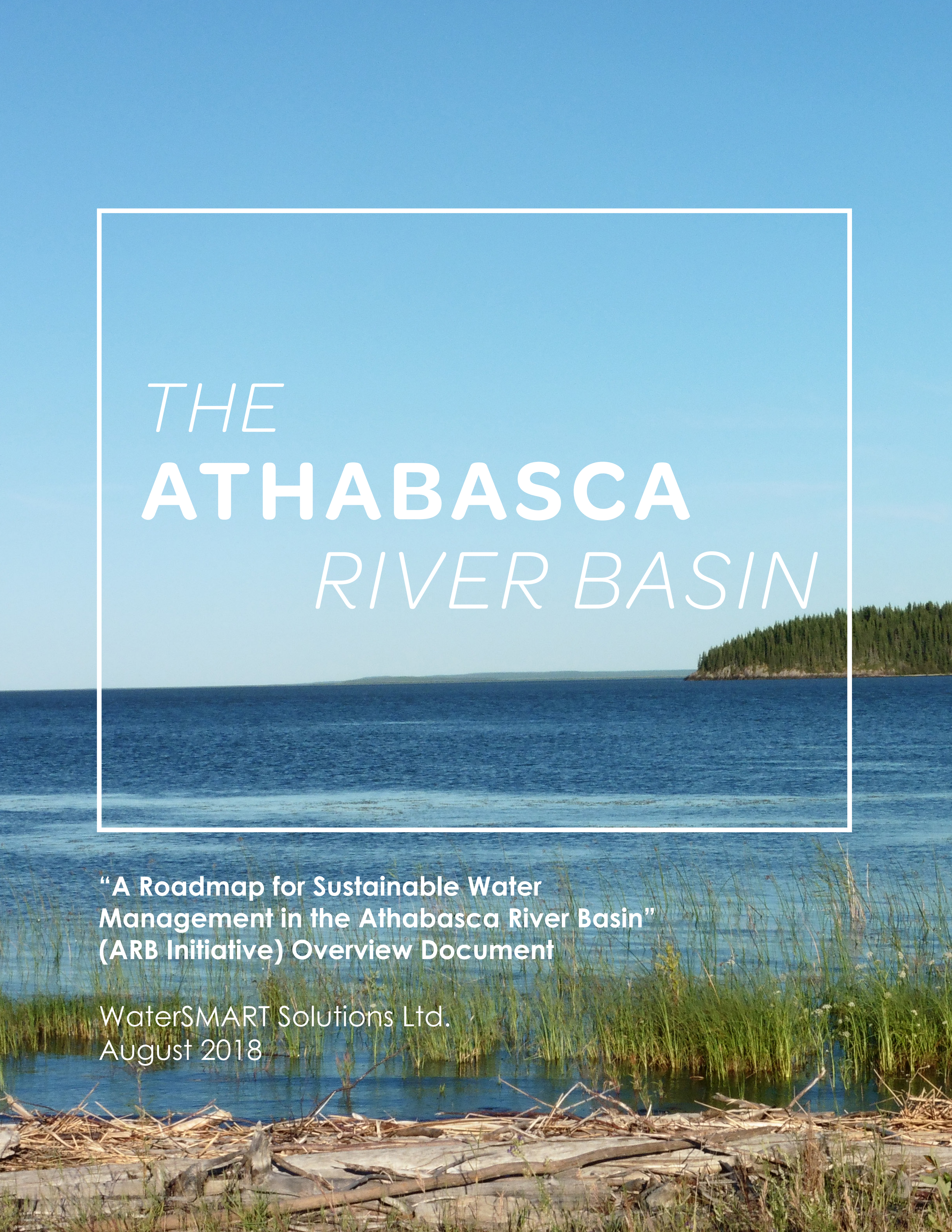


THE ATHABASCA RIVER BASIN

"A Roadmap for Sustainable Water Management in the Athabasca River Basin" (ARB Initiative) Overview Document

WaterSMART Solutions Ltd.

August 2018

THANK YOU TO *OUR FUNDERS*

The Sustainable Water Management in the Athabasca River Basin Initiative was enabled through core funding provided by Alberta Innovates and matching funds contributed by the Alberta Energy Regulator, Alberta Environment and Parks, ATCO, Repsol Oil and Gas, Suncor Energy, and Westmoreland Coal Company.

DISCLAIMER

INTRODUCTION TO *THE ARB INITIATIVE*

The Sustainable Water Management in the Athabasca River Basin Initiative (the ARB Initiative or Initiative) was an innovative project to identify water management issues, assess opportunities, and propose ways to build resilience to change. It examined surface water quantity in the Athabasca River mainstem and major tributaries, considering implications of changes in streamflow for certain water quality parameters as well as the effects of basin landscape and climate change on streamflow.

An inclusive and diverse Working Group comprising representatives from across the basin openly shared knowledge, experience, perspectives, and ideas for a well-managed watershed in the ARB. The group used a collaborative modelling process and an integrated modelling tool (the Athabasca Integrated River Model or AIRM) to inform and drive the discussion. The AIRM enabled the Working Group to explore mitigation, adaptation, and management opportunities in response to a range of potential climate, land use, and development changes in the ARB. Participants, many of whom had disparate goals, could then design strategies to examine how individual or cumulative changes in land use, climate, and river systems affected water availability and identify solutions that satisfied their objectives. The Working Group included:

- 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)

The Working Group identified 10 challenges facing the region and subsequently proposed 12 strategies to address them. The modelling was then used to illustrate the strategy and results, and to support discussion on the benefits, trade-offs, implementation feasibility, and an assessment as to whether the strategy was most promising, least promising, or uncertain. The 12 strategies and the six recommendations for sustainable water management in the ARB are outlined at a high level below.

