BEAVER RIVER INTEGRATED WATERSHED MANAGEMENT PLAN







LICA
ENVIRONMENTAL STEWARDS

ACKNOWLEDGEMENTS

LICA would like to thank the IWMP Committee, technical provincial, municipal, First Nation and Métis staff advisors, and all stakeholders for their contribution to the Beaver River IWMP.

LICA IWMP Committee

Abdi Siad-Omar, Alberta Environment and Parks
Al Bertschi, Portage College
Amanda Avery-Bibo, LICA Board
Annette Hobart, Alberta Energy Regulator
Bill Parker, City of Cold Lake
Bob Buckle, City of Cold Lake
Clem Parenteau, Métis Nation Region 2
Dana Swigart, MD of Bonnyville
Delano Tolley, Community
Dylan Landstrom, Beaver Lake Cree Nation
Fin MacDermid, Cold Lake First Nations
Joe Kapala, Town of Bonnyville
Katlyn Degenhardt, MD of Bonnyville
Kellie Nichiporik, Lakeland Agriculture Research Association
Kristen Berezanski, Strathcona Resources
Louise White-Gibbs, Community
Madison Arsenault, Youth
Madison Rehm, MD of Bonnyville
Maureen Delorme-Ouellette, Fishing Lake Métis Settlement
Mitch Sylvester, Moose Lake Watershed Society
Monty Moore, Husky Energy
Randi Dupras, Lac la Biche County
Richard Bourgeois, Muriel Lake Basin Management Society
Richard Pearce, Community
Roxane Bretzlaff, Canadian Natural Resources Ltd.
Robert Machatis, Cold Lake First Nations
Shana Langley, Military
Shelby Kennedy, Kikino Métis Settlement

Ex-officio Members

Kayla Hellum, Environmental Coordinator (current)
Vicky Krawchuk, Executive Director (current)
Rachel Bates, Education & Outreach Coordinator
Kristina Morris, Executive Director
Tricia Fleming, Environmental Coordinator

Dedication

LICA dedicates this plan to Delano Tolley who was a devoted member of the community and advocate for environmental stewardship.

Cover Photos

K. Hellum (centre); L. Vining (R); N. Gillis (top-L); LICA (top-R); R. Bretzlaff (lower-L); Unrau (L; lower-R)

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Palliser Environmental Services Ltd.

EXECUTIVE SUMMARY

LICA Environmental Stewards (LICA) is a community-based not-for-profit association that is a Synergy Group, an Airshed Zone, and the Watershed Planning and Advisory Council (WPAC) for the Beaver River watershed. LICA completed the Beaver River Integrated Watershed Management Plan (IWMP) as a guidance document and planning tool to achieve the vision of *"A healthy Beaver River watershed for the future."* The IWMP Committee, formed to help oversee Plan development, engaged with watershed Stakeholders, First Nations, and the Métis at key stages to ensure that it is relevant, and reflects local and regional perspectives.

The Beaver River IWMP addresses matters of water quantity, water quality, riparian areas and wetlands, biodiversity, land use, and knowledge and understanding. It establishes common goals for watershed resources, as well as management targets and thresholds that can be used to measure success in achieving the goals. Recommendations were formed that consider available science, and stakeholder, First Nations and Métis input. Implementation tables accompany the recommendations to indicate implementation actions, roles and responsibilities, and timelines.

Watershed management planning and the implementation of the recommendations put forward in this plan are a shared responsibility that require the collaboration of all stakeholders, First Nations, and the Métis. The IWMP will be considered successful when:

- It is fully implemented through the collaboration of all stakeholders.
- Targets and thresholds are achieved and/or measurable improvements are observed for established indicators.

The IWMP Committee identified five implementation priorities for the recommendations. The priorities listed below have multiple benefits for all stakeholders, First Nations and the Métis:

1. Develop and implement a long-term surface water quality monitoring program in collaboration with all stakeholders to leverage resources and achieve mutual goals.

2. Collaborate to implement BMPs and land use strategies to protect water quality and riparian health, particularly where riparian intactness scores are below the target and threshold and water quality is a concern.

3. Seek opportunities to support riparian restoration where assessments indicated health condition does not achieve targets and/or thresholds.

4. Collaborate with stakeholders to prioritize and develop a fishery monitoring program, including key habitat. Update fisheries management objectives prior to tourism and recreation planning (proposed in the Cold Lake Sub-Regional Plan).

4. Prioritize the completion of floodplain maps for watercourses and high-water marks for lakes to support implementation and enforcement of urban development setbacks through policy and planning.

LICA will track the progress of the Beaver River IWMP implementation and reported on actions regularly. A more comprehensive review of the plan will take place every five years.

TABLE OF CONTENTS

ACRONYMS

AAF	Alberta Agriculture and Forestry
ABMI	Alberta Biodiversity Monitoring Institute
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
AIS	Aquatic Invasive Species
ALMS	Alberta Lake Management Society
ALSA	Alberta Land Stewardship Act
ALUS	Alternative Land Use Services
ASB	Agricultural Service Board
AOPA	Agricultural Operations Practices Act
ASVA	Association of Summer Villages in Alberta
AUMA	Alberta Urban Municipalities Association
AWC	Alberta Water Council
AWC	Athabasca Watershed Council
BMP	Beneficial (Best) Management Practice
BRWA	Beaver River Watershed Alliance
CEP	Water Conservation, Efficiency and Productivity
CLAWR	Cold Lake Air Weapons Range
CLBR WMP	Cold Lake-Beaver River Water Management Plan
CLFN	Cold Lake First Nation
CLSR	Cold Lake Subregion
CLSRP	Cold Lake Subregional Plan
DUC	Ducks Unlimited Canada
EFP	Environmental Farm Plan
EPEA	Environmental Protection and Enhancement Act
FCM	Federation of Canadian Municipalities
FMO	Fisheries Management Objectives
FIN	Fall Index Netting
FSI	Fish Sustainability Index
GOA	Government of Alberta
IBA	Important Bird Area
IBI	Index of Biological Integrity
IOGC	Indian Oil and Gas Commission
IRP	Industry Respected Practice
GOWN	Groundwater Well Observation Network
IWMP	Integrated Watershed Management Plan
IWMPC	Integrated Watershed Management Plan Committee
LARA	Lakeland Agriculture Research Association
LARP	Lower Athabasca Regional Plan
LICA	Lakeland Industry Community Association
LUB	Land Use Bylaw
MDP	Municipal Development Plan
LICA	Lakeland Industry Community Association
OGCR	Oil and Gas Conservation Rules
PPWB	Prairie Provinces Water Board
QWAES	Qualified Wetland and Aquatic Environmental Specialist
SHL	Special Harvest Licence
SWAD	Surface Water Allocation Directive
TEK	Traditional Ecological Knowledge
USEPA	United States Environmental Protection Agency
WCO	Water Conservation Objective
WPAC	Watershed Planning and Advisory Council
WQO	Water Quality Objective
WSC	Water Survey of Canada
WSG	Watershed Stewardship Group

1.0 INTRODUCTION

LICA Environmental Stewards (LICA) is a community-based not-for-profit association that is a Synergy Group, an Airshed Zone, and the Watershed Planning and Advisory Council (WPAC) for the Beaver River watershed. LICA focuses on environmental monitoring, environmental management, and community education and outreach. As the designated provincial WPAC for the Beaver River watershed in Alberta, LICA reports on watershed health, leads collaborative planning, and facilitates education and stewardship activities. This work supports the goals of Alberta's *Water for Life Strategy*, namely:

- Healthy aquatic ecosystems
- Safe, secure drinking water supplies
- Reliable, quality water supplies for a sustainable economy

LICA initiated the Beaver River Integrated Watershed Management Plan (IWMP) process to help direct future watershed management activities and achieve the vision of "*A healthy Beaver River watershed for the future*". The Beaver River IWMP is a guidance document and planning tool for resource managers, including governments, planners, Indigenous communities, other stakeholders and landowners in the watershed. The plan identifies goals for improving and/or maintaining watershed health, and makes recommendations on how to reach those goals. An implementation strategy accompanies the IWMP to indicate implementation roles and responsibilities, priorities and timelines.

LICA's IWMP Committee (IWMPC) provided technical knowledge and support in the development of the Beaver River IWMP in collaboration with stakeholders, First Nations and the Métis. Appendix A provides a list of key stakeholders, First Nations and Métis in the watershed. The IWMPC worked collaboratively with communities and stakeholders to establish goals and objectives for watershed management that are supported by clear and comprehensive recommendations regarding water quantity, water quality, wetlands and riparian areas, biodiversity, land use and knowledge and understanding. Effort was made to ensure that this Plan is relevant and reflects local and regional concerns to achieve shared environmental, social, and economic outcomes supportive of a healthy watershed. This Plan builds on previous initiatives devoted to resource management in the Beaver River watershed and is aligned with current provincial and municipal initiatives that support watershed planning in the basin.

1.1 Previous Planning Initiatives

Coordinated planning efforts for the management of natural resources in the Beaver River watershed have occurred for more than 35 years. The list below are provincial plans relevant to the Beaver River watershed. More detail regarding these plans is provided in Appendix B.1.

