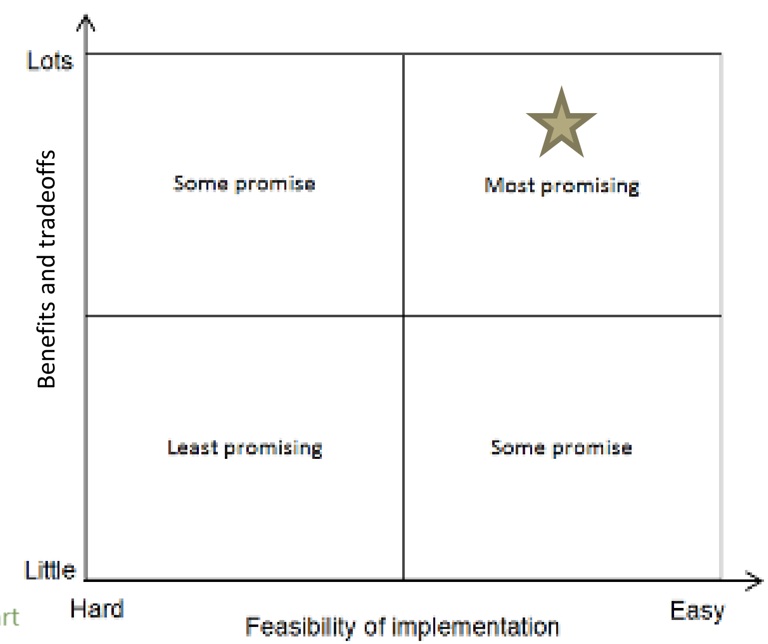
- There is no water management plan in place that speaks directly to IFN minimum flows

Actions

- Establish IFNs in an approved water management plan by exploring the potential of using a modified desktop method to establish the IFN targets
- Develop a database of tributaries that have habitat at risk and/or species at risk and limit water allocations, implement IFNs, and/or restrict activities in those areas
- Determine watershed withdrawal limits based on environmental factors (e.g., a carrying capacity) and manage licences with that limit in mind
- Communicate broadly, in an accessible way, when IFNs are implemented on a licence or a specific stream

Screening assessment

- This strategy was identified as a most promising strategy
- The most promising use of this strategy is to use the model to determine where this strategy would have the highest impact, by applying the desktop limits (or modified desktop limits as is currently being developed) to see where the pressures are for water supply. This can be used to illustrate and quantify supply risks to the "next person in the licence queue".



Strategy overview: Navigational flows

Implement minimum flows to improve navigation in the lower Athabasca basin

Overview:

Improve navigation during the open water season on the Athabasca River downstream of the confluence with the Firebag River. The minimum flow is based on the AXF, which is defines a minimum flow of 400 m^3/s between April 16 and October 28 (196 days). In this strategy, upstream licence demands are shorted to meet the AXF flow target whenever necessary.

What's already happening with this strategy:

- Currently there is no established minimum flow for navigational purposes in the ARB

How it was simulated in the model

- Based on the flow and timing suggested by the AXF, the model applies a minimum flow target of 400 m^3/s downstream of the confluence with the Firebag River, between April 16 and October 28 of each year. The model will short upstream licence users during that period to keep flow in the river and reach the 400 m^3/s target

Key modelling results and discussion: Navigational flows

Period and Location	Dry – Navigational flows	Historic – Navigational flows	Wet – Navigational flows
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	13.0 Days	6.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	0.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	-1.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Lesser Slave River	-10.0 Days	-1.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	-0.29%	-0.48%	0.00%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.00%	0.00%	0.00%
Spring - at the Mouth	0.03%	0.02%	0.00%
Fall - at the Mouth	0.02%	0.02%	0.00%
Winter - at the Mouth	0.00%	0.00%	0.00%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	0.67 m3/s	0.45 m3/s	0.0 m3/s
Winter - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Fall - whole system	0.7 m3/s	0.62 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Benefits and tradeoffs: Navigational flows

Benefits

- Under dry conditions this strategy provides 13 more days where the navigational flow targets are met, under historic conditions the navigational flow targets are met six more days
- This strategy increases walleye recruitment because of higher streamflow during the open water season which overlaps with the walleye recruitment window
- This strategy decreases the number of days when the IFN is violated in some sub-basins by a small amount

Trade-offs

- In this strategy upstream water users would be shorted during the spring and fall. Users would be shorted in a priority sequence; however, all upstream users may experience a shortage

Implementation: Navigational flows

Challenges

- There is no water management plan in place that defines minimum flows for optimal and sub-optimal navigation
- This strategy requires a greater understanding of navigational needs along different reaches in the Lower Athabasca River, at different temporal scales, including what constitutes minimum acceptable conditions for navigation as well as optimal conditions
- A better understanding of the impacts of climate change on navigational requirements would facilitate implementation

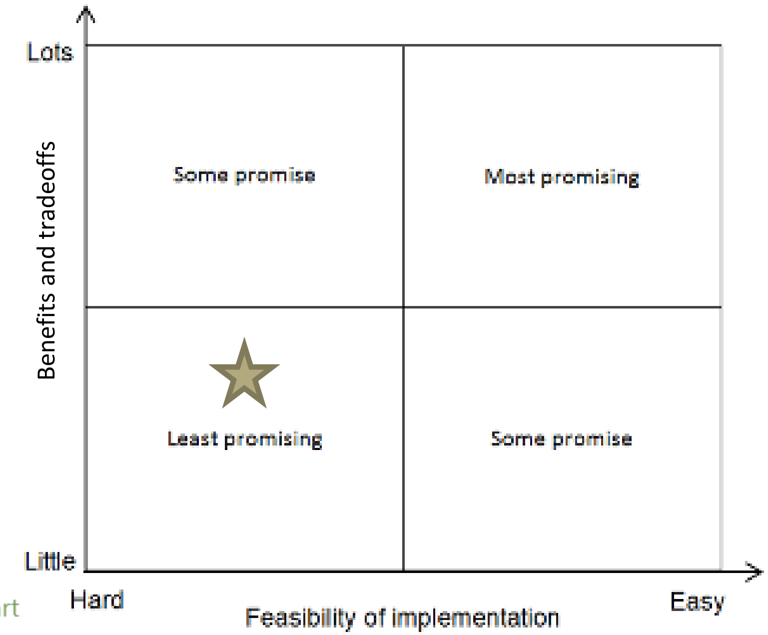
Actions

- Develop a navigation model to understand navigation channels and their changes through time; this model should consider possible future changes in streamflow
- Assess means of obtaining minimum flows for navigation or alternate navigation
- Develop a better understanding of navigation challenges experienced by communities
- Develop a binding water management plan that defines minimum flows and a way to meet these minimum flows for optimal and sub-optimal navigation, which varies by season and location within the basin

Implementation: Navigational flows

Screening assessment

- This strategy was identified as a least promising strategy (as it is modelled)
- Most Working Group participants thought this strategy would have little benefit and that it would be reasonably difficult to implement (i.e., cutting off all water licences upstream). Combining this strategy with others could maximize the benefits and make implementation more feasible
- It was widely noted that minimum flows for navigation should be implemented in conjunction with other water management strategies, such as off-stream storage)



Strategy overview: Land conservation

Increase the quantity and improve the condition of conserved and restored land across the basin, particularly in areas of high biodiversity or hydrologic importance

Overview

This strategy is intended to maintain and improve hydrologic function and watershed health. It has potential throughout the entire basin but is focused on the upper and central portions. Areas for conservation and restoration have been pre-identified by the Canadian Parks and Wilderness Society (CPAWS), the Alberta Wilderness Association, and Ducks Unlimited Canada.