If you are interested in additional information on each of the strategies or the ARB Initiative, please see the final report and other information available at **www.watersmartsolutions.ca/publications**

An brief introduction to the

ATHABASCA *RIVER BASIN*

The Athabasca River stretches 1,500 km from the Columbia Icefield in Jasper National Park to the northeastern corner of Alberta and into western Saskatchewan. Characterized by diverse regions, the Athabasca River Basin (ARB) is unique in natural resources, ecology, climate, and development. The Athabasca River connects these regions as it flows through the river network, creating the ARB.

~15%	~35%	~50%	<1%
ROCKY MOUNTAINS	FOOTHILLS	BOREAL FOREST	CANADIAN SHIELD

The Natural Regions in the ARB include the Rocky Mountains, Foothills, Boreal Forest, and Canadian Shield. Over half of the ARB is part of the Boreal Forest region, while only <1% is part of the Canadian Shield region.

Rocky Mountains

Characterized by: Steep topography, high elevations, large glaciers, high winter snowpack, and widespread coniferous forests

This mountainous area is ecologically diverse and has little human activity outside of the towns of Jasper and Hilton.

Seasonal Streamflow

The Rocky Mountain Region is characterized by low flow in the fall and streamflow remains relatively flat until May snowmelt causes the flow to increase. The river is also supplemented during the late summer by glacier melt, which does not affect streamflow outside of the Rocky Mountain Region.

DEVELOPMENT:

Mining

Foothills

Characterized by: Gently sloping topography, mixed forests dominated by lodgepole pine

As the Athabasca River passes through the Foothills, it gains more water from major tributaries. This is an active location for agriculture, forestry, and oil and gas. This area is occupied by very few people.

Seasonal Streamflow

The seasonal streamflow within the Foothills Region is characterized by low flows throughout the fall and winter, followed by high spring runoff and a gentle recession towards late summer and fall base flows.

DEVELOPMENT:

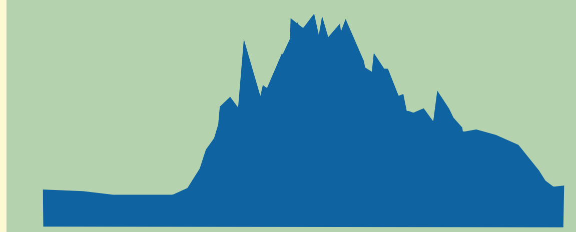
Forestry · Oil & Gas · Mining

Boreal Forest

Characterized by: Flat topography, lakes, inter-spaced uplands, and extensive wetlands

For over half its length, the Athabasca River passes through the Boreal Natural Region. There are several major tributaries and this area has been extensively developed.

Seasonal Streamflow



The Boreal Forest region also maintains a lower streamflow in the fall and over the winter. Snowpack is often lower with melt early in the spring, leading to a quick peak in streamflow (typically in April), followed by relatively large sporadic increases following summer precipitation events.

DEVELOPMENT:

Agriculture · Forestry · Oil & Gas

Canadian Shield

Characterized by: Exposed bedrock and hummocky topography

Only a small portion of Canadian Shield is included in the ARB between Fort McMurray and Fort Chipewyan.

DEVELOPMENT:

little development

Peace-Athabasca Delta

The Athabasca River drains into Lake Athabasca in northeast Alberta. Peace River joins from the North, forming the Peace-Athabasca Delta (PAD) which is a prized ecological area and UNESCO World Heritage Site. The PAD is sensitive to changes in Lake Athabasca water level, which plays a role in maintaining the ecological functions of the delta.

Climate Change

Potential changes in future climate poses a challenge for water management in the ARB as snowmelt timing is expected to shift substantially in the future, resulting in longer snow-free periods. Other possible outcomes could include:

- Higher spring flows
- Lower summer flows
- Higher glacial contribution (medium-term)
- Lower glacial contribution (long-term)