- 1985 Cold Lake-Beaver River Long-Term Water Management Plan [Summary Document] (Alberta Environment 1985); A plan focused on water quantity and quality to meet long-term user requirements
- 1996 Cold Lake Sub-Regional Integrated Resource Plan (AEP 1996a)
- 2006 Cold Lake-Beaver River Basin Water Management Plan (CLBR WMP) (Alberta Environment 2006a); An update of the 1985 plan to align with the *Water Act* (GOA 1999) and Water for Life Strategy (GOA 2003). It included a key shift to an integrated approach that recognized surface water and groundwater interactions. The Director under the *Water Act*, considers this plan in decision-making.
- 2012 Lower Athabasca Regional Plan (LARP) (GOA 2012) established under the *Alberta Land Stewardship Act* (ALSA)

- 2022 Cold Lake Sub-Regional Plan (GOA 2022a); A plan developed to reduce human footprint in caribou range; implemented under ALSA

1.2 Need for a New Plan

Healthy watersheds support interdependent human, animal, and ecosystem health. Integrated Watershed Management Plans are important for guiding land and water resource management in consideration of the environment, sociocultural values and the economy. Implementation strategies that accompany IWMPs are essential for initiating action. While the CLBR WMP (Alberta Environment 2006a) provides a strong foundation for the management of the eastern Lower Beaver River, it pre-dates important legislative changes that affect watershed management, and it excludes parts of the greater Beaver River watershed. A new plan should also better reflect all stakeholder concerns, including First Nations and Métis Rights and Indigenous knowledge.

2.0 PURPOSE, INTENT, PLANNING CONTEXT AND SCOPE

2.1 Purpose, Intent and Authority

The Beaver River IWMP provides broad guidance for watershed management, and sets out clear direction that will result in consistent, specific actions for integrated management of land and water resources to support long-term watershed health. The IWMP will not replace the existing authorized CLBR WMP[1] (Alberta Environment 2006a), but rather augment it with aspects not previously considered.

While the watershed plan is not legally binding, developing the plan collaboratively means it is more likely to be supported and implemented by decision-makers in the Beaver River watershed.

To maximize opportunities for successful implementation, the IWMP should be supported by all stakeholders, First Nations and the Métis. Recommendations should be incorporated in future planning documents and updates of existing plans that have legal/regulatory authority (e.g., the CLBR WMP, the Lower Athabasca Regional Plan and sub-regional management frameworks, and municipal statutory plans and policies).

2.2 Legislative Policy and Planning Context

The development of the Beaver River IWMP is guided in part by the Framework for Water Management Planning (Alberta Environment 1999), the Guide to Watershed Planning in Alberta (GOA 2015) and the *Water for Life Strategy* (GOA 2003; renewed in 2008). The IWMP:

- Was developed within the context of existing federal, provincial and municipal legislation, policies and regional plans
- Acknowledges and adheres to the commitments outlined in the Inter-provincial Master Agreement on Apportionment (1969) as administered by the Prairie Provinces Water Board[2]
- Reflects current policies and practices in place since the CLBR WMP was completed in 2006

[1] Water Management Plans provide a framework for Alberta Environment and Parks to make water management decisions under Alberta's *Water Act* and *Environmental Protection and Enhancement Act* (EPEA).
[2] 68% of the natural flow of the Beaver River and Cold Lake basins must be allowed to flow to the adjacent province (Saskatchewan).

- Encourages the advancement of policies and practices for continued effort to steward the Beaver River watershed

A compilation of legislation, policy, plans and procedures relevant to the Beaver River watershed is provided in Appendix B.3. At the provincial level, the most notable changes to legislation, policies and plans since 2006 are the *Alberta Land Stewardship Act*, the *Alberta Wetland Policy*, the Lower Athabasca Regional Plan (GOA 2012), and the Cold Lake Subregional Plan.

2.3 Scope

In response to recommendations put forward in the 2006 CLBR WMP, the IWMP:

- Includes the entire Beaver River watershed in its planning area
- Better reflects all stakeholder concerns, including First Nations and the Métis
- Improves municipal influence by providing recommendations related to municipal development planning, including area structure plans for lakeshore (subdivision) development
- Creates a more comprehensive plan by broadening the focus from a specific sector (i.e., oil/gas) to address additional resource management objectives that consider and reflect watershed-scale processes and needs
- Integrates and addresses wildlife and fisheries management issues
- Provides specific recommendations with more implementation detail, as opposed to general recommendations that are not easily implemented

The scope of matters addressed in the plan includes those identified in Section 6.0.

Limitations

The IWMP will not:

- Gather new information to fill data gaps
- Formulate legislation, policy, or regulations
- Address air quality unless it relates to other watershed issues
- Consider the Saskatchewan portion of the watershed

3.0 PLANNING AREA

The Beaver River watershed is located in the boreal plain of east-central Alberta and west-central Saskatchewan (Figure 1), in Treaty 6, 8 and 10 territories and in the Métis homeland northeast of Edmonton (Figure 2). The total drainage area of the Beaver River at its confluence with the Churchill River is 50,003 km^2, with about half of the watershed (22,000 km^2) in Alberta (Beaver River Watershed Alliance (BRWA) 2013).

The Beaver River originates near the Hamlet of Lac La Biche as the outflow from Beaver Lake. It flows in an easterly direction for about 250 km, flowing south of Cold Lake (*Kinosoo*) before entering Saskatchewan. The Cold River originates at the east end of Cold Lake in Saskatchewan becoming the Waterhen River, and continues flowing east to join the Beaver River. The river flows north and joins the Churchill River at Île à-la-Crosse before flowing into Hudson Bay (Figure 1). The length of the river from its source to its mouth is about 661 km. Additional detail about the Beaver River watershed and its sub-watersheds in Alberta can be found in Appendix C, and in the Beaver River State of the Watershed Report (BRWA 2013).

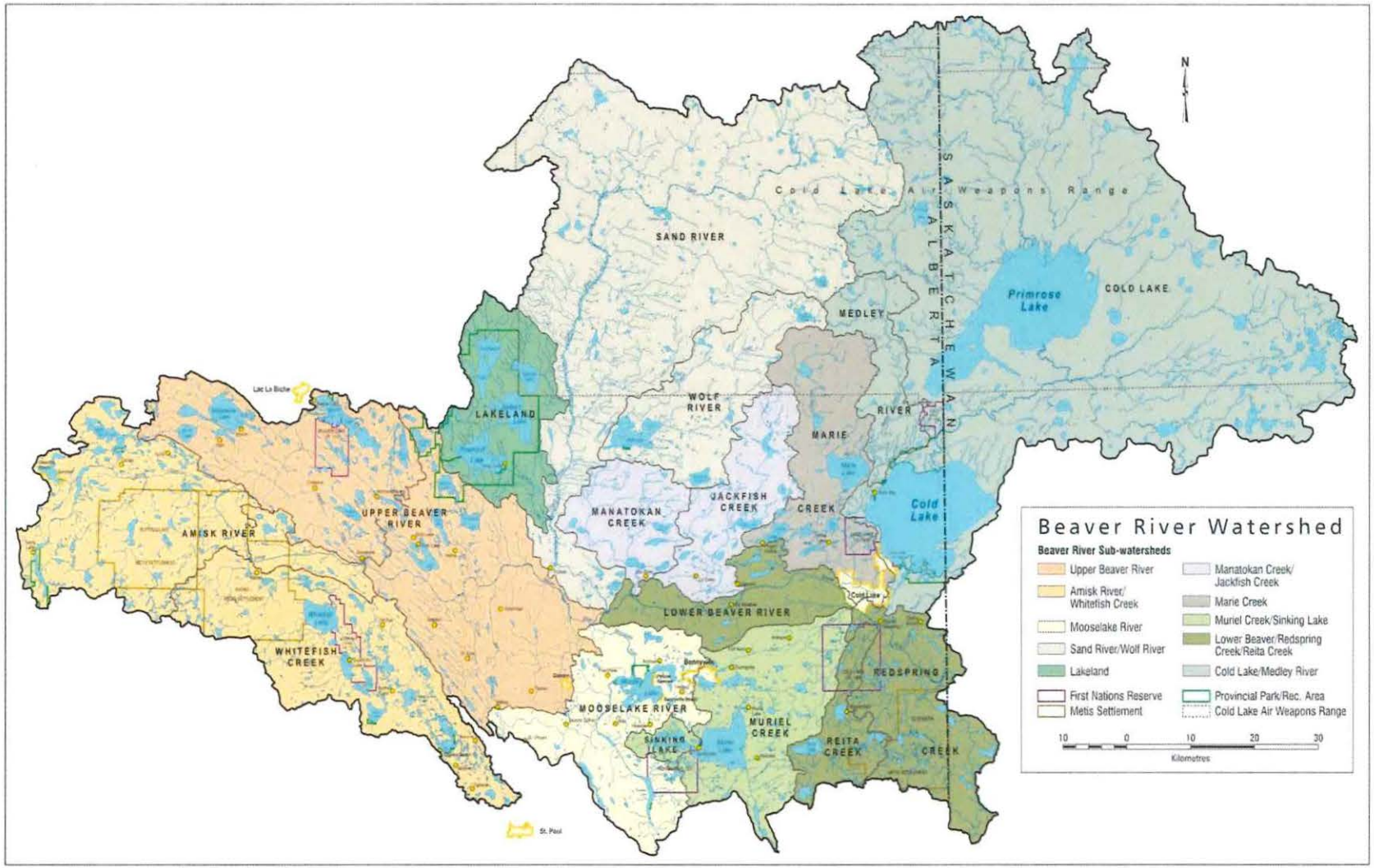
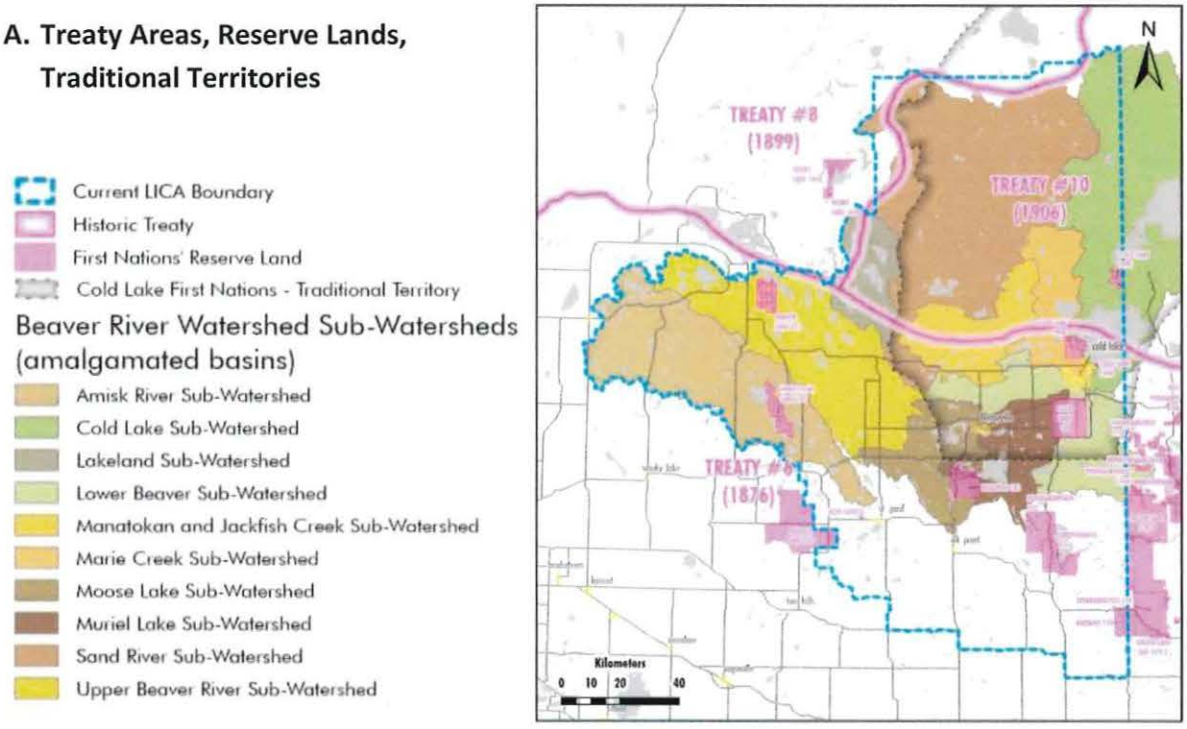