What's already happening with this strategy:

- Possible conservations areas include the CPAWS high conservation areas for biodiversity, the CPAWS Net Present Value model areas, the AWA areas of concern, and the DUC key wetland areas
- Under LARP, approximately 16% of the Lower Athabasca's land base is managed as new conservation areas in addition to the 6% already protected as wildland provincial parks

Strategy overview: Land conservation

How it was simulated in the model

- Any areas in the CPAWS NPV20 (CPAWS20), and CPAWS NPV50 (CPAWS50) footprints that are human-made were simulated as being restored to a natural land cover
- Footprints to be restored included agriculture, mines, small roads, pipelines, seismic lines, and powerlines
- Features to be excluded from conversion included urban areas, major roads, recreation areas, and trails
- In the model, fires were suppressed and would not be active in the conserved landscape. Suppressing fire was agreed to at a Working Group meeting in order to isolate the effect of simply conserving land without other confounding factors

Key modelling results and discussion: Land conservation (CPAWS20)

Period and Location	Dry - CPAWS20	Historic - CPAWS20	Wet - CPAWS20
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	-3.0 Days	-3.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	-3.0 Days	1.0 Days
Annual - Lesser Slave River	-1.0 Days	-4.0 Days	-23.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-1.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	94.0 Days	56.0 Days	7.0 Days
Annual - Mouth of the McLeod River	1.0 Days	5.0 Days	5.0 Days
Annual - Mouth of the Clearwater River	311.0 Days	200.0 Days	36.0 Days
Annual - Mouth of the Lesser Slave River	59.0 Days	144.0 Days	118.0 Days
Annual - Mouth of the Pembina River	-73.0 Days	-52.0 Days	-21.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	0.00%	0.00%	0.00%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	-0.02%	-0.02%	-0.01%
Spring - at the Mouth	0.05%	-0.04%	-0.01%
Fall - at the Mouth	-0.04%	-0.01%	-0.02%
Winter - at the Mouth	-0.03%	-0.01%	-0.02%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	0.02 m3/s	0.0 m3/s	0.0 m3/s
Winter - whole system	0.04 m3/s	0.0 m3/s	0.0 m3/s
Fall - whole system	-0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Key modelling results and discussion: Land conservation (CPAWS50)

Period and Location	Dry - CPAWS50	Historic - CPAWS50	Wet - CPAWS50
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	-11.0 Days	-8.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	-1.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	0.0 Days	-3.0 Days	2.0 Days
Annual - Lesser Slave River	-4.0 Days	-22.0 Days	-68.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-5.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	503.0 Days	404.0 Days	407.0 Days
Annual - Mouth of the McLeod River	176.0 Days	128.0 Days	137.0 Days
Annual - Mouth of the Clearwater River	546.0 Days	333.0 Days	153.0 Days
Annual - Mouth of the Lesser Slave River	322.0 Days	601.0 Days	382.0 Days
Annual - Mouth of the Pembina River	-199.0 Days	-160.0 Days	-115.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	0.00%	0.00%	0.00%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	-0.14%	-0.05%	-0.09%
Spring - at the Mouth	-0.16%	-0.09%	-0.05%
Fall - at the Mouth	-0.12%	-0.05%	0.01%
Winter - at the Mouth	-0.19%	-0.07%	-0.07%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	0.04 m3/s	0.0 m3/s	0.0 m3/s
Winter - whole system	0.1 m3/s	0.0 m3/s	0.0 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Benefits and trade-offs: Land conservation

Benefits

This strategy would have many benefits that cannot be seen in the model, including:

- Potential improvements in water quality and potentially less alteration to the hydrologic regime of the basin
- More natural landscape and potentially higher biodiversity
- Fewer flood days on the Lesser Slave River
- Fewer IFN violations in the Pembina Basin

Trade-offs

- More days where flow is below the navigational target because water is being stored rather than contributing to runoff
- More IFN violations in all other sub-basins; however, this is confounded by the current IFN calculation
- More shortages under dry conditions

Implementation: Land conservation

Challenges

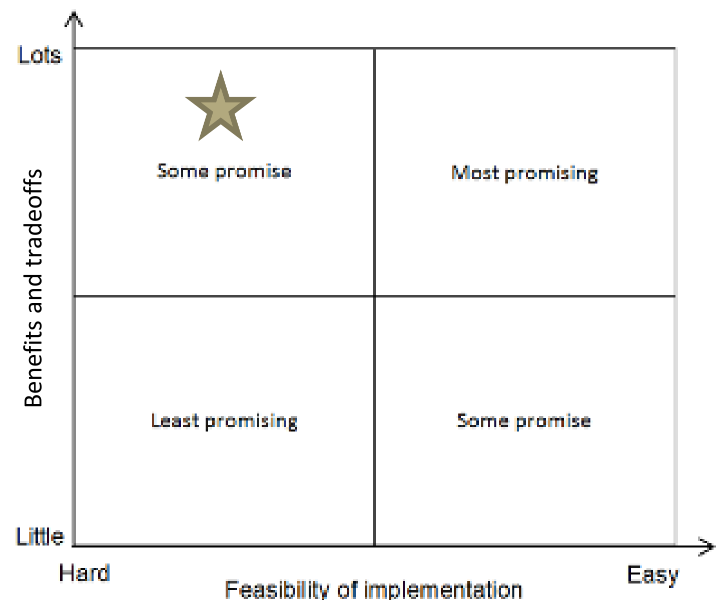
- Any increase in conservation will likely present political challenges
- The largest areas restored were agricultural lands, but it is not likely that agricultural lands will be restored to their natural state

Actions

- Develop a land use plan for the whole basin that sets aside areas for conservation
- Make available adequate funding to support conservation and restoration initiatives
- Identify sites of highest conservation and restoration priority that would have the greatest positive impact on peatland complexes, tributaries, and connectivity
    - Potential to build on work from recent WRRP project in the Bow and North Saskatchewan Basins

Screening Assessment

- This strategy was identified as having some promise
- Considering that the Lower Athabasca Regional Plan sets aside 16% of the land in that region for conservation, a CPAWS 20% conservation target may be achievable. A 50% target would be more challenging



Strategy overview: Forestry practices

Support practices in Forest Management Agreements (FMAs) that minimize hydrologic change

Overview

This strategy envisions the continued promotion and enforcement of timber harvest best management practices that minimize hydrologic change. Examples of such practices include:

- Completing detailed Forest Management Plans and Sustainability Plans
- Minimizing Equivalent Clearcut Area
- Maintaining healthy riparian reserve zones and management areas
- Deactivating roads

What's already happening with this strategy:

- FMAs have been established in the ARB
- Forest Stewardship Council has set out National Stewardship Standards
- Alpac and Ducks Unlimited MOU to establish watershed conservation partnership

How it was simulated in the model:

- Simulation explored the strategy by modelling the hydrologic effect of not managing forest disturbance
- This was done by doubling forest disturbance relative to current (approximately 28,000 km^2 of new disturbed forest relative to base case)

Benefits and trade-offs: Forestry practices

Benefits

- Benefits would be most noticeable in smaller watersheds with higher relative levels of disturbance and with higher amounts of forest cover, as opposed to the entire basin
- Management of disturbance levels could reduce the potential for alterations in streamflow regimes

Trade-offs

- Tradeoffs such as changes in timber supply should be evaluated when determining how forest harvest regimes could change in order to minimize effects in streamflow. However, these tradeoffs are difficult to quantify at the screening level given that efficiencies and innovative practices can play a role in offsetting the effects of reduced timber supply

This strategy was modelled in an inverse manner, therefore the modelling results show the outcomes of a lack of forest practices that minimise hydrological change.

Implementation: Forestry practices

Challenges

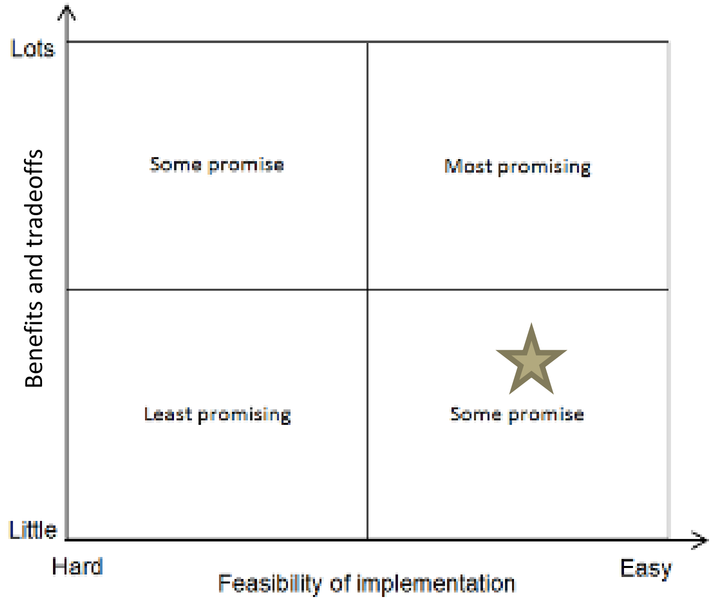
- BMPs can help mitigate the hydrologic effects of forest disturbance at all scales but they are not always put in place. As well, deviations can be granted to Operating Ground Rules with little transparency, wetlands are not always buffered, riparian assessment and retention practices often vary from one FMA to another, and forestry activities are not regulated on private land

Actions

- Complete detailed watershed assessments to identify potential for hydrologic alteration
- Alter harvest regimes in some watersheds identified to be hydrologically sensitive
- Improve compliance and application of forestry BMPs
- Incentivize BMPs (e.g., vary types of trees that are replanted, desynchronize runoff from the watershed, reclaim logging roads, retain riparian reserves and management zones around lakes, wetlands, and streams)

Screening Assessment

- This strategy was identified as having some promise
- This strategy is easy to implement, and would yield moderate benefit at large scales, with potential for substantial benefit at smaller scales



Strategy overview: Wetlands

Avoid further wetland loss and functional impairment and promote more wetland restoration, education, and best management practices focused on minimizing impacts

Overview

Avoid wetland loss and promote wetland restoration through the continued refinement, implementation, and enforcement of related legislation, policies, and mechanisms such as the Alberta Wetland Policy. The rationale for this strategy is to maintain or improve the hydrological benefits of wetlands, including groundwater recharge, sustained baseflow, water quality, flow attenuation, and others. The strategy would be most effective in the central and lower portions of the basin where wetlands play a larger role on the landscape.