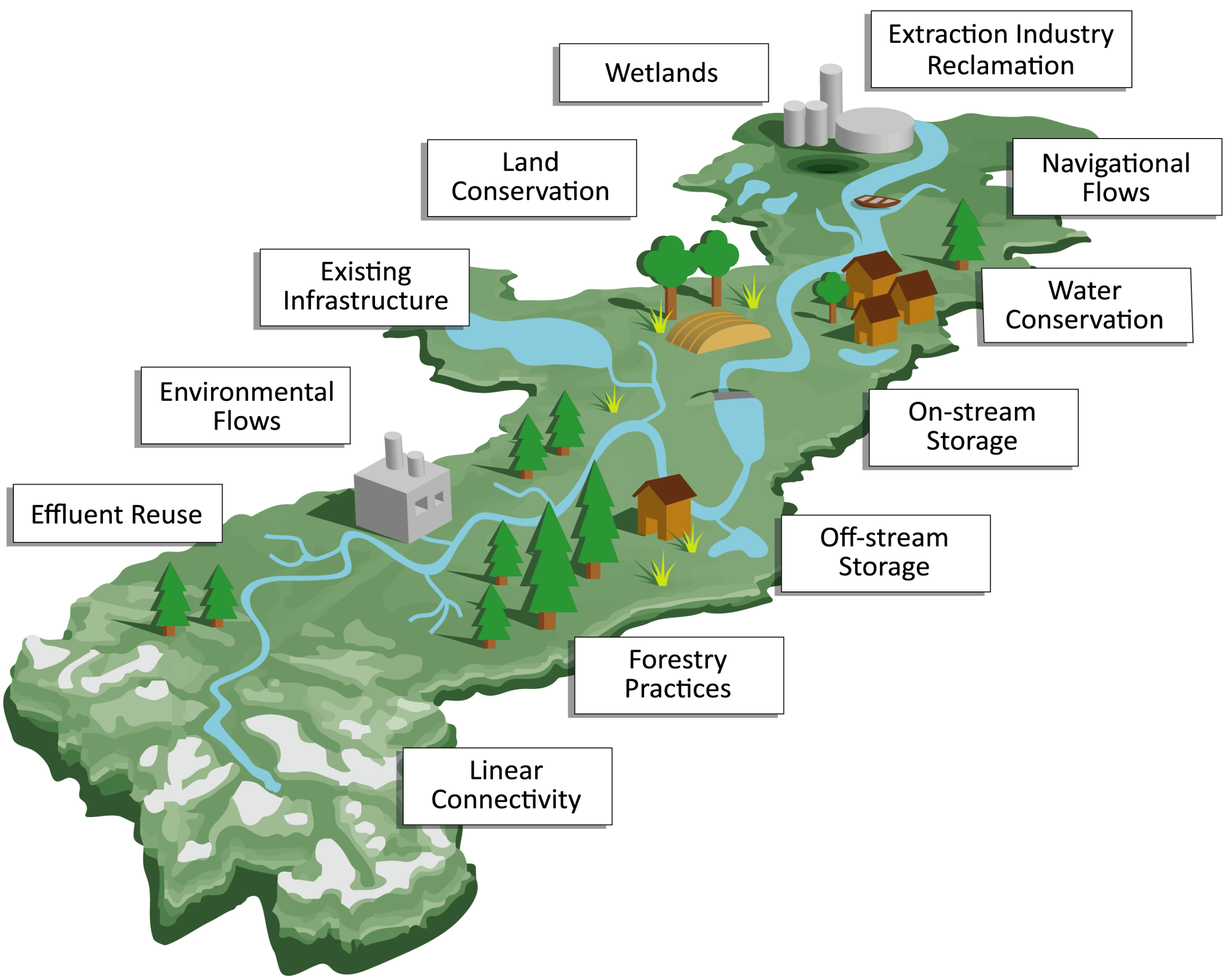
Overall, the hydrological regime of the ARB is likely to be very different from the last several decades. However, thoughtful water management planning can help ensure environmental, social, cultural, and economic effects of changes in climate are not exacerbated by human influence.

Water Management

The ARB has historically attracted settlement and development and represents a rich and diverse ecological heritage. The natural attributes are important to the region's identity, which has driven the development of policy and legislation to provide the broader context and necessary frameworks for water management in the basin.

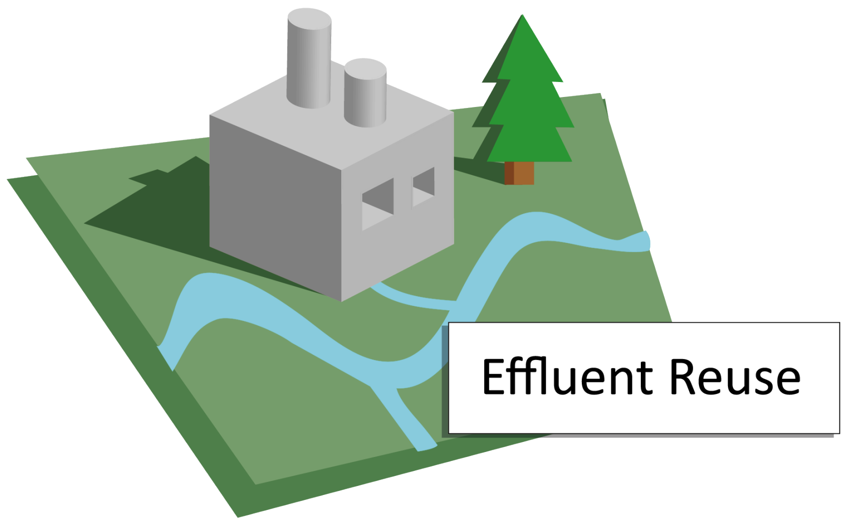
STRATEGIES FOR *WATER MANAGEMENT*

Over the course of the ARB Initiative, a collaborative and diverse Working Group identified and assessed possible strategies for future and current actions for sustainable water management across the ARB. Here are a few water management approaches assessed through this process.



STRATEGIES FOR *WATER MANAGEMENT*

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



STRATEGY DESCRIPTION

Take return flows (treated wastewater) from industrial, municipal, or commercial operations and reuse that water for other industrial purposes. This approach supports development without needing to withdraw additional freshwater, while also reducing release of treated wastewater back into the river.

POSSIBLE BENEFITS

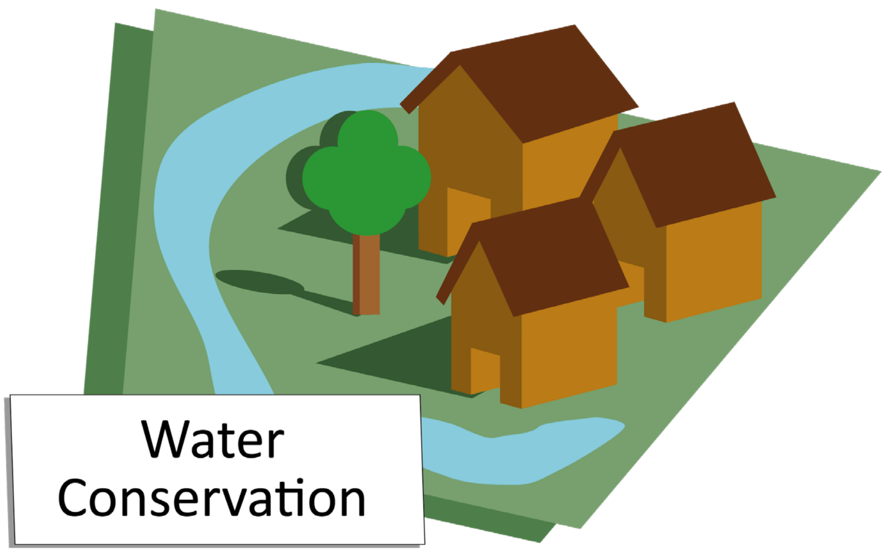
- Takes pressure off smaller streams
- May improve water quality for downstream users by reducing the treated effluent returned to the river
- Could provide a back-up water source when fresh water systems are stressed
- Effluent suppliers can save on water treatment