Figure 1. Map of the Beaver River watershed planning area (BRWA 2013).

A. Treaty Areas, Reserve Lands, Traditional Territories



B. Metis Nation of Alberta Association Regions, Settlements

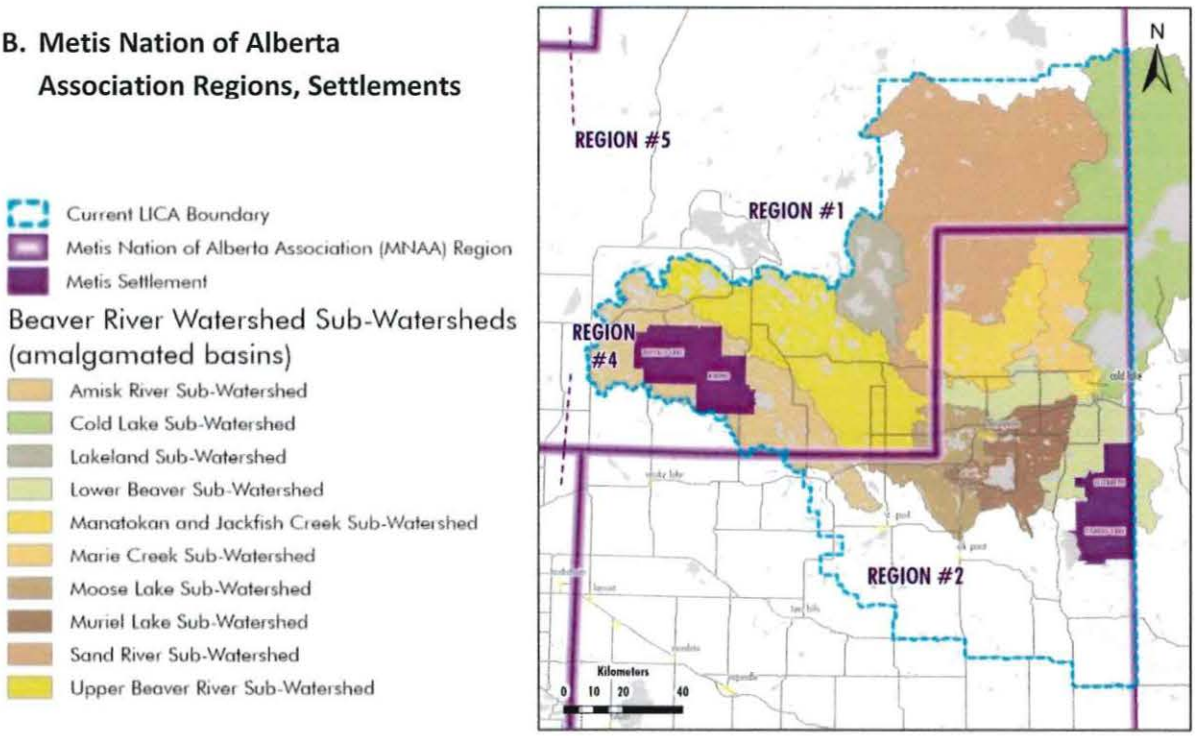


Figure 2. Maps showing A) First Nations treaty areas, reserve lands and traditional territories, and B) Métis Nations of Alberta Association Regions and Métis Settlements.

3.1 Human Footprint

3.1.1 First People

Human presence in the Beaver River watershed dates back to time immemorial. Prior to the arrival of Europeans, the Cree and Dené had established an independent and organized society that included a nomadic lifestyle. The land provided First Nations with everything they required for their mental, physical, spiritual, and emotional well-being (Alberta Regional Professional Development Consortium N.D.). Specifically, the Beaver River watershed and surrounding area provided abundant trapping, hunting, fishing, berry picking, plant harvesting, collection of medicines and camping opportunities. A network of trails was established to reach important places throughout the watershed. Knowledge and traditions were passed down through generations.

The Denesųłiné (Dené, people of Cold Lake First Nations and the only Dené represented in Treaty 6) travelled in small family groups and followed the caribou and other game within their Traditional Territory (Figure 2a). The Dené families spent their winters at Primrose Lake and summers around Cold Lake (thooway-show-tway)[3] and neighbouring lakes.[4] They excelled in trapping and hunting and, on the arrival of the Europeans, the Dené controlled a large portion of the fur trade, being well known for their skills in hide preparation, trade and commerce, and guiding.

The Cree (people of Beaver Lake First Nation, Frog Lake First Nation, Kehewin First Nation, Saddle Lake Cree Nation and Whitefish (Goodfish) Lake First Nation #128) also relied on abundant resources for trapping (e.g., hare, beaver, mink, and others), hunting (e.g., moose and woodland caribou) and fishing. Waterfowl and upland game were seasonally harvested in spring and fall (i.e., ducks and geese), and in winter (i.e., grouse and ptarmigan). Fish was a reliable and staple food during the winter months. Fishing was carried out extensively using complex fishing technology to catch whitefish, lake trout, pickerel [walleye] and pike, among other species (Korea National Oil Corporation 2009).

3.1.2 First Nations Treaties and Métis Harvesting Rights

The traditional practices of trapping, hunting, fishing, and gathering, along with spiritual and cultural practices, continue to be upheld by the Cree and Dené First Nations today. First Nations have traditional values and rights, constitutional rights and key principles embodied in the Treaties (Treaty 6 signed 1876, Treaty 8 signed 1899, and Treaty 10 signed 1906), which guide their way of life and jurisdiction in the Beaver River watershed. Treaty rights are recognized and affirmed in the *Constitution Act* (S. 35), 1982. The 2018 Métis Harvesting in Alberta Policy (GOA 2019) ensures that Métis people who are entitled to harvesting rights as guaranteed by the Constitution Act (s. 35), 1982, have the ability to hunt, fish and trap for subsistence (food). Refer to Section 4.3 and Section 4.6 for additional context regarding First Nations and Métis rights, respectively.

3.1.3 European Settlement

Land use began to change with the migration of European Settlers to the area. These settlers were traditionally farmers who found the rich soils suitable for crop production and raising livestock for subsistence. A chronology of key events that have shaped the current social/cultural, economic and environmental state of the watershed is provided in Table 1.

[3] Cold Lake is called thooway-show-tway in Chipewyan, or "big fish Lake", and takikawew-sahigan in Cree, meaning "cold lake"; both names were originally given to the nearby lake (Dempsey 1969); Kinosoo or "big fish" is also Cree
[4] Cold Lake First Nations (CLFNS) website

Table 1. Historical timeline of events in the Beaver River watershed from pre-contact to present (compiled by LICA). Note that the establishment date for Whitefish (Goodfish) Lake First Nation #128 is currently not available.