What's already happening with this strategy:

- Alberta Wetland policy
- Ducks Unlimited, Alberta Pacific Forest Industries Inc., Canadian Forest Products Ltd., Millar Western Forest Products Ltd., Tolko Industries Ltd., West Fraser and Weyerhaeuser Company focused on Boreal forest wetland conservation
- Suncor and Syncrude have wetland reclamation as part of their mine closure plans and sustainability goals

Strategy overview: Wetlands

How it was simulated in the model

Model simulated a 30% relative decrease in wetland coverage in the following sub-basins:

- Athabasca River (between Athabasca and Fort McMurray)
- Lac La Biche
- House River
- Christina River

This represents approximately 458 km^2 of wetlands converted to disturbed (non permeable) land

This strategy is modelled as a decrease in wetlands to illustrate the importance of wetlands and their conservation on the landscape

Benefits and trade-offs: Wetlands

Benefits

- Simulation results suggest there could be higher streamflow as a result of less storage of water in wetlands
- Wetland conservation and restoration can increase overall ecosystem health, providing habitat for wildlife, hydrologic connectivity, and diversity across the landscape

Trade-offs

- None identified

This strategy was modelled in an inverse manner, therefore the modelling results show the outcomes of a decreasing wetlands.

Implementation: Wetlands

Challenges

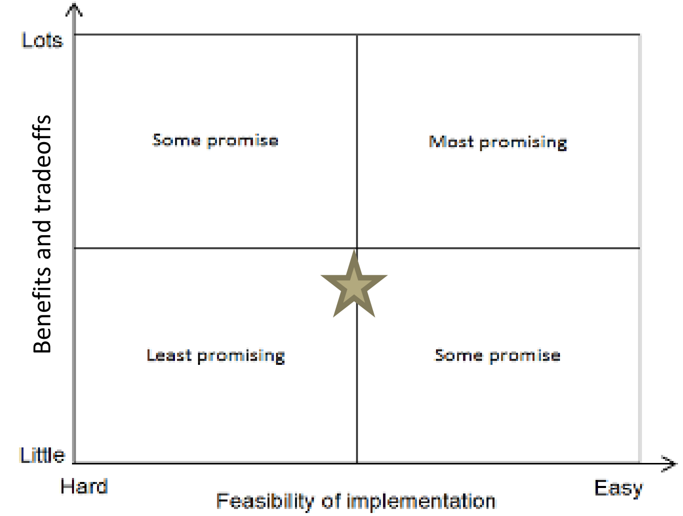
- This strategy would benefit from a deeper understanding and classification of wetland types and associated hydrological sensitivities (e.g., fens may be more sensitive than bogs, swamps, or marshes)
- Traditional Knowledge could be another valuable resource for better understanding wetlands and their role and the need to protect and conserve them

Actions

- Implement land use planning restrictions to limit residential development and its impacts on lakes and wetlands, specifically in the Lac La Biche area
- Improve understanding of hydrologically sensitive wetlands (additional data and modelling are needed to support this)
- Additional research about how changes in hydrologic connectivity affect streamflow
- Additional research on wetland construction methods that result in natural wetland function
- Implement and adopt as standard operations wetland BMPs, including avoidance of wetland loss

Screening Assessment

- This strategy was identified as a strategy having some promise
- This strategy would provide moderate benefits
- Implementation would be fairly easy if it means following the Alberta Wetland Policy more rigorously. Alternatively, if it means that all wetlands in the ARB must be preserved, implementation would be much more challenging



Strategy overview: Linear connectivity

Reclaim or deactivate linear features and reduce future linear disturbances in watersheds

Overview

Reduce the total linear footprint on the landscape by 40% through mechanisms such as road and trail deactivation, seismic line reclamation, and restrictions on off-highway vehicle use. Linear features fragment the landscape and have the potential to interrupt hydrologic functions, ultimately affecting streamflow. This strategy reduces this interruption and aims to determine the hydrological impact of linear disturbances in terms of changes to streamflow. This strategy has potential application for the whole basin and industry does often reclaim linear features such as roads where possible.

What's already happening with this strategy:

- COSIA has a few major initiatives to address linear disturbances
    - Algar Historic Restoration Project
    - Linear Deactivation Project
    - Cenvous Caribou Habitat Restoration Project
- Integrated land management plan outlined in LARP strongly emphasizes timely restoration of linear disturbances.
- Today’s reclamation requirements highlight a number of BMPs related to conserving or restoring hydrological processes but many are not being followed

Strategy overview: Linear connectivity

How it was simulated in the model

- This strategy was tested by reclaiming 40% of linear features (trails, minor roads, seismic lines, pipelines) in the following regions:
    - Christina River (15 km^2 reclaimed)
    - Hangingstone River (4 km^2 reclaimed)
    - Muskeg River (20 km^2 reclaimed)
    - MacKay River (8 km^2 reclaimed)

- The AIRM replaces disturbed features, which are characterized by surfaces with low permeability and no vegetation, with forest (higher soil permeability and vegetation)

- It is important to note that flow interruption and changes in runoff routing were not simulated here; therefore, these effects are not captured

Key modelling results and discussion: Linear connectivity

Period and Location	Dry – Linear connectivity	Historic – Linear connectivity	Wet – Linear connectivity
Change in number of days meeting Aboriginal Extreme Flow. *Challenge: Ensure sufficient flow for navigation*			
Annual - below Firebag confluence	0.0 Days	0.0 Days	0.0 Days
Change in number of days over 1:100 flood thresholds. *Challenge: Limit damage from floods*			
Annual - Athabasca River at Athabasca	0.0 Days	0.0 Days	0.0 Days
Annual - McLeod River	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca upstream of Whitecourt	0.0 Days	0.0 Days	0.0 Days
Annual - Athabasca River at Hinton	3.0 Days	0.0 Days	0.0 Days
Annual - Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Pembina River at Sangudo	0.0 Days	0.0 Days	0.0 Days
Annual - Ft. McMurray	0.0 Days	0.0 Days	-1.0 Days
Change in annual instream flow needs violations. *Challenge: Maintain or improve ecosystem health*			
Annual - Mouth of the Lac La Biche River	1.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the McLeod River	-4.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Clearwater River	38.0 Days	21.0 Days	21.0 Days
Annual - Mouth of the Lesser Slave River	0.0 Days	0.0 Days	0.0 Days
Annual - Mouth of the Pembina River	0.0 Days	0.0 Days	0.0 Days
Change in walleye recruitment reduction. *Challenge: Maintain or improve ecosystem health*			
Annual - below Ft. McMurray	0.00%	0.00%	0.00%
Change in seasonal streamflow as a percentage of naturalized streamflow. *Challenge: Minimize the effect of development footprint on basin hydrology*			
Summer - at the Mouth	0.00%	0.00%	0.00%
Spring - at the Mouth	0.01%	0.00%	0.00%
Fall - at the Mouth	0.00%	0.00%	0.00%
Winter - at the Mouth	0.00%	0.00%	0.00%
Change in seasonal system shortages (m3/s). *Challenge: Provide water supply certainty for municipalities and development*			
Spring - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Winter - whole system	-0.0 m3/s	0.0 m3/s	0.0 m3/s
Fall - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s
Summer - whole system	0.0 m3/s	0.0 m3/s	0.0 m3/s

Benefits and trade-offs: Linear connectivity

Benefits

- Low net benefit to streamflow at the scale of the basin, since hydrologic change is often proportional to the area disturbed and linear features don’t represent a large area in and of themselves
- From an ecosystem perspective, reclaiming linear features can help improve water quality by reversing the fragmenting effects on wildlife

Trade-offs

- Slightly more IFN violations due to increased interception and lower streamflows

Implementation: Linear connectivity

Challenges

- This strategy should be viewed as an opportunity to be more proactive in reducing linear disturbance of development
- The focus should be first on conservation of natural landscapes and then on reclamation or deactivation of linear features
- Techniques to reduce linear disturbance in development include pooling leases, encouraging common infrastructure, implementing BMPs, and sharing and decommissioning of roads (revegetating redundant roads)