POSSIBLE TRADE-OFFS

- Reduced tributary flows from reduced return flows might affect fish and aquatic species if implemented on a large scale

STRATEGIES FOR
WATER MANAGEMENT

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



STRATEGY DESCRIPTION

Promote conservation and efficiency practices for municipal, industrial, and commercial water use. This strategy aims to support future development without increasing the demand for freshwater across the entire basin. This strategy would focus heavily on reducing freshwater demand for industrial and commercial uses, as municipalities typically see a relatively high return rate so reductions in municipal water use would have less effect on river flow.

POSSIBLE BENEFITS

Benefits would be proportional to the degree of conservation practiced. Some benefits could include:

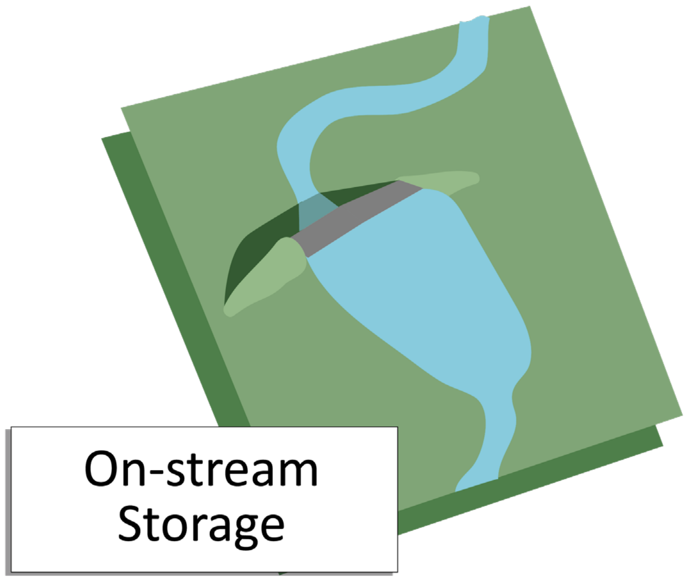
- Increased walleye recruitment
- Reduced water shortages
- Reduction in instream flow need violations

POSSIBLE TRADE-OFFS

- Expenses and effort required to implement conversation throughout basin
- Some sectors might struggle to meet the conversation targets without experiencing diminishing returns

STRATEGIES FOR *WATER MANAGEMENT*

On-stream storage: Explore new on-stream multi-purpose storage options



STRATEGY DESCRIPTION

On-stream storage refers to infrastructure built on the river with the capacity to alter flows, such as reservoirs and dams. This strategy includes further exploring new, multi-purpose storage opinions based on the needs of the basin and water users.

POSSIBLE BENEFITS

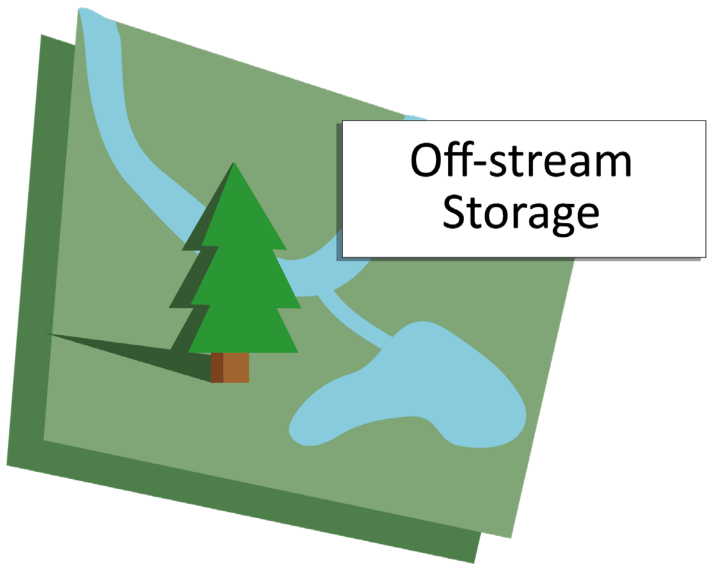
- Storage of water during high flow and releasing during low flow could help meet navigational flows, reduce shortages to licensed demands, and reduce Instream Flow Need violations
- Potential for managing ice-jams
- Fewer flood days for communities
- Flexibility to deal with changing flows due to changing climate
- Potential for hydropower generation

POSSIBLE TRADE-OFFS

- Infrastructure could negatively affect Indigenous communities, lands uses and sites, as well as cultural and recreational uses
- Changing flow to the PAD
- Sediment transport downstream of the reservoir
- Possible reduction in spring and summer peak flows could impact riparian health and fish migration

STRATEGIES FOR
WATER MANAGEMENT

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



STRATEGY DESCRIPTION

Off-stream storage refers to water-storing infrastructure (e.g., reservoirs, lakes) located away from the river and tributaries. This strategy includes further exploring new, multi-purpose storage opinions based on the needs of the basin and water users.