Year	Event	
Pre-Contact	The naming of lakes and rivers	• Long before European settlement, the Cree and Dene People inhabited the shores and woodlands of this area. Named "Kinosoo" or "big fish" after a Cree legend. Cold Lake was renamed by European Settlers upon arrival due to the deep depths and cold water.[1]
1700-1789	Fur Trade	• The Dene Suline was indirectly exposed to the Fur Trade and its activities as early as 1716.[2]
		• Cold Lake House was a trading post built by Montreal traders near the present-day Beaver Crossing (1781)[3], and a second, Shaw House at Moose Lake (1789).[4]
		• Angus Shaw, a fur trader in the North West Company, came to Moose Lake in 1789 and established the North West Company post (Shaw House) on the Northwest shores of the lake.[4] The rivers and streams of this area were the original transportation routes.
1876-1906	Treaties Signed	• The signing of Treaty 6 (1876), Treaty 8 (1899), and Treaty 10 (1906). What is now known as the Beaver River watershed is located within the traditional land of the Dene, Cree, and Métis homeland.
	FN Reserve Established	• Kehewin Reserve was surveyed (1884). 'Reserve Status' was officially granted in 1889 and the Kehewin Indian Reserve #123 was formed.[4]
		• Saddle Lake Indian Reserve was established (1886).[5]
		• Cold Lake First Nations community was established through an Order in Council, prior to formation of Alberta and Saskatchewan (1904)
1900-1910	Industry	• Two sawmills operated on the North and East ends of Muriel Lake (1900).[6]
	Expansion	• The start of new settlers arriving in the Bonnyville area (1907).[4]
	Fisheries	• The first commercial fishing business opened (1908).[4]
	Fur Trade	• Closing of a Hudson Bay trading post near Bonnyville (1908).[4]
	Expansion	• Land surveys were completed in Bonnyville and Cold Lake Areas (1910).[4]
1911-1920	Reserve Established	• Beaver Lake Indian Reserve #131 was established (1911).[5]
	Natural Disaster	• A wildfire burned 60-70 acres near Cold Lake (1919).[4]
		• A wildfire struck the timber around Muriel Lake. Much of the land transitioned from forestry to agricultural use as the local sawmill lost its timber supply (1920).[6]
		• A major drought occurred in the region (1920).[7]
1921-1940	Industry/ Expansion	• The first steam engine arrived in Bonnyville (1928).[4]
	Natural Disaster	• The start of the depression. Very poor growing conditions lead to poor crop yields (1929).[4]
	Tourism	• Tourism bloomed in the Cold Lake area with fishing a large attraction (1920-1930s).[4]
	Natural Disaster	• Jessie Lake dried up and resembled a hay field (1930s).[7]
	Métis Settlement	• Fishing Lake Métis Settlement established (1938). It was not until 1949 that they were given title to the land boundaries they have today.[8]
		• Kikino Métis Settlement established (1938)
		• Elizabeth Métis Settlement established (1939).[9]

Year	Event	
1941-1950	Métis Settlement	• Buffalo Lake Métis Settlement established (1941).[10]
	Industry	• The first powered generator in Cold Lake (1946).[4]
		• A natural gas field was discovered in the Town of Bonnyville limits (1949).[4]
	Natural Disaster	• Flood at Muriel Lake (1950).[6]
1951-1960	Expansion	• Rat control in Alberta is administered and coordinated by Alberta Agriculture and Food. It was established to keep Alberta free of Norway rats (1950).[11]
	Expansion	• Sewer systems opened in Bonnyville (1951).[4]
	Military	• Construction of Canadian Air Force Base Cold Lake began which resulted in the loss of Cold Lake First Nations Traditional Territory (1952).[2]
	Municipal	• MD of Bonnyville officially formed (1955).[4]
1961-1980	Industry	• Imperial Oil starts to look to Cold Lake, proposing projects for the area (1964).[4]
	Métis Nation Zones	• The Métis Association of Alberta's Regions was created. The MAA Bylaws were amended for the first time creating 6 zones (1972).[12]
	Industry	• Exploration of Canada's first steps into tapping the massive oil resource. In 1980, one Plant by Cold Lake was one of only two under construction in Canada's oil sands (1980).[13]
	Industry	• Imperial Oil Ltd. began production of heavy oil in the region (1975).[11]
1981-2000	Infrastructure	• Moose Lake Weir was built to improve fish and wildlife habitat, stabilize the lake level and improve the water supply storage for the Town of Bonnyville (1985).[14]
		• Murphy Road was upgraded to a high-grade road which ran between Muriel Lake to the west with the creeks feeding Muriel Lake to the east (1987).[6]
	Natural Disaster	• Drought in the region (2000).[15]
2001-2020	Natural Disaster	• An agricultural disaster declared in the MD of Bonnyville due to drought and grasshoppers (2015).[16]
		• The highest recorded lake levels since 1966 occurred at Moose Lake and caused flooding (2017).[16]
		• Wildfires occur around Moose Lake (2019).[17]
2021	Infrastructure	• Ongoing discussion and community engagement for the removal and naturalization of the Moose Lake Weir.[14]
		• Walkways constructed in several subdivisions in the MD of Bonnyville that impacted natural drainage and resulted in localized flooding.[16]
	Natural Disaster	• An agriculture disaster declared in the County of St. Paul, MD of Bonnyville, and Lac La Biche County due to severe drought conditions. [16]
2022	Infrastructure	• Removal of the Moose Lake Weir.

[1] Kehewin Cree Nation website; [2] Cold Lake First Nations website; [3] BRWA 2013; [4] Historical Society of Cold Lake and District 1980; [5] Beaver Lake Cree Nation website; [6] Bourgeois, pers. comm. 2022; [7] Ilchuk, pers. comm. 2022; [8] Fishing Lake Métis Settlement website; [9] Elizabeth Métis Settlement Website; [10] Buffalo Lake Métis Settlement website; [11] The Canadian Encyclopedia https://thecanadianencyclopedia.ca/en/article/cold-lake; [12] Métis Nation of Alberta website; [13] City of Cold Lake website; [14] GOA 2021; [15] Elgert, pers. comm. 2022; [16] Lakeland Today 2021; [17] Hellum, pers. comm. 2022

3.1.4 Current Conditions

Today, the Beaver River watershed continues to be rich in natural resources. Watershed resources support First Nations and Métis traditional land use and cultural practices, as well as a variety of industries that contribute to the local, regional, and provincial economy (e.g., oil and gas, agriculture, mining, forestry, development, and tourism and recreation). Maintaining watershed health is an overarching goal for this Beaver River IWMP.

The human footprint is an important indicator of watershed health. The cumulative impact of land use activities in the watershed can affect local hydrology, water quality, riparian areas and wetlands, and biodiversity by altering the natural system that functions to maintain balance in the watershed.

In 2018, the total human footprint covered about 20% of the Beaver River watershed. Agricultural land use accounted for the largest percentage of the human footprint (72%). The majority of the agricultural footprint is categorized as tame pasture. The oil and gas industry footprint accounted for 9%, roads and trails (7%) and forestry activity accounted for 6% of the total human footprint (Figure 3; Figure 4).

This Beaver River IWMP considers the cumulative impact of land use and recommends strategies to minimize and mitigate impacts on watershed health.

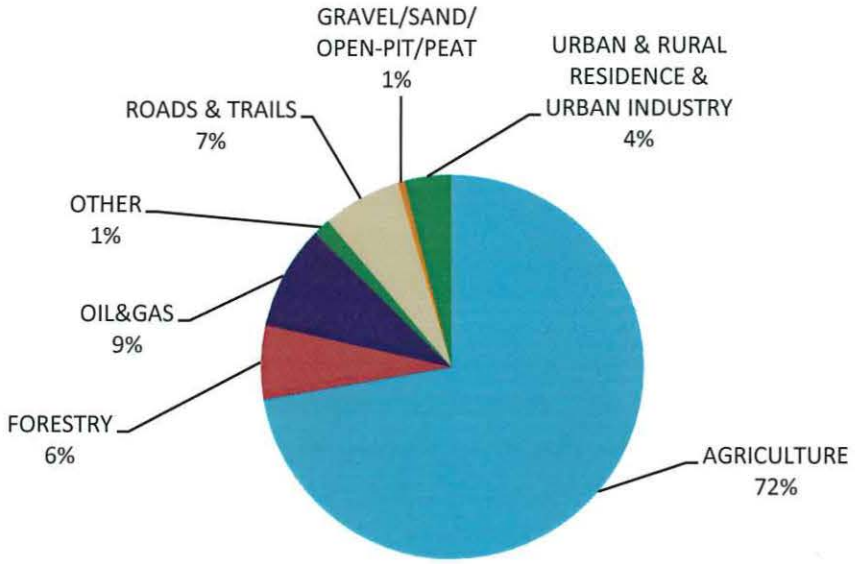


Figure 3. Summary of land use activities that contribute to the total human footprint in the Beaver River watershed (ABMI 2018).