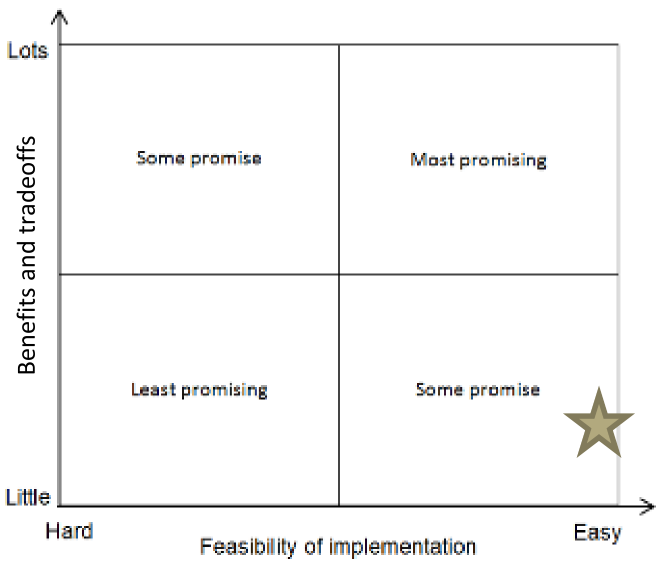
Actions

- Develop policy that describes appropriate levels of linear development. An example of this is the draft Livingstone-Porcupine Hills Land Footprint Management Plan for southwest Alberta
- Reduce linear disturbance of development by encouraging industry to collaborate and minimize disturbance
- Increase reclamation compliance by revisiting old reclamation plans and matching their intent and details with current policy goals and practices, and by improving enforcement and timing of reclamation
- Address access management by improving land use management to minimize the impact of all types of access on the landscape
- Target priority reclamation sites by building on the WRRP work in the Bow Basin for identifying high value restoration and conservation sites
- Fill the data and science gap by increasing understanding of how changes in hydrologic connectivity affect water volume, and acquiring data about which seismic lines are and are not compacted in the basin

Implementation: Linear connectivity

Screening Assessment

- This strategy was identified as having some promise
- Although the overall net benefit is low at the scale assessed in this analysis, this strategy would be feasible and easy to implement. Furthermore, the strategy would likely have environmental and ecological benefits that are unrelated to water quantity, such as improved water quality and aquatic health, improved wildlife habitat and connectivity, and improved biodiversity on the landscape
- There is already a push for linear reclamation in the ARB and this strategy could be part of a greater conservation and reclamation land use strategy



Strategy overview: Extraction industry reclamation

Continue to set and meet high standards of reclamation of extraction footprint to maintain or improve hydrological functions in a watershed

Overview:

Support continued reclamation practices and enforcement in the energy sector. This strategy aims to ensure mines and pits are reclaimed in a manner that restores or improves watershed functions. It would apply wherever there is an energy footprint in the basin.

What's already happening with this strategy:

- Muskeg River Watershed Management Framework
- Oil Sands Mine reclamation plans

How it was simulated in the model

- No modelling was done for this strategy directly as detailed facility scale water management was not in the scope of the project

Benefits and trade-offs: Extraction industry reclamation

Benefits

- Potential benefits should include re-establishment of hydrologic functions and naturalization of the hydrograph
- From a basin-wide perspective, there would be social benefits and potential water quality impacts following implementation of this strategy

Trade-offs

- Potential decreases in streamflow as a result of increased interception

Implementation: Extraction industry reclamation

Challenges

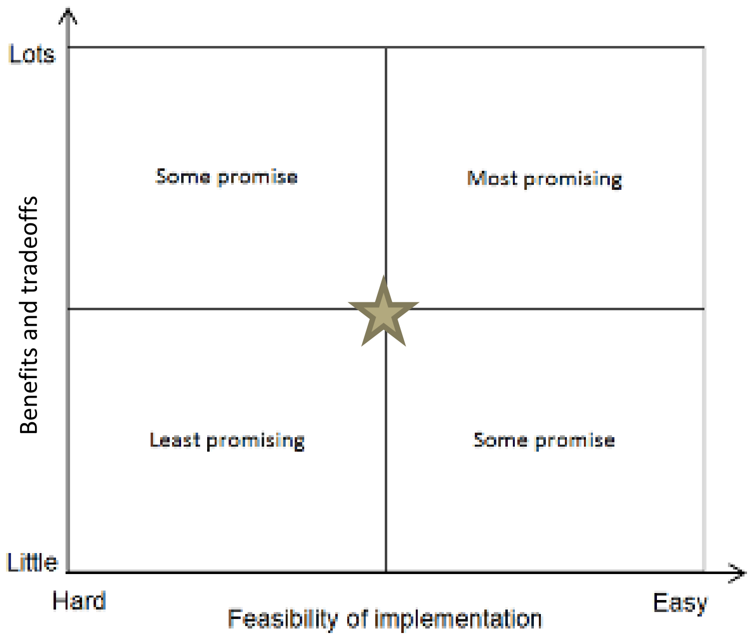
- End-of-life reclamation plans should already be in place for existing operations in the basin
- Companies are required to carry out the reclamation details in their closure plans
- The timing depends typically on the rate of development and the life of the project
- Progressive reclamation is becoming more common as companies, regulators and investors prefer staged reclamation throughout the life of the facility

Actions

- Potential to build on the mine reclamation modelling work of CEMA to support and inform reclamation in the region

Screening assessment

- This strategy was identified as a strategy with some promise. However, detailed modelling should be conducted to thoroughly and more confidently screen the degree of promise that this strategy holds



Where does the water in the ARB come from?

Commonly held perceptions: The water in the Athabasca River and its tributaries comes from multiple sources, mainly glaciers, melting snow and rainfall.

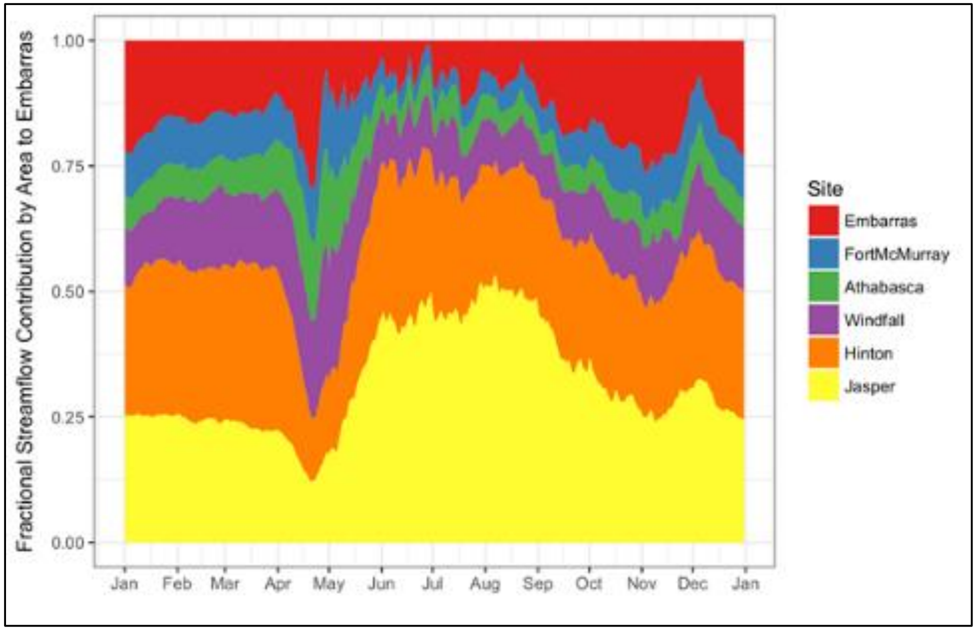
Learning from this project:

Streamflow peaks in spring due to snowmelt and tapers off in fall as the winter snowpack becomes depleted

During the late summer and fall, streamflow periodically increases due to large summer precipitation events

The Athabasca River is supplemented during the late summer by glacier melt

On a per-area basis, much of the water in the Athabasca River is generated in its headwaters, at high elevations in the Rocky Mountains



Fractional streamflow contributions for various points-of-interest on the Athabasca River mainstem

Where does the water in the ARB go?

Commonly held perceptions: Industry withdraws and consumes a large portion of the water in the Athabasca River and its tributaries every year.