POSSIBLE BENEFITS

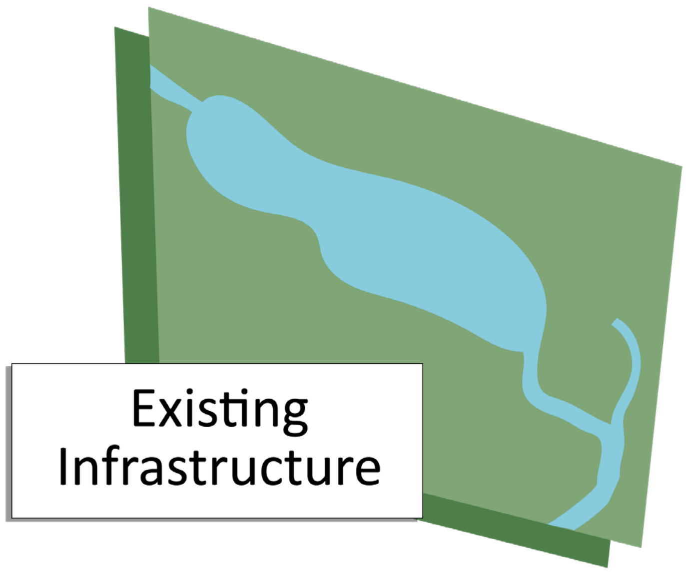
- Potential reduction in shortages to water users
- Meeting navigational flow targets
- Higher winter streamflow to augment low flows
- Potential for hydropower generation

POSSIBLE TRADE-OFFS

- Potential for negative impact on water quality and water temperature

STRATEGIES FOR *WATER MANAGEMENT*

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



STRATEGY DESCRIPTION

Alter existing water storage operations and infrastructure to meet multiple basin objectives for flexible water management. This includes examining lakes, dams, and smaller weirs and structures to increase the water management benefits.

POSSIBLE BENEFITS

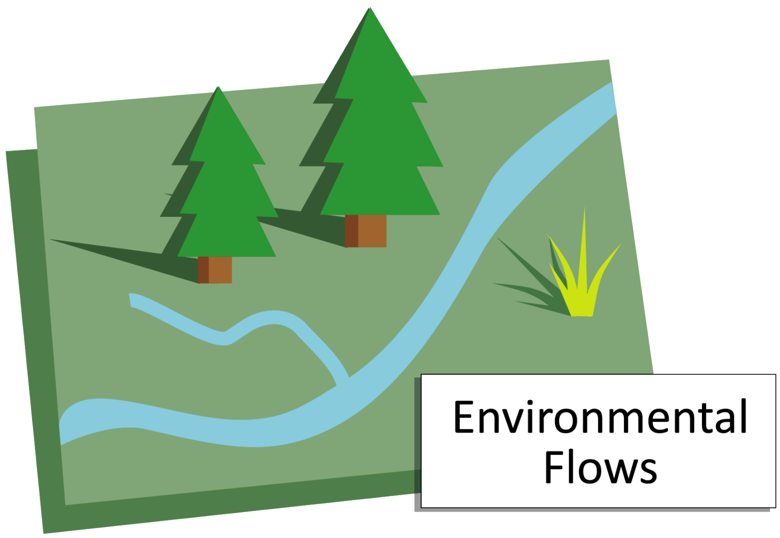
Benefits would depend on the current infrastructure and the suggested operational changes.

POSSIBLE TRADE-OFFS

Trade-offs would depend on the current infrastructure and the suggested operational changes.

STRATEGIES FOR
WATER MANAGEMENT

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



STRATEGY DESCRIPTION

Set Instream Flow Needs (IFNs) on some of the larger tributaries in the basin. This strategy includes investigating how often the targets would be met if a minimum flow was implemented and the volume of shortages that would result from flow target violations. This strategy is intended to proactively manage ecosystem health and naturalize streamflow.

POSSIBLE BENEFITS

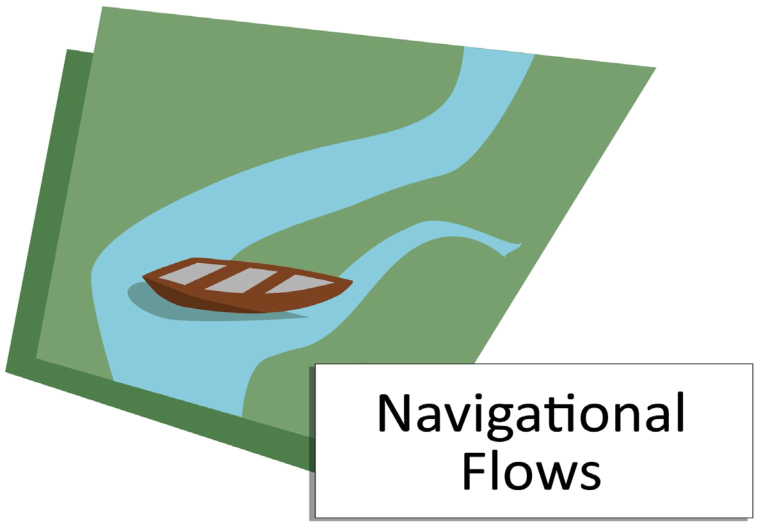
- Fewer IFN violations in the basin
- Increase seasonal naturalized streamflow
- Increased walleye recruitment and fishery health
- May increase the ability to meet navigation flow targets in dry conditions

POSSIBLE TRADE-OFFS

- Increase in water shortages for water users to meet IFN targets

STRATEGIES FOR *WATER MANAGEMENT*

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



STRATEGY DESCRIPTION

Implementing minimum navigational flows to improve navigation for Indigenous peoples on the Athabasca River. This strategy aims to meet navigational flows through water management as ideal minimum flows are not met naturally in many cases.