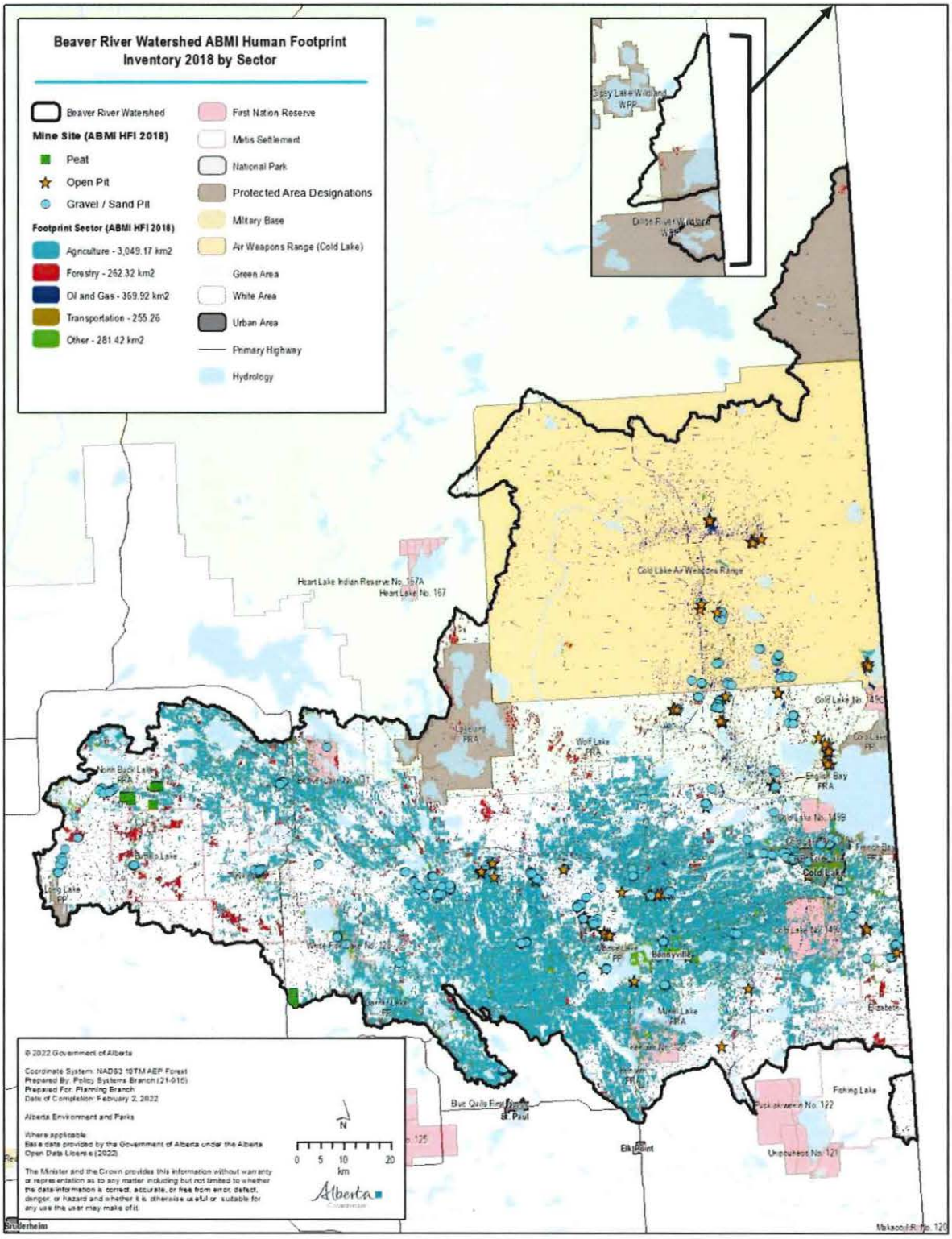


Figure 4. Human footprint in the Beaver River watershed (ABMI 2018). A high-resolution map is available at www.lica.ca. The map inset shows two small parts of the watershed that are disconnected to the north from the larger watershed in Alberta, and are not visible at this scale.

4.0 ROLES AND RESPONSIBILITIES

Watershed management planning and implementation of recommendations is a shared responsibility that requires the collaboration of multiple levels of government, various industries (e.g., agriculture, oil and gas), non-government organizations, landowners, leaseholders, and residents in the watershed. The planning process is considered successful when stakeholders recognize and support their individual or shared responsibility for achieving the collective goals and objectives of the IWMP. General roles and responsibilities for Beaver River watershed management are further described below.

4.1 Lakeland Industry and Community Association

LICA is the designated provincial WPAC for the Beaver River watershed in Alberta; as such LICA reports on watershed health, leads collaborative planning, and facilitates education and stewardship activities. This work supports the goals of Alberta's *Water for Life Strategy*:

- Healthy aquatic ecosystems
- Safe, secure drinking water supplies
- Reliable, quality water supplies for a sustainable economy

LICA will continue to collaborate and engage with stakeholders, First Nations, and the Métis during the implementation phase of the Beaver River IWMP. LICA will also continue to ensure the best combination of scientific information, Indigenous Knowledge and stakeholder, First Nations and Métis feedback is considered in watershed planning. LICA will lead communication, education, and engagement, and help to implement the IWMP by acting on action items specific to LICA and providing support to others implementing the plan.

The role of stewardship groups in the Beaver River watershed is essential to understanding and managing specific lake management concerns. As a WPAC, LICA can support stewardship group activity by

i. Assisting with joint funding applications for projects that will achieve common goals across the watershed (e.g., riparian intactness assessment, water quality investigations, etc.)
ii. Collaborating to host an annual Stewardship Group Forum to facilitate sharing of knowledge and joint planning across the watershed

4.2 Federal Government

The federal government performs a key role in the shared management of watershed resources. The *Canada Water Act* enables cooperative agreements between the federal, provincial, and territorial governments to regulate, apportion, and monitor water resources, and to implement joint programs. The federal government has authority over water quality and publishes water quality guidelines pertaining to the environment, drinking water and recreation. The Department of Fisheries and Oceans oversees fisheries resources and fish habitat under the *Fisheries Act*. Other federal roles include pollution control, and the management of interprovincial waters (e.g., Cold Lake), navigation and water on federal lands.

The Department of National Defence (CFB Cold Lake)

The Department of National Defence has created a Defence Environmental Strategy that identifies the military's approach to integrating environmental management into activities that support its mandate, including the use of best practices and sustainable development.

4.3 First Nations

The Beaver River watershed is located on Treaty 6, 8, and 10 territories. Beaver Lake Cree Nation, Cold Lake First Nations, Frog Lake First Nation, Kehewin Cree Nation, Saddle Lake Cree Nation, and Whitefish (Goodfish) Lake First Nation #128 have reserve lands and associated traditional territories located in this region.

First Nations have traditional values and rights, constitutional rights and key principles embodied in their treaties, which guide their way of life and jurisdiction in the watershed. Treaty rights are recognized and affirmed in the *Constitution Act* (S. 35), 1982. Treaty rights include protection of traditional ways of life, the right to occupy and use lands and resources (e.g., the right to hunt, fish and trap on unoccupied Crown land), cultural and social rights, rights to consultation, and rights to participate in land and resources management decisions (Government of Canada 2020).

In 2007, the United Nations Declaration on the Rights of Indigenous Peoples was signed. The Declaration affirms and sets out minimum standard rights of Indigenous peoples related to self-determination and self-government, culture and identity, lands, territories and resources, and environment to name a few.

First Nations are reliant on healthy watersheds for sustenance, and to support their way of life. They retain Indigenous Knowledge and information regarding Indigenous Practices that can increase common understanding of watershed resources, and inform recommendations that support the protection and/or restoration of water and land resources.

LICA wants to clearly communicate to First Nations that by participating in the Beaver River watershed planning process, First Nations will not abrogate any rights they have, and the obligation of governments to duly consult with First Nations will not be diminished. Neither the LICA Board of Directors, nor the LICA staff considers any discussion entered into with First Nations to fall within any mandated duty to consult.

4.4 Provincial Government

The provincial government includes multiple ministries that are responsible for the management of public lands and natural resources on behalf of Albertans.

Alberta Agriculture and Forestry (AAF)

AAF is a *Water for Life* partner and shares responsibility for achieving its goals. AAF is responsible for the *Agricultural Operations Practices Act* (*AOPA*), legislation that sets manure management standards in Alberta. AAF strives to develop the agriculture and food industry, sustain the industry's natural resource base and encourage the development of rural communities.

Alberta Energy Regulator (AER)

The AER was founded in 2013 as the single regulator of energy development (e.g., oil, oil sands, natural gas, and coal projects) in Alberta. AER regulates application and exploration, construction and development, abandonment, reclamation, and remediation activities. AER is authorized to make decisions on applications for energy development, monitoring for compliance assurance, decommissioning of developments, and all other aspects of energy resource activities. This authority extends to authorizations pursuant to the *Public Lands Act*, the *Environmental Protection and Enhancement Act (EPEA)* and the *Water Act* that relate to energy resource activities. Oil and gas activity is regulated by the Alberta Energy Regulator.

Alberta Environment and Parks (AEP)

AEP has a legislated mandate to manage air quality, water resources, waste management, cumulative effects, provincial Crown (public) lands, the bed and shore of naturally occurring water bodies, and biodiversity (including fish and wildlife resources). AEP is responsible for key legislation and policies influencing watershed management, including Alberta's *Water Act* and Wetland Policy.

4.5 Municipal Governments

The Beaver River watershed is represented by the rural municipalities of Athabasca County, County of St. Paul, Lac La Biche County, Municipal District of Bonnyville, Smoky Lake County, and Thorhild County. Urban centres include the City of Cold Lake, the Town of Bonnyville, and the Village of Glendon. Under Part 17 of the *Municipal Government Act* (MGA), municipalities have responsibilities in planning, regulating, subdividing, and developing land in Alberta. Municipalities have the authority to create statutory plans (i.e., intermunicipal development plans, municipal development plans, area structure plans, and area redevelopment plans) to identify future plans for development within municipal boundaries and the immediate surrounding area. Municipalities are required, by the MGA, to adopt a Land Use Bylaw that divides the municipality into districts, prescribes the types of land uses permitted, establishes development standards, and provides a system for issuing permits. Municipalities promote economic development in the region. Many municipalities also support programs, services and education initiatives that promote stewardship of watershed resources.

Agricultural Services Boards (ASBs) form part of the rural municipal government and are responsible for administering and developing programs to complement Provincial legislation, including the *Agricultural Service Board Act*, the *Weed Control Act*, the *Agricultural Pests Act*, and the *Soil Conservation Act*. It is generally the role of the Agricultural Fieldman to implement the work plan established by the ASB.