Learning from this project:

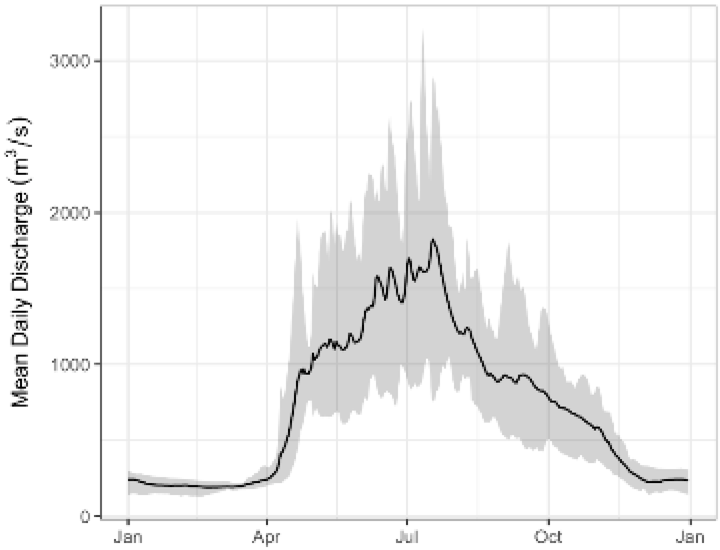
Natural uses include evaporation, transpiration, infiltration, and percolation, and storage.

Human uses are, for the most part, managed through a system of water diversion licences.

Summary of water licenses held in the Athabasca River Basin by allocation volume and type of user

Type	# Licences	Withdrawal volume	% by volume
Higher volume licences	57	733,428,757 m^3	88%
Agricultural & Irrigation	1	1,800,000 m^3	
Commercial & Industrial	36	682,795,155 m^3	
Environmental Management	3	11,103,400 m^3	
First Nation	8	838,000 m^3	
Municipal	9	36,892,202 m^3	
Lower volume licences	651	32,116,155 m^3	3.8%
Agricultural & Irrigation	233	3,529,876 m^3	
Commercial & Industrial	303	10,477,726 m^3	
Environmental Management	64	9,090,616 m^3	
Municipal	51	9,017,936 m^3	
TDLs	336	68,800,806 m^3	8.2%
TOTAL	1045	834,345,718 m^3	100%

Daily average streamflow (1971 – 2015) for the Athabasca River at Embarras (WSC: 07DD001)



This suggests that of the annual flow at Embarras (~19.5 billion m^3):

- Licenced allocations (~834 million m^3) would account for ~4%
  - 83% of allocations to industrial uses (~3.5% of annual flow)
  - 0.6% of allocations to agricultural uses (~0.03% of annual flow)
  - 5.5% of allocations to municipal uses (~0.24% of annual flow)

What will climate change likely mean for water supply in the ARB?

Commonly held perceptions: Climate change will mean typically less precipitation (snow and rain) each year and warmer temperatures causing earlier melting of glaciers and snow. All of this means less water supply in most years.

Learning from this project:

Repeated decadal droughts are relatively common in the ARB

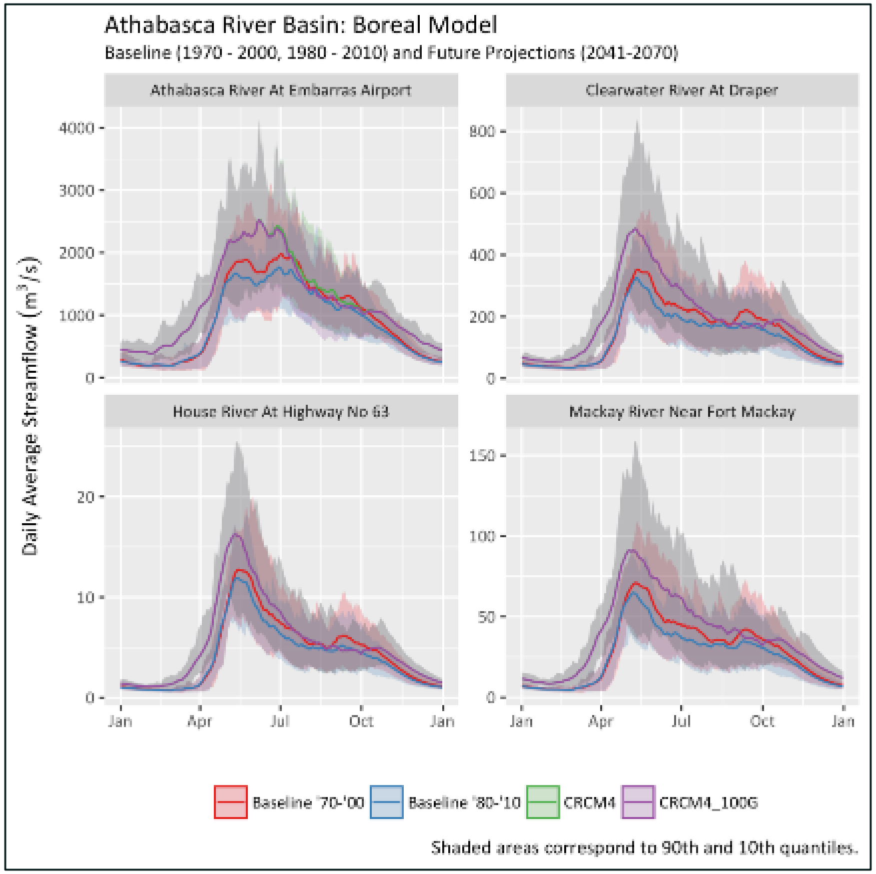
The potential future climate scenarios evaluated through this study suggest:

- precipitation will likely increase across much of the ARB, with the exception of the headwaters in winter
- air temperature is likely to increase

Earlier spring snowmelt

Higher freshets from higher spring precipitation

Lower summer flows

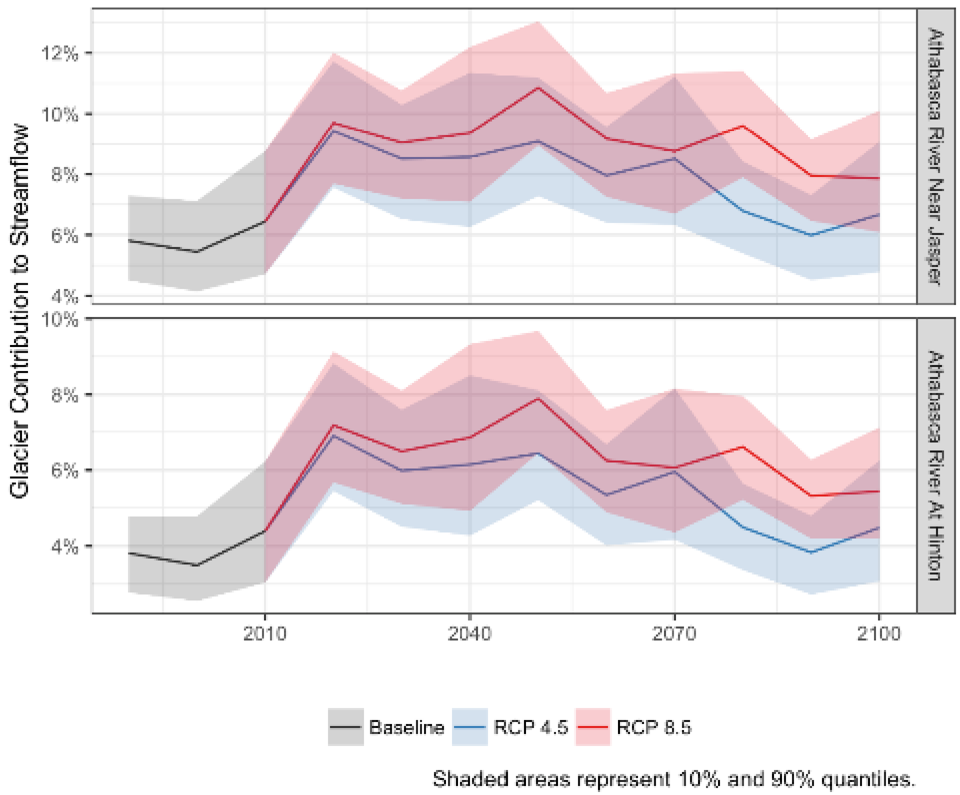


Average daily streamflow for 30 year periods in the headwaters

How might rapidly melting glaciers impact long term water supply in the ARB?

Commonly held perceptions: Glaciers worldwide are melting faster now than historically due to warmer air temperatures from climate change. We expect the glaciers in the Athabasca River Basin are similarly retreating therefore we expect that we will run out of glacier water supply at some point soon.

Simulated glacier contribution to total annual streamflow in the Athabasca River at Jasper and Hinton from 1980 to 2100 under two potential future climate change scenarios



Learning from this project:

Glaciers provide an important late-season source of water for the Athabasca River

Future changes in climate are likely to result in higher glacial contribution to streamflow over the medium term (next 50 years or so) from higher ice melt

Over the long-term (in the next 100 years), glaciers will contribute less and less to streamflow in the Athabasca as glacier ice recedes substantially

How might changes in land use affect water supply in the ARB?