POSSIBLE BENEFITS

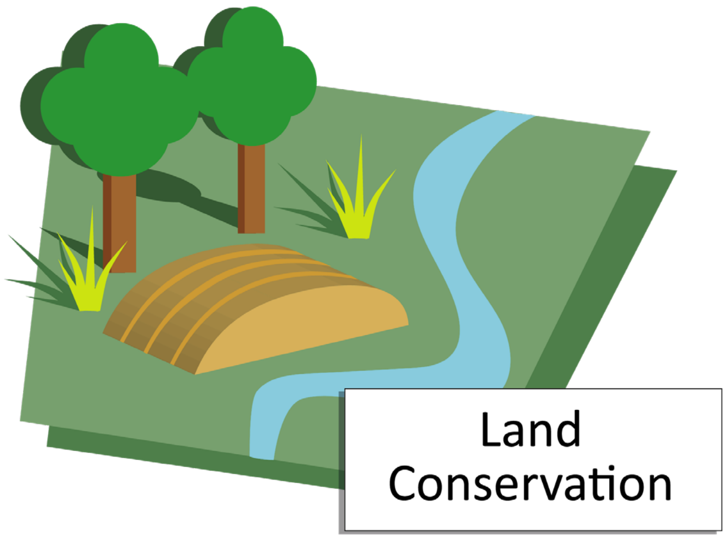
- Increased days where navigational flow targets are met
- Increased walleye recruitment
- Decreased days where IFN targets are violated

POSSIBLE TRADE-OFFS

- Upstream water users might be shorted during the spring and fall if reduced water use were needed to meet desired flow targets

STRATEGIES FOR *WATER MANAGEMENT*

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



STRATEGY DESCRIPTION

Increase the amount and improve the condition of conserved and restored land across the basin, particularly in areas of high biodiversity or hydrologic importance. This strategy aims to maintain and improve hydrologic function and watershed health, while focusing on areas that have low value for resource development but still meet biodiversity targets. This will minimize the lost opportunity cost of protecting an area while still improving streamflow and water quality while providing for a well managed and intact landscape that can help to mitigate flooding, etc.

POSSIBLE BENEFITS

- Potential water quality improvements
- A more natural landscape with potentially higher biodiversity
- Potentially less alteration to the hydrological regime of the basin
- Potentially fewer flood days
- Potentially fewer IFN violations

POSSIBLE TRADE-OFFS

- Industrial activity may move to other parts of the basin, impacting industrial footprint in other areas
- Potential decrease in meeting navigational targets due to storing more water on the landscape
- Potential increase in shortages under dry conditions

STRATEGIES FOR *WATER MANAGEMENT*

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

STRATEGY DESCRIPTION

Implement sustainable forest management and stewardship to minimize hydrologic impacts of timber harvest. Forest canopies play a role in the watershed through evapotranspiration of precipitation, effects on snow accumulation and ablation, and influence on soil water storage. This strategy aims to improve sustainable forest management and stewardship to minimize hydrologic change.

POSSIBLE BENEFITS

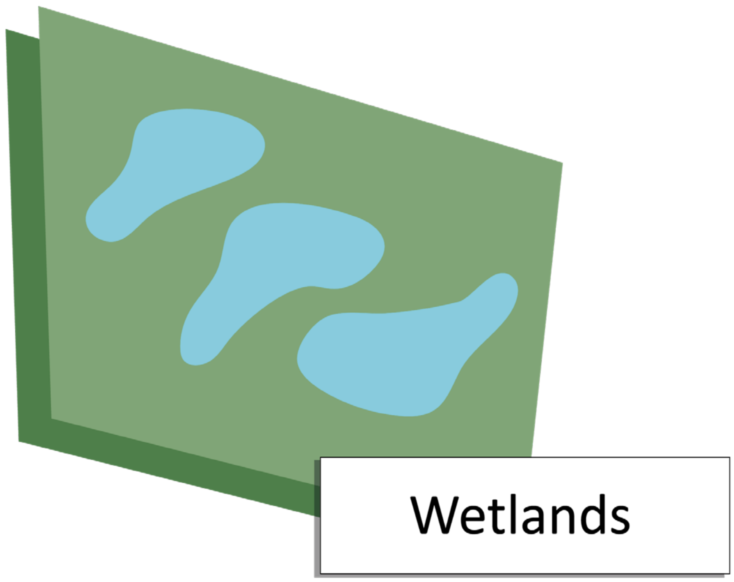
- Reducing the potential to alter streamflow regimes by managing forest disturbance

POSSIBLE TRADE-OFFS

- Possible impacts on timber supply, though efficiencies and innovative practices could help offset these effects

STRATEGIES FOR *WATER MANAGEMENT*

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



STRATEGY DESCRIPTION

Avoiding wetland loss and promoting wetland restoration through the continued refinement, implementation, and enforcement of related legislation, policies, and mechanisms. Wetlands create unique and diverse habitats for a wide range of organisms, serving a vitally important role on the landscape. This strategy aims to maintain or improve the hydrological benefits of wetlands.