Summer Villages

Summer Villages are designated municipalities established by the Government of Alberta. The Summer Villages of Bondiss, Bonnyville Beach, Mewatha Beach and Pelican Narrows are in the Beaver River watershed. All four Summer Villages have Land Use Bylaws in place, some with specific reference to shoreline management. The Association of Summer Villages in Alberta (ASVA) provides a forum for all Summer Villages in the province. The ASVA undertakes special initiatives that seek to address challenges facing Alberta's lake communities (e.g., Lake Stewardship Guide). Summer villages strive to minimize or mitigate human impact on the environment by promoting lake stewardship, including lake planning and implementation of actions that help protect water quality.

4.6 The Métis

Métis Nation of Alberta

The Métis Nation of Alberta (MNA) is the representative voice of the Métis people in Alberta. The MNA governance is divided into six regions across the province, including Region 1 and Region 2 that span areas of the Beaver River watershed. The MNA represents all Métis at the provincial and federal levels. The MNA is striving to establish a modern-day treaty with the Federal Government that recognizes land and resource rights including secure harvesting rights, and rights to self-government.

In 2019, the MNA signed the first self-government agreement between the Government of Canada and a Métis government.

Métis Settlements

In 1938, the MNA lobbied for the *Métis Population Better Act* that provided Métis with a secure land base and services on Métis settlements. In the Beaver River watershed, the Métis Settlements of Elizabeth, Fishing Lake, Buffalo Lake and Kikino coordinate the development of natural resources with the GOA. The Métis Settlements General Council (MSGC), established by the *Métis Settlements Act,* addresses matters that affect the collective interests of the Métis Settlements.

The 2018 Métis Harvesting in Alberta Policy (GOA 2019) ensures that Métis people who are entitled to harvesting rights as guaranteed by the *Constitution Act (s. 35), 1982*, have the ability to hunt, fish and trap for subsistence (food). Both the Métis Nation of Alberta and Métis Settlement members have harvesting rights in designated harvesting areas if they have a demonstrated historical connection to a Métis Harvesting Area in Alberta and a contemporary connection to the same community. Harvesting Areas B and D cover most of the Beaver River watershed.

4.7 Industry

Agriculture

Agricultural lands cover about one-third of the watershed. About half of the agricultural land in the watershed is pasture land and 36% of the area is cropland. As a main industry in the Beaver River watershed, farmers and ranchers have a large role in watershed management, including the maintenance of water quantity and quality, and healthy riparian areas and grassland. Agricultural activity must comply with provincial legislation (*AOPA)*. The Grazing Lease Stewardship Code of Practice was signed by the Alberta Beef Producers, the Alberta Grazing Leaseholders Association, the Western Stock Growers Association, and the provincial government. The Code of Practice identifies the roles and responsibilities that public land grazing leaseholders have in land management.

Forestry

Two Community Timber Permit Programs are currently active in the Lac La Biche Forest Area's Forest Management Unit LO1. The programs' annual volume harvests are 30,000 m^3 of deciduous and 14,000 m^3 of conifer trees. All forestry operations in the watershed are conducted according to the Alberta Timber Harvest Planning and Operating Ground Rules (GOA 2022b) and Timber Harvest Planning and Operating Ground Rules: Northeast Alberta Regional Area- Specific Addendum (GOA 2022c). Approximately 8 timber permits are issued annually to program members and competitive sale winners.

Oil and Gas

The Cold Lake oil sands deposit is one of the largest in Alberta. Since Imperial Oil began production of bitumen in 1975, oil and gas exploration and development have increased in the Beaver River watershed. Several companies now conduct *in situ* recovery operations from the Cold Lake oil sands, including areas within the Cold Lake Air Weapons Range (BRWA 2013). Oil and gas activity is regulated by the Alberta Energy Regulator. Oil and gas companies have a responsibility to develop resources in a way that minimizes impacts on watershed resources. The Canadian Association of Petroleum Producers (CAPP) encourages responsible development in the upstream oil and gas industry. CAPP aims to enable environmentally and socially responsible performance, and encourages the use of best management practices to reduce impacts on air, land, water, and people.

Oil and gas activity is regulated by Federal and Provincial laws, regulations and Codes of Practice, including EPEA, the *Water Act*, the Water Ministerial Regulation and the Enhanced Approval Process as

specified in the *Public Lands Act*. The Oil and Gas Conservation Rules (OGCR) encompass management Directives, including OGCR Section 2.120 which regulates water pollution control.

Sand and Gravel Extraction

The Alberta Sand and Gravel Association (ASGA) represents Alberta's sand and gravel operators on key industry-related issues and proposed regulatory changes, while advocating environmental responsibility. ASGA works with communities and regulatory bodies to encourage responsible development and to ensure land reclamation following gravel extraction. Land must be reclaimed to a capability equal to or better than pre-disturbance. Exploration, extraction, and reclamation activities are regulated by Federal and Provincial environmental laws, regulations, and Codes of Practice (e.g., *Environmental Protection and Enhancement Act (EPEA), the Conservation and Reclamation Regulation* and Code of Practice for Pits), as well as the *Municipal Government Act*.

Peat Mining

Peat has been harvested in Alberta for horticultural purposes (e.g., growing media by commercial growers) since the mid-1960s (GOA 2016). In the Beaver River watershed, peat mining activities encompass an area of about 4.7 km^2 (ABMI 2018). Removal of peat from public land requires a formal disposition under the *Public Lands Act* and the *Public Lands Administrative Regulation* (*PLAR*). The PLAR requires reclamation of public land to an equivalent capability when operations end for any reason (e.g., expiry, abandonment). Peat mining is further regulated by *EPEA*, and wetland drainage is subject to approval under the *Water Act*. Peat land available for allocation is categorized as Low Sensitivity Public Lands (no constraint) or High Sensitivity (constraints imposed by sensitive or critical habitat (GOA 2016).

4.8 Watershed Stewardship Groups, Non-Profit Organizations, Academia

As partners in the *Water for Life Strategy*, Watershed Stewardship Groups (WSGs) are key partners in watershed management planning, beneficial management practice implementation, and education and outreach programs in the Beaver River watershed. WSGs encourage watershed stewardship at a local level. Similarly, many non-profit organizations support watershed management and stewardship efforts through planning, environmental condition monitoring and evaluation, and education initiatives. Universities and research institutes provide essential data and perspectives on emerging watershed issues and environmental conditions by undertaking primary research. Academia may identify research needs, as well as suggest how data and knowledge gaps can be addressed.

4.9 Residents

Residents have valuable knowledge and insight about current watershed conditions and can provide direction on how to achieve community goals. Residents also have a role in local stewardship and helping to maintain a healthy watershed.

5.0 INFORMATION ASSEMBLED

LICA worked closely with the IWMP Committee and technical advisors to compile relevant plans, policies, and technical reports for the Beaver River watershed. The Beaver River State of the Watershed Report (2013), LakeWatch Lake Monitoring Reports (ALMS), and Riparian Intactness Assessments (Fiera Biological 2021a and 2021b) were considered. In some instances, raw data (related to water quantity and quality) and Provincial spatial data relevant to the Plan were available; this data was accessed, summarized, or mapped and used to support stakeholder engagement and recommendations. Refer to Section 12.0 for a complete list of literature cited in the development of this plan.

6.0 MATTERS, GOALS AND OBJECTIVES

6.1 Matters

The scope of matters listed below reflects concerns expressed by the community during the engagement process (Section 8.0), as well as the best available science. Concerns are related to surface water and groundwater quantity and quality, wetlands and riparian areas, biodiversity, land use, climate change and knowledge and understanding. Matters may not apply to all areas in the watershed.

Surface Water

Quantity

- Fluctuating water levels (lakes and wetlands) and streamflows caused by climate change, climate variability (e.g., temperature, evaporation, and precipitation), and/or development that can:
    - Impact water availability for municipal water supplies, agricultural uses, and First Nations and Métis
    - Increase risk of flooding, and impacts associated with drought
    - Impact recreation activity
    - Impact infrastructure
    - Alter aquatic, riparian, and upland habitat
    - Alter land use (e.g., cultivation, development) around wetlands and ephemeral streams (watercourses that flow briefly in direct response to rainfall or snowmelt (USEPA 2015)).
- Surface water withdrawals.
- Altered drainage patterns and/or discharges of treated effluent, and stormwater.

Quality

- Water quality in lakes and streams does not meet the desired end uses (e.g., drinking water, contact recreation, agriculture, Indigenous traditional practices, and/or wildlife and aquatic species needs) in some areas due to soil type and geology, climate change and variability, and/or influx of point and non-point source pollution from adjacent lands (e.g., nutrients, sediment, bacteria).
- The influx of nutrients originating from external sources and the internal natural cycling of nutrients contributes to eutrophication in many lakes in the watershed.

Groundwater

Quantity

- Uncertainty regarding groundwater quantity resulting from climate change and variability, and withdrawals for human and industrial use.

- Limited understanding of the impact that groundwater withdrawals have on aquifer dynamics (e.g., shallow/deep aquifer interactions) and on lake water levels and streamflows (i.e., groundwater-surface water interactions).

Quality

- Human health concerns related to naturally occurring and/or human-caused mobilization (e.g., thermal mobilization) of trace metals (i.e., arsenic and uranium) in concentrations above drinking water guidelines.
- Concerns related to land use, including potential contamination from improperly/maintained abandoned water wells, landfills, agricultural activity, septic fields and, oil and gas activity (casing failures).