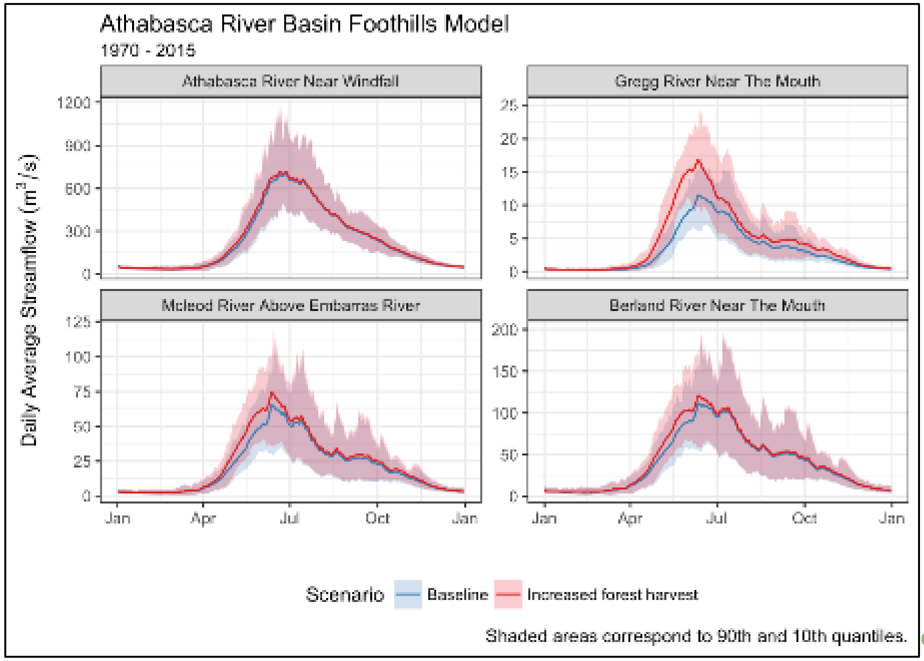
Commonly held perceptions: Changes in how land is used and what covers the land can significantly change the amount of water that flows in the rivers in the Athabasca River Basin.

Learning from this project:

If surfaces are hardened e.g. changed from grass to pavement, less water infiltrates the soil and more water drains off the area.

If trees and shrubs are removed, less snow is intercepted, less water is lost to evapotranspiration, and snow melts and drains faster.

If waterbodies are intersected by linear features including trails, seismic lines and cut lines, natural drainage patterns are changed resulting in water typically running off the landscape faster.



These complex hydrological dynamics and impacts are typically evidenced and managed locally, rather than at the basin scale.

Daily average streamflow at four locations under baseline (1970 -2015) and under 50% higher forest harvest

com

Does converting land into farmland or increasing irrigation have greater potential effect on surface water quality or quantity?

Commonly held perceptions: Developing new farmland will cause water quality problems due to sediment and nutrient runoff. Increasing irrigation will create higher water demand leading to water quantity problems.

Learning from this project:

Developing new farmland

Modelled 30% increase in agricultural area

Results suggest this would not have a substantial effect on surface water quantity at the scale assessed

Need to minimize effects on water quantity at smaller spatial scales and to limit effects of agriculture on water quality due to increased sediment and nutrient runoff

Increasing irrigation

Modelled increased water demand at existing licences in agricultural area

Results suggest this would not have a substantial effect on surface water quantity at the scale assessed

The main consideration is likely the impact of runoff into river systems due to increased sediment and nutrient loading

If new farmland were developed or irrigated in the ARB, it should have no new net impact to the existing issues around sediment and nutrient runoff

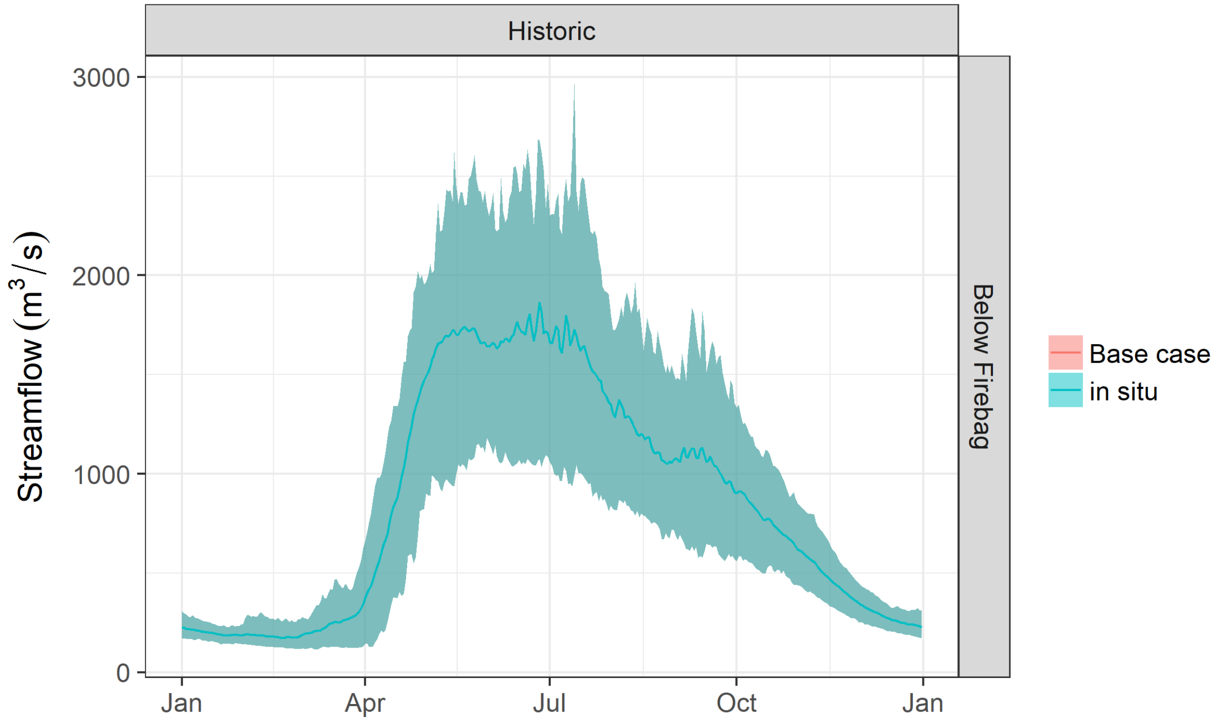
Will using alternatives to freshwater in in-situ facilities make a noticeable difference in flow in the Athabasca River?

Commonly held perceptions: In-situ facilities currently use a lot of fresh water in their operations and asking industry to change to alternative processes or non-fresh water sources will result in less water being diverted from the Athabasca River or its tributaries.

Learning from this project:

Very few in-situ facilities hold surface water licences to divert fresh water and of them, very few, if any, actively draw from freshwater sources

Modelling simulation showed no detectable difference in flow in the mainstem by using alternatives to freshwater use in currently licenced in-situ facilities



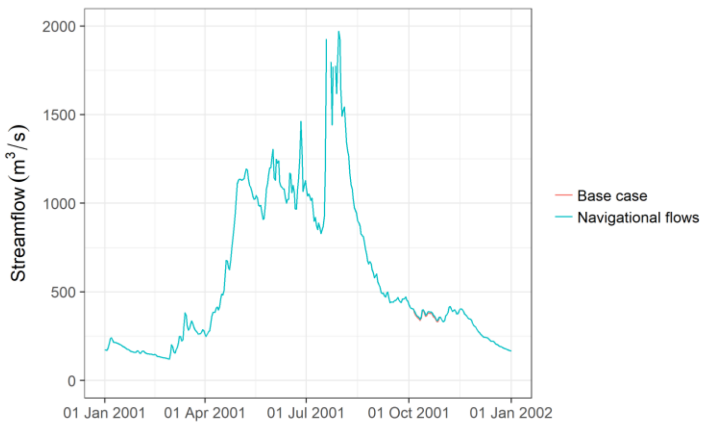
Comparison of average daily streamflow for the Athabasca River below Firebag during base case and removing in-situ withdrawal.

Can shutting off water licence withdrawals improve navigation on the Athabasca River?

Commonly held perceptions: Industrial water withdrawals are high. If they are shutoff, higher flows would substantially help navigation in the lower basin.