POSSIBLE BENEFITS

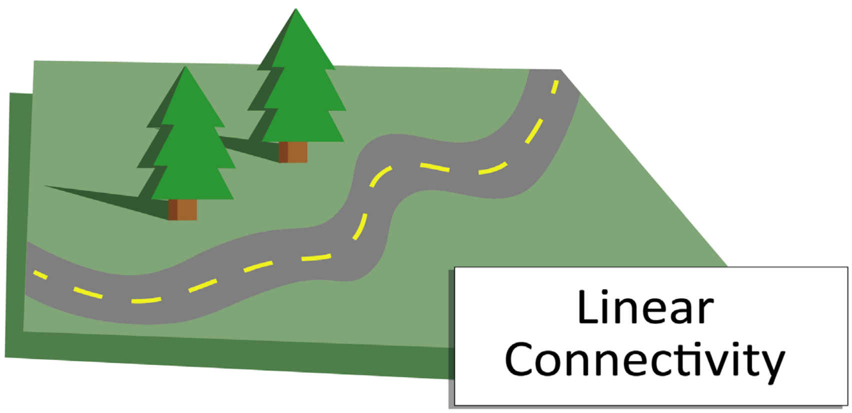
- Decreased peak or flashy streamflows as a result of more storage of water in wetlands
- Increase in overall ecosystem health, benefiting wildlife, hydrologic connectivity, and diversity
- Extend residence time so that there are higher flows for longer periods through more a regulated baseflow

POSSIBLE TRADE-OFFS

- Potential to add challenges to future development
- Cost of reclaiming wetlands

STRATEGIES FOR *WATER MANAGEMENT*

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



STRATEGY DESCRIPTION

Reduce the total linear footprint on the landscape 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 and ultimately affect streamflow. This strategy aims to reduce this interruption and to determine the hydrological impact of linear disturbances in terms of changes to streamflow.

POSSIBLE BENEFITS

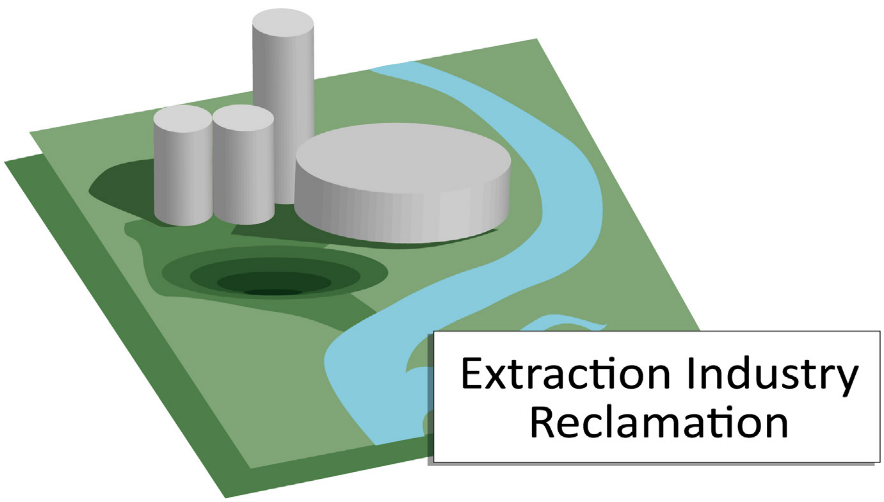
- Low net benefit to streamflow but possible increase in water quality due to reduction in sediment runoff

POSSIBLE TRADE-OFFS

- Potential to add challenges to future development
- Cost to reclaim existing linear features

STRATEGIES FOR
WATER MANAGEMENT

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



STRATEGY DESCRIPTION

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

POSSIBLE BENEFITS

- Potential re-establishment of hydrologic functions, resulting in more natural streamflow regimes
- Potential positive benefits for water quality and communities

POSSIBLE TRADE-OFFS

- Potential decrease in streamflow due to increased interception on the landscape

ARB LEARNINGS:
incidental take-aways

While having informed discussions with the Working Group throughout the ARB Initiative, a number of related learnings surfaced and were explored. These learnings were not strategies for sustainable water management; instead, they were facts or observations about the basin and water management that either supported or provided a counterpoint to commonly held perceptions. These learnings are included here to add to the information and platform of knowledge that offers a reference point for water questions in the basin.

Where does the water come from?

COMMON PERCEPTION

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

NEW LEARNINGS

Snow melt is the primary water-source in the ARB, resulting in a streamflow which is low during the winter months, peaks during the spring, and tapers off into the fall as the snowpack is depleted. The Athabasca River is also supplemented by glacier melt and summer precipitation events. Much of the water in the Athabasca River is generated in its headwaters, at high elevations in the Rocky Mountains.

Where does the water in the ARB go?

COMMON PERCEPTION

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

NEW LEARNINGS

While more information on water allocation, withdrawal, and reuse is required to accurately calculate how much water is fully consumed in the basin, only an average of ~4% of the water flowing past Embarras is allocated for human use through licences. Of this allocated amount, 83.1% goes to industrial uses (oil and gas, oil sands, coal, pulp and paper, agriculture), meaning industrial allocation only accounts for ~3.5% of the annual flow at Embarras. Of that allocated amount, industry typically uses (actual consumption) less than they are allocated (around 85% of their allocation on average annually based on reported actual use data).

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

COMMON PERCEPTION

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.

NEW LEARNINGS

Scenarios modelled in this study show that precipitation will likely increase across much of the ARB, likely experience an earlier spring snowmelt, and higher spring freshets from higher spring precipitation resulting in an overall increase in streamflow especially during the spring and winter. Streamflow is likely to decline during the summer making this a challenging time for water supply. The potential for increased winter flows could be beneficial to aquatic species as problematic low flow periods are often present in the ARB during the winter.

Much of the water in the Athabasca River is generated in its headwaters, at high elevations in the Rocky Mountains

photo by Brie Nelson

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

COMMON PERCEPTION

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

NEW LEARNINGS

Changes in climate will likely result in an increase in glacial contribution over the medium term (next 50 years or so) and gradually contribute less and less as the glaciers recede (in the next 100 years).