Riparian Areas and Wetlands

- Loss of riparian areas and wetlands and their respective functions:
  - Water storage (absorptive capacity, flood control) and water balance in lakes/streams
  - Groundwater recharge
  - Water quality (retention of nutrients, suspended sediment, soil and associated contaminants)
  - Biodiversity
  - Ecological services (recreation, carbon sequestration, stormwater treatment)

Biodiversity

- Fragmented and poor-quality habitat, due to increased road density, access, recreational activity, industrial activity (e.g., pipelines, well-sites, mining [sand and gravel]), forestry and other developments).
- Changing abundance and/or size of certain fish and wildlife species in the watershed.
- Beaver dam removal and the need for due consideration of potential environmental impacts
- Potential threat of terrestrial and aquatic invasive species (e.g., quagga mussel, Himalayan Balsam) in and adjacent to waterbodies in the watershed.
- Berries, plants, and animals are safe to eat.

Land Use

- Cumulative impact of development and industry on water resources, ecosystem and landscape function (including riparian areas and wetlands), biodiversity, and First Nations and Métis traditional land use.

Climate Change

- Impacts of climate change as it relates to:
  - Water availability and quality
  - Increased risk of drought, fire and floods,
  - Pest management (e.g., forest insects and diseases)
  - Altered landscapes and habitat conditions
  - Risks to fish, wildlife, and vegetation

Knowledge and Understanding

- Gaps in knowledge and understanding of natural conditions and anthropogenic (human-caused) impacts on watershed function.
- Limited public understanding or use of First Nations and Métis Rights, Indigenous Knowledge and Practices in the development and implementation of plans and policies.

6.2 IWMP Goals and Objectives

6.2.1 Overarching Goal

Collaborative management of land and water resources that results in a healthy Beaver River watershed.

The LICA IWMP Committee (2020) established that a healthy watershed supports interdependent human, animal, and ecosystem (aquatic and terrestrial) health where:

- Human health is described by individual and community physical, mental and social well-being, including the ability to express one's culture.
- Domestic and production animal health involves physical and psychological well-being that supports productivity, reproduction, and expressions of innate characteristics.
- Wildlife health involves resiliency under changing environmental conditions and the ability to sustain their ecological, social, and cultural roles.
- Ecosystem health involves the ability to maintain and improve organizational structure and function, resilience under stress, and to continuously provide quality ecosystem services.

6.2.2 Specific Goals and Objectives

Specific goals and objectives were formed to provide a clear direction of purpose for the Beaver River IWMP (Table 2). The goals are broad statements that reflect the main concerns for natural resource management in the basin; the goals emphasize what the IWMP will accomplish (the outcomes of the Plan). Objectives were established to guide the planning process and achieve the goals. These objectives are measurable and may be used to indicate milestones throughout the planning process.

Table 2. Values, goals and objectives leading the development of the Beaver River IWMP.

Value	Goal (Outcome)	Objective
Water Quantity	Secure, reliable water supplies are available for desired uses (i.e., environmental, First Nations and Métis, municipal, agricultural, industrial, and recreational).	1. Review and determine the status of existing Water Conservation Objectives in the original Cold Lake Beaver River Water Management Plan (Alberta Environment 2006a). 2. Review the need to establish Water Conservation Objectives for streams and lakes outside of the original CLBR WMP planning area. 3. Recommend strategies to address fluctuating water levels at priority lakes[5] where human impacts contribute to flooding or low water levels in the watershed. 4. Recommend strategies that encourage water conservation. 5. Understand the status of current surface water and groundwater initiatives and recommend strategies to better manage the resource.
Water Quality	Surface water and groundwater quality that is protected from external sources of contamination,	1. Establish Water Quality Objectives that are compatible with the Surface Water Quality Management Framework for watercourses having sufficient data available.

[5] Appendix E summarizes criteria used to identify priority lakes.

Value	Goal (Outcome)	Objective
	and is maintained within the range of natural variability.	2. Establish Water Quality Objectives for major recreational lakes. 3. Identify stormwater management targets and Low Impact Development strategies to minimize development impacts on water quality (and quantity). 4. Identify appropriate land use, management and stewardship strategies to maintain and/or improve water quality.
Riparian Areas and Wetlands	Healthy riparian areas and wetlands contribute to watershed resiliency with respect to flood and drought, quality water, and critical habitat.	1. Establish riparian setbacks and management objectives/targets that can be applied consistently throughout the watershed. 2. Recommend actions that contribute to healthy riparian areas and wetlands.
Biodiversity	Fish, wildlife, and plants are healthy and resilient to changing environmental conditions. Their ecological, social, and cultural roles in the watershed are sustained.	1. Identify appropriate land use targets and thresholds to better understand and track cumulative impacts on aquatic and terrestrial habitat. 2. Recommend best management practices and actions that improve wildlife habitat, health, and biodiversity. 3. Recommend appropriate actions to address the risks associated with invasive species.
Land Use	Cumulative effects of diverse land uses are reduced or mitigated to maintain and/or improve ecosystem health.	1. Recommend appropriate water and land management practices that mitigate impacts of industry and development (i.e., urban, recreation, agriculture, oil and gas, forestry, and sand and gravel extraction), and maintain and/or improve ecosystem health.
Climate Change	Climate change considerations are central to all watershed-related planning and decision-making processes.	1. Recommend climate actions and climate change mitigation and adaptation strategies related to watershed management for consideration by decision-makers, resource managers and residents.
Knowledge and Understanding	Indigenous Knowledge and scientific research guide decision-making.	1. Assess and prioritize knowledge gaps in the Beaver River watershed. 2. Recommend outreach materials and other tools to disseminate Indigenous Knowledge and scientific research related to watershed health.

7.0 INDICATORS, TARGETS AND THRESHOLDS

Indicators, targets and thresholds will be used to measure success in achieving watershed goals, objectives, and desired outcomes. Indicators are identified for major watershed values (Table 3). Indicators refer to an easily measurable attribute that reflects one aspect of the underlying condition or state of watershed health (ESRD 2012b). Examples of indicators include nutrient concentrations and riparian health scores. The indicators expand on those identified in the State of the Watershed Report (BRWA 2013). Criteria used to establish indicators included: relevance to the watershed, importance to residents and stakeholders, and measurability.

Targets and thresholds are numerical (quantitative) or written (qualitative statements) that reflect desired or achievable conditions of attributes used to measure watershed health. Targets are used to

determine how valued components in the watershed rate or compare to acceptable or desired ratings and/or conditions. Interim targets, thresholds and objectives may be established when comprehensive or local data is unavailable.

Recommendations in the IWMP will be reviewed using a social and economic filter. Watersheds should be liveable places and support thriving communities.

Table 3. Watershed condition indicators for the Beaver River watershed.

Value	Indicator	Measure	Significance
Water Quantity	Water Supply	Streamflow volume (deviation from the natural (baseline) condition)	Streamflow and water levels should reflect a normal range of conditions and support channel processes (erosion/bank building), aquatic life, the riparian environment, and communities.
		Lake water levels	Maintaining appropriate water levels supports: - Water supplies for communities - Recreation (boat access, beaches, fish habitat) - Aquatic life - Downstream needs for aquatic life and waste assimilation
		Water Conservation Objectives/Instream flows	Established to maintain a minimum flow in streams to support aquatic life or meet transboundary water apportionment.
	Water allocation and use	Water licences and registration; water use reports	Water supplies support aquatic life, communities, and economic activity.
	Groundwater	Water levels	Groundwater is an important water supply.
			Groundwater contributes to the overall water balance in watersheds.
Water Quality	Lake trophic status	Phosphorus, chlorophyll *a* and secchi disk measurements	Deviation from normal conditions (established through long-term trend analysis) suggests a change in water quality (e.g., a degradation or improvement). Surface water quality should support designated or desired end uses.
	Water chemistry	Dissolved oxygen, salinity, nutrients, metals (including arsenic), pathogens, and other toxins (pesticides). Concentration and/or load, spatial and temporal trends	
		Number of parameters and frequency that parameters exceed established guidelines or objectives	Guidelines and objectives are established to determine water suitability for a variety of uses (e.g., drinking water, contact recreation, crop irrigation, livestock water, aquatic life).
	Aquatic Life	Species diversity and abundance	Tolerance of benthic invertebrates and fish to water quality conditions differs among species.
	Water temperature	Optimum (range) and maximum (threshold) water temperature	Optimum and maximum water temperature tolerance should be maintained to support all life stages of aquatic life.

Value	Indicator	Measure	Significance
	Recreation	Number of water quality advisories posted per year	Posted water quality advisories indicate poor water quality and concerns for human health.
Riparian Areas and Wetlands	Riparian function (lotic systems)	Riparian health scores (condition)	Functioning riparian areas contribute to water supply, water quality, river channel and shoreline stability, and biodiversity.
		Intactness (condition, extent)	
	Wetland cover (lentic systems)	Percentage wetland area	
		Wetland loss	
		Impact thresholds (i.e., footprint on each wetland type)	
Biodiversity	Fish, Wildlife and Vegetation	Species composition (variety of seasonal and resident species)	Aquatic and upland systems that support a diverse group of native fish, wildlife, and plant species are more resilient to ecological adversity or changes to environmental conditions.
		Population estimates	
		Index of Biological Integrity	
		Regulated invasive plants, disturbance and rare plants	
		Percentage change in land cover (footprint, linear disturbance, critical habitat)	
		Watercourse crossings and stream connectivity.	Poorly placed or maintained crossings and culverts can increase sediment and erosion, and impede fish passage.
Land Use	Change to human footprint	Percentage change in land use cover (agriculture, forestry, oil and gas)	Monitors land use changes and quantifies cumulative impacts of multiple land uses in watersheds.
	Population	Census data	Important social and economic indicators for municipalities
		Growth rate	
	Recreation and Tourism	User data (day use, registrations)	Trends indicate whether pressure on resources is increasing, stable or decreasing.
	Access	Road density	High road densities can impact fish through increased sedimentation, impassable culverts that prevent upstream migration and increased harvest due to improved accessibility.