Learning from this project: SWQMF supports minimum flow targets in the Lower Athabasca by limiting total oil sands withdrawals to 4.4 m^3/s during low flow periods (<87 m^3/s at Fort McMurray)

2010 'As Long as the River Flows' report suggested 400 m^3/s minimum extreme flow (AXF) and ~1,600 m^3/s ideal flow (ABF) to support Aboriginal navigation and access in the lower basin



- Modelled targeting 400 m3/s downstream of the Firebag River, between April 16 and October 28 by shorting any upstream licences
- Results showed generally increased flow during the open water season but not by very much
- The 400 m^3/s target remained often not met

Potential alternatives to a minimum flow might include:

- Construction of instream structures to increase water depth in specific locations
- Construction of a dam and reservoir upstream to store and release water for navigation
- Better understanding of navigation channels and their changes through time; may lead to suggestions for channel management including targeted dredging
- Investment in alternate transportation; water craft, road navigation

What critical gaps exist in water related data, processes, policy, and knowledge for the ARB?

Commonly held perceptions: There are many gaps in what we need to know to properly manage water in the ARB. While much has been and continues to be done towards sustainable water management, gaps exist in data collection and access, fundamental science, formal and informal processes, provincial and local policies, and individual and collective knowledge.

Learning from this project:

The Working Group could not identify which of these gaps would be considered most critical as it would likely vary between groups depending on needs and perspectives.

An underlying theme for addressing many of these gaps is awareness and ready access to data.

Data	Knowledge	Processes	Policy
Technology for real-time measurement of winter flows	Understanding the linkage between hydrology, soil moisture and wildfires	Address how to manage tributaries where there is currently no flow data	Implement a basin-wide water re-use policy
Monitoring and data collection of snowpack, tributary streamflow, and meteorological data in the upper portion of the ARB	Mapping of hydrologically sensitive areas in the basin that supply water to sub-basins and are locally important to communities	Include water incident-related reporting and monitoring (industrial incidents) in water data	Establish a water conservation objective for the basin
Awareness of and ready access to all public datasets (e.g., snow surveys)	Development of indicators that correlate changes in flow and ecosystem effects	Prioritize reclamation through comprehensive reclamation modelling	Establish a water management plan for the basin focusing efforts on greatest risks
Spill tracking records system and reporting requirements	Understanding of the hydrological effect of watershed and local scale connectivity	Understand more of the specific concerns around Traditional Knowledge (TK) and implementing TK into policy. Require TK in the process of policy development	
Groundwater withdrawal reporting	Understanding of the effect of oil sands mining on sub-basin hydrology		
All water use data for allocation management			

Recommendations for sustainable water management in the ARB

The project team has developed six actionable recommendations for sustainable water management in the ARB

- Are these recommendations useful to move towards sustainable water management in the ARB?
- Are these recommendations founded on work done by the Working Group?

Setting the long term view for sustainable water management in the ARB

Water challenges facing the ARB

- Maintaining or improving ecosystem health
- Providing water supply certainty for development
- Minimizing the effect of the development footprint on basin hydrology
- Ensuring sufficient flow for navigation
- Limiting damage from floods or extreme events
- Maintaining or improving the health of the Peace-Athabasca Delta
- Addressing concerns around Indigenous rights
- Accessing water-related data and knowledge in the basin
- Maintaining or improving water quality
- Understanding the renewable energy potential of the basin

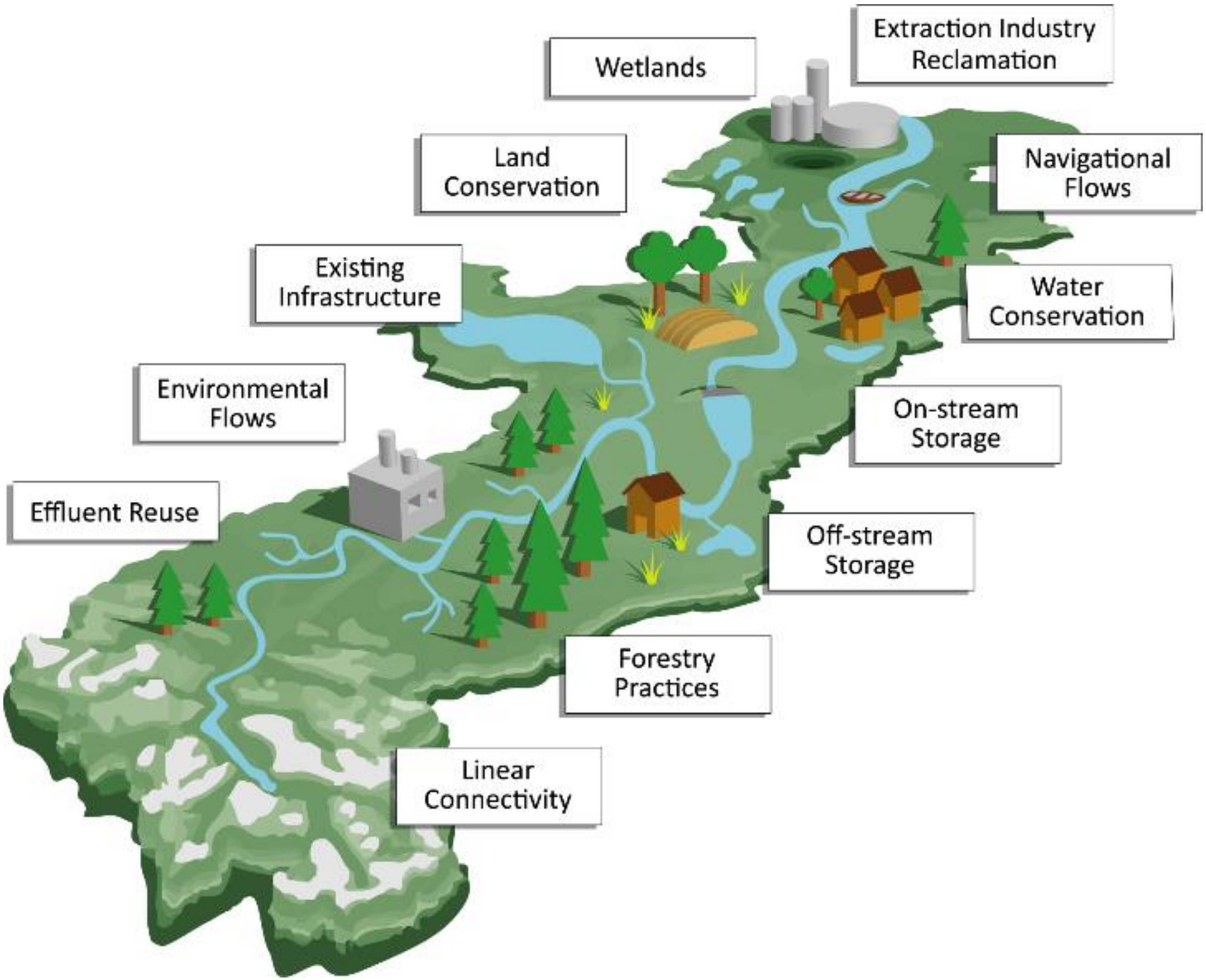
Urgency to address water challenges now

Decisions and actions today are likely to impact the long term sustainability of the basin; we have an opportunity to get ahead of the curve, and provide the information and knowledge to determine what we want to basin to look like long term :

- Climate Leadership Plan is pressing for more renewable energy; eyes are looking to hydro potential in the ARB
- Global shift to a low-carbon global economy are forcing diversification throughout the province
- Municipalities and Indigenous communities continue to seek residential, commercial, and industrial growth
- Regulatory frameworks are demanding reclamation plans be set and begun early in project life cycles
- Long term land use plans are being set for the basin
- UNDRIP and TRC mandates are shifting Indigenous involvement and expectations

From a sustainable water management perspective, considering the many interests and perspectives in the basin, how do we collectively want to move forward?