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

COMMON PERCEPTION

Changes in how land is used (natural areas, forestry, farming, resource extraction, towns, etc.) and what covers the land (forest, rangeland, crops, cut lines, trails, paved surface, etc.), can significantly change the amount of water that flows in the ARB's rivers.

NEW LEARNINGS

Changes in land use do affect hydrological functions and these impacts are varied depending on the nature and scale of the changes. For example; converting an area from grass to pavement results in less water infiltrating the soil and more water drainage. These complex hydrological dynamics and impacts are typically evidenced and managed locally, rather than at the basin scale. From a surface water flow perspective, changes in land use and cover in the ARB result in small changes in streamflow quantity, however, managing water flow from land into the Athabasca and tributaries is an important part of the water management system in the ARB.

Which has greater potential effect on surface water quality or quantity: converting land into farmland or increasing irrigation?

COMMON PERCEPTION

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.

NEW LEARNINGS

The results of simulating both an increase in agriculture area and an increase in irrigation resulted in little changes to water quantity. Alternatively, water quality may be more affected due to the potential increased runoff into the river systems or potential landscape changes. Best Management Practices (BMPs) could potentially mitigate this effect. New farmland development or irrigation should have no net impact to the existing issues around sediment and nutrient runoff if effective education and incentives for farmers to implement BMPs are available.

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

COMMON PERCEPTION

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

NEW LEARNINGS

Very few in-situ facilities hold surface water licences to divert freshwater and of them, very few, if any, actively draw from freshwater sources. These operations typically use saline water from groundwater wells. Modelling results show no detectable difference in flow in the mainstream when these current in-situ facilities received water from an alternative source.

photo by Brie Nelson

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

COMMON PERCEPTION

Industrial water withdrawals are high. If they are shut off, higher flows would substantially help navigation in the lower basin.

NEW LEARNINGS

Modelling in the ARB region showed that stopping the licence withdrawals made a limited contribution to achieving higher flows in the lower basin to support navigation and navigation targets were still often not met. Alternatives with a larger impact on navigational flow might include in-stream structures, an upstream dam and reservoir, better bathymetry and navigation models, or investment in alternative transportation.

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

COMMON PERCEPTION

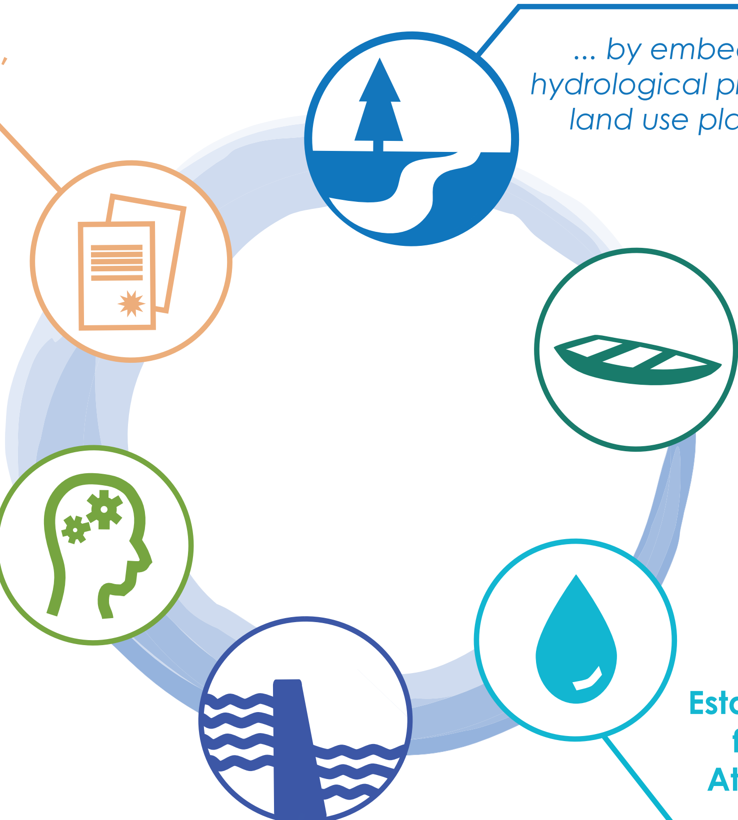
There are many gaps in what we need to know to properly manage water in the ARB. While much has been and continues to be done towards sustainable water management, gaps exist in data collection and access, fundamental science, formal and informal processes, provincial and local policies, and individual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

NEW LEARNINGS

Many gaps were identified by the Working Group, though defining the most critical would likely vary between groups based on needs and perspectives. An underlying theme for addressing many of these gaps is awareness and ready access to data. There are instances where significant investment and effort have gone into developing datasets that are not productively used as they are not known or cannot be readily accessed.

RECOMMENDED *STRATEGIES & PRACTICES*

This set of strategies and practical actions developed by a collaborative and inclusive Working Group serves as a potential guide towards sustainable water management in the ARB. These strategies were not identified to solve any one problem in the basin, but taken as a group, they provide one approach towards future water management in the ARB.



Maintain or improve the natural hydrological functions

... by embedding hydrological priorities in land use planning

Reduce water navigation limitations in the lower basin

... by employing a suite of alternative methods to meet navigational flows

Establish environmental flow needs for the Athabasca River and tributaries

... by calculating and communicating reach-specific environmental flows

Increase the adaptive capacity of the basin

... by investigating multi-purpose infrastructure to manage flow regimes

Continue to develop the means to share and apply traditional knowledge

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

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

... by prioritizing and closing the gaps most critical to the ARB

ADDRESSING *WATER CHALLENGES*

Participants in the ARB Working group collaboratively identified water challenges within the basin. Collectively, these six recommendations touch on each of the water challenges identified.