8.0 ENGAGEMENT PROCESS

8.1 Goal and Objectives

Watershed stakeholders, First Nations and the Métis were encouraged to participate in the development of the Beaver River IWMP to ensure relevancy, long-term viability, and collaborative implementation of the plan. Appendix A lists key stakeholders in the Beaver River watershed.

The following objectives guided the engagement process:

1. Involve stakeholders, First Nations and the Métis in the IWMP development process; seek input at key stages in the development of the IWMP
2. Share information about the IWMP, Beaver River watershed, and progress related to IWMP development

3. Identify and gather existing technical and scientific material to support the development of the IWMP, and address questions and concerns
4. Facilitate and establish a common public understanding of the hydrological, ecological, socio-cultural, and economic state of the Beaver River watershed and associated issues
5. Promote communication between agencies responsible for watershed management, stakeholders, First Nations and the Métis to maximize collaboration and effective stewardship of the Beaver River watershed.

8.2 Engagement Sessions

The IWMP Committee met with stakeholders during scheduled engagement sessions hosted at key stages in the development of the IWMP (Table 4). Stakeholders had the opportunity to provide input at virtual and in-person workshops, through online response forms, and by written letter or email submitted to LICA or the IWMP Committee during the designated time periods. Stakeholders, First Nations and the Métis were encouraged to contribute insight, ideas, and technical information to reflect community perspectives in the IWMP. "What We Heard" summary reports related to stakeholder engagement are posted on LICA's website (https://lica.ca/watershed/iwmp/).

Input gathered through engagement was considered alongside best scientific information and Indigenous Knowledge to develop credible recommendations for resource management.

Table 4. Engagement sessions hosted at key stages in the development of the Beaver River IWMP.[6]

Draft Terms of Reference (February-April 2021)	•Review intent and scope of the Beaver River IWMP •Review and confirm watershed condition, key issues and opportunities for watershed management •Review roles and responsibilities, work plan and schedule •Seek input into data availability: technical reports, research, knowledge
Draft #1: Indicators, Targets and Thresholds, Early Recommendations (March 2022)	•Review "What we Heard: Session I •Review and confirm draft indicators, targets and thresholds •Review and discuss preliminary recommendations
Draft #2: Recommendations and Implementation Strategy (June 2022)	•Review "What we Heard: Session II •Review, discuss and refine recommendations •Develop implementation strategy
Beaver River IWMP (October 2022)	•Presentation of the Final Beaver River IWMP •Summary of next steps

[6] The Beaver River IWMP Terms of Reference was drafted using previous planning initiatives related to the Beaver River IWMP 2014-2016 (Keess 2013; Keess 2014; Riemersma and Dolan 2016).

9.0 RECOMMENDATIONS AND IMPLEMENTATION TABLES

Recommendations are put forward to address issues and achieve the goals and objectives established in Section 6.2.2. Relevant recommendations from existing plans relevant to the Beaver River watershed were carried forward in this IWMP. New recommendations were developed collaboratively to address new matters, and to align with current initiatives, directions, and values.

9.1 Plan Administration

9.1.1 Adoption

a) The goals, objectives and desired outcomes in the Beaver River IWMP should be adopted by all stakeholders.

9.1.2 Governance

a) Recommendations should be considered in the development and update of municipal and provincial policies, procedures, and planning and development standards and guidelines.

b) An IWMP Implementation Committee should be struck to promote the implementation of the Beaver River IWMP within members respective sphere of influence. Committee members should respect, support and collaborate with other watershed stewards to achieve common goals and objectives for the Beaver River watershed, where possible.

c) IWMP Implementation Committee members should work with their respective colleagues in each jurisdiction to implement the Plan and achieve desired outcomes according to each jurisdiction's priorities.

9.1.3 Implementation and Review

a) All stakeholders having a role in implementation (Section 4.0) should review the recommendations and prioritize actions according to the guidance provided in the implementation tables. Some of the recommended actions may be accomplished by individual partners, while other actions may be undertaken collectively. The IWMP should be used to develop work plans that will support the active implementation of recommendations.

b) LICA should undertake an annual review of the Beaver River IWMP implementation progress to determine if the desired results of the Plan are being achieved.

c) Amendments to the IWMP may be made periodically by consensus of the LICA Board. Minor changes should be made at the discretion of LICA; fundamental changes (e.g., targets) should be brought to Stakeholders. The Plan should remain adaptive and flexible to respond to new information as it becomes available.

d) A more comprehensive review of the IWMP should occur every five years. At that time, the implementation status of the recommendations should be thoroughly reviewed; recommendations that have been achieved should be removed from the plan, new legislation,

policies, or plans should be documented, and new issues should be highlighted and addressed. LICA should lead the review and update of the plan in collaboration with stakeholders, First Nations and the Métis.

9.1.4 Communication with Stakeholders

a) LICA should assist in tracking IWMP implementation progress in collaboration with its partners and develop an annual IWMP implementation progress report to disseminate to stakeholders.

9.2 Water Quantity

9.2.1 Goals and Objectives (from Section 6.2)

Goal: Secure, reliable water supplies are available for desired uses (i.e., environmental, First Nations and Métis, municipal, agricultural, industrial, and recreational).

Objective 1. Review and determine the status of existing Water Conservation Objectives (WCOs) in the original CLBR WMP (Alberta Environment 2006a).

Objective 2. Review the need to establish WCOs for streams and lakes outside of the original CLBR WMP planning area.

Objective 3. Recommend strategies that encourage water conservation and how to achieve them.

Objective 4. Understand the status of current surface water and groundwater initiatives and recommend strategies to better manage the resource.

9.2.2 Targets and Thresholds

9.2.2.1 Existing 1969 Master Agreement on Apportionment

Water management in the Beaver River and the Cold Lake sub-basins must adhere to the Inter-provincial Master Agreement on Apportionment (1969) which states:

> "Sixty-eight percent (68%) of the natural flow of the Beaver River and Cold Lake basins must be allowed to flow to the adjacent province (Saskatchewan)."

9.2.2.2 Existing Cold Lake-Beaver River Water Management Plan

Water conservation objectives (WCOs) were recommended in the CLBR WMP (Alberta Environment 2006a) specifically for the Beaver and Sand rivers, and for May, Manatokan, Muriel, Reita and Tucker lakes (Table 4). In addition, general targets were established for other streams, lakes, and wetlands in the watershed. Targets relate to

i. Diversions and withdrawals for industrial use (namely steam injection) and municipal purposes (provisions for household and traditional agricultural use under the *Water Act* are summarized in Section 9.2.2.3)
ii. Licensed withdrawals (restrictions when water levels reach a particular threshold)

The existing WCOs presented in Table 5 are currently applied by Alberta Environment and Parks to support decision-making. This Beaver River IWMP supports the continued use of the established WCOs and targets.

Table 5. Established WCOs and targets for select rivers and lakes named in the CLBR WMP (Alberta Environment 2006a).

Application	Water Conservation Objectives and Targets	Objective
Rivers		
Beaver River	No diversions for steam injection purposes. Other diversions will be considered on a case-by-case basis, providing they do not harm these values and functions.	Protection of recreational values, fish populations, other freshwater aquatic life, and aquatic ecosystem functions.
Sand River		
Other Streams		
Lakes		
May	No licensed withdrawals.	Conservation of fisheries, wildlife, and recreation.
Manatokan		
Muriel		
Reita		
Tucker		
Other		
Cold River and Long Bay	The cut-off level for industrial diversions from Cold Lake is 534.55 m a.s.l. When this cut-off level is reached, municipal withdrawals shall also be reduced through the implementation of additional conservation measures.	Maintain access to critical fish spawning habitats.
Lakes and Wetlands	No long-term diversions (i.e., more than one year) for steam injection purposes from lakes and wetlands in the CLBR Basin outside Cold Lake. Other diversions from surface waters will be considered on a case-by-case basis, providing they do not harm these values and functions.	Protection of fish, wildlife and recreational values and aquatic ecosystem functions

9.2.2.3 Existing Household Statutory Right and Traditional Agricultural Registration

Under the *Water Act*, the Household Statutory Right provides for the use of up to 1,250 m^3 per year of water for human consumption, sanitation, and the watering of lawns, gardens, trees, and some animals. This water use must be associated with a household or dwelling place and the water must be sourced on or under the land where it is used. There is no document issued for household users who have priority over all other users in the basin.

When the *Water Act* was first proclaimed (1999), traditional agricultural users were encouraged to register their livestock use and establish priority within the prior allocation system. The Traditional Agricultural Registration is for water use within a farm unit of up to 6,250 m^3 per year for the purpose of raising animals or applying pesticides to crops. The water must be sourced on or under the land where it is used. A document provides a record of the registration including the location of the water source and a priority number (first date of use). Registrations differ from licenses in that they cannot be transferred to another location. The registration is similar to a license as it determines who is entitled to receive water first during a water shortage.

9.2.2.4 Recommended Surface Water Allocation Directive Targets

Uncertainty exists for the future condition of river flows and lake water levels in the watershed. This uncertainty stems from unknown developments that may be proposed and the impact that climate change and climate variability may have on watershed hydrology in the future.

Water Conservation Objectives (WCOs) and Instream Objectives (IOs) are administrative tools that are implemented by the Director appointed to manage water under Alberta's *Water Act*. Currently, no WCOs