Strategies across the watershed



Recommendations for sustainable water management in the ARB

1. Maintain or improve the natural hydrological functions of the watershed

- ***to protect water supply, water quality, and watershed health***
- ***by embedding hydrological priorities in land use planning and enforcement at the regional, sub-regional, and local scales.***

Implementable actions:

- Identify sites of highest conservation and restoration priority that would have the greatest positive impact on peatland complexes, tributaries, and connectivity
- Improve understanding of the location and overall function of hydrologically sensitive wetlands
- Fill data and science gaps by increasing the understanding of how changes in hydrologic connectivity affect water volumes
- Support and inform conservation and restoration areas in future land use plans and ongoing planning

2. Establish environmental flow needs for the Athabasca River and all tributaries

- ***to clarify flows needed for watershed health and volumes available for use***
- ***by calculating and publicly communicating reach-specific IFNs or similar.***

Implementable actions:

- Establish IFN targets for all streams and rivers, likely using a modified Alberta Desktop Method
- Communicate broadly, in an accessible way, all IFNs that are calculated for the ARB

Recommendations for sustainable water management in the ARB

3. Reduce water navigation limitations in the lower basin

- ***to maintain traditional access and activities***
- ***by recognizing that further minimum flow targets are unlikely to provide navigational flows and, instead, employing a suite of alternative methods.***

Implementable actions:

- Investigate potential for instream structures to increase water depth in specific locations
- Better understand navigation channels and their changes through time and consider select channel management including targeted dredging
- Investigate the potential for investment in alternate water craft and provision of year-round road access

4. Increase the adaptive capacity of the basin

- ***to be more resilient to climate change impacts on water supply while meeting multiple basin needs***
- ***by investigating multi-purpose infrastructure to manage the flow regimes of the Athabasca River and major tributaries.***

Implementable actions:

- Establish multi-purpose objectives for new projects to understand and inform how future storage could support basin flow needs

Recommendations for sustainable water management in the ARB

5. Continue to develop the means to share and apply Traditional Knowledge

- ***to lend the experience and expertise of Indigenous Peoples to formal sustainable water management in the basin***
- ***by developing and enabling meaningful processes that support the UNDRIP and TRC mandates.***

Implementable actions:

- Example: collect and share a dataset of traditional sites in the ARB

6. Address the most critical gaps in water data, processes, policy, and knowledge

- ***to better inform sustainable water management***
- ***by prioritizing and closing gaps most critical to the ARB.***

Implementable actions:

- Continue to provide resources, budget, and mandate to AEP in its work to publicly and efficiently share already existing water data
- Find and invest in the instrumentation solution to provide near real time measurements under ice flow
- Complete and implement the provincial water reuse policy that is currently under development to change, clarify, or create clear direction for decisions on water reuse
- Resource and incentivize water communication to inform sustainable water management decisions individually, organizationally, and collectively
- Close the gaps between Traditional Knowledge, culture, and society through inclusion of Traditional Knowledge into policy

Recommendations and how they relate to challenges articulated during the ARB Initiative

1. Maintain or improve the natural hydrological functions of the watershed
2. Establish environmental flow needs for the Athabasca River and all tributaries
3. Reduce water navigation limitations in the lower basin
4. Increase the adaptive capacity of the basin
5. Continue to develop the means to share and apply Traditional Knowledge
6. Address the most critical gaps in water data, processes, policy, and knowledge

Challenges	Recommendation					
	1	2	3	4	5	6
Maintaining or improving ecosystem health	√	√		√	√	√
Providing water supply certainty for development		√		√		
Minimizing the effect of the development footprint on basin hydrology	√	√			√	√
Ensuring sufficient flow for navigation			√		√	
Limiting damage from floods or extreme events				√		
Maintaining or improving the health of the Peace-Athabasca Delta		√		√	√	√
Addressing concerns around Indigenous rights		√	√		√	
Accessing water-related data and knowledge in the basin					√	√
Maintaining or improving water quality	√	√				√
Understanding the renewable energy potential of the basin				√		

Recommendations for sustainable water management in the ARB

1. **Maintain or improve the natural hydrological functions of the watershed**

   … to protect water supply, water quality, and watershed health

   … by embedding hydrological priorities in land use planning and enforcement at the regional, sub-regional and local scales.

2. **Establish environmental flow needs for the Athabasca River and all tributaries**

   … to clarify flows needed for watershed health and volumes available for use

   … by calculating and publicly communicating reach specific IFNs or similar.

3. **Reduce water navigation limitations in the lower basin**

   … to maintain traditional access and activities

   … by recognizing that further minimum flow targets are unlikely to provide navigational flows and, instead, by employing a suite of alternative methods.

4. **Increase the adaptive capacity of the basin**

   … to be more resilient to climate change impacts on water supply while meeting multiple basin needs

   … by investigating multi-purpose infrastructure to manage the flow regimes of the Athabasca River and major tributaries

5. **Continue to develop the means to share and apply Traditional Knowledge**

   … to lend the experience and expertise of Indigenous Peoples to formal sustainable water management in the basin

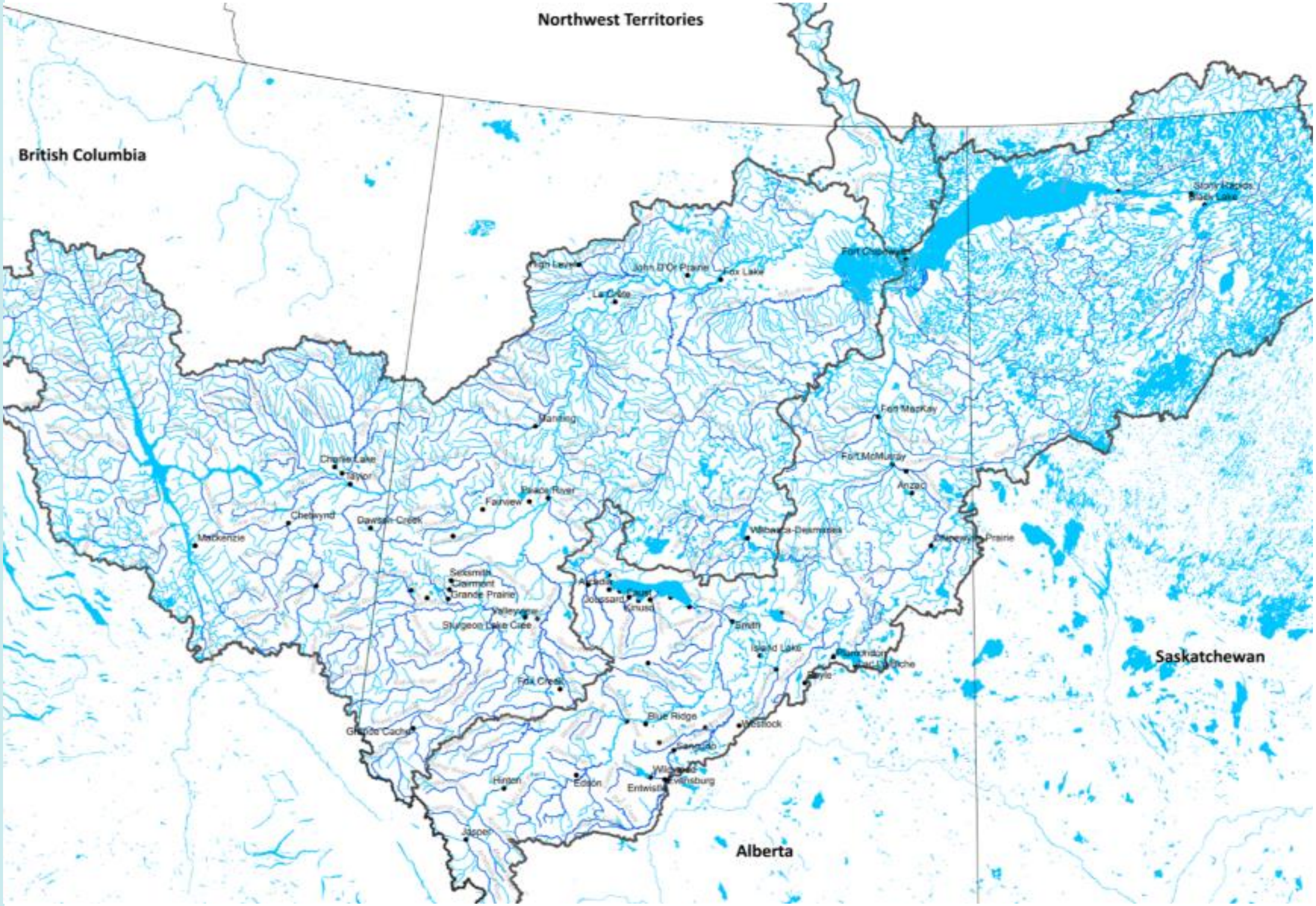
   … by developing and enabling meaningful processes that support the UNDRIP and TRC mandates

6. **Address the most critical gaps in water data, processes, policy, and knowledge**

   … to better inform sustainable water management

   … by prioritizing and closing gaps most critical to the ARB

Opportunity to expand AIRM to whole Slave Basin



Thank you!

Thank you to our funders:

Thank you to those who have contributed by sharing invaluable perspectives, including:

- First Nations and Métis communities
- Federal and Provincial Governments and related agencies
- Municipalities, Counties and Districts
- Watershed Planning and Advisory Councils (WPACs)
- Environmental non-government organizations (ENGOs)
- Industry (coal, agriculture, oil and gas, forestry, oil sands, utility companies)

All meeting and project materials are posted on the ARB Initiative website (visit www.albertawatersmart.com or Google "ARB Initiative")

Water: the key to our sustainable future

ALBERTA
waterSMART
Water Management Solutions

For more information:

WaterSMART Solutions Ltd.
www.albertawatersmart.com

Alberta WaterPortal
www.albertawater.com

Email:
mike.nemeth@albertawatersmart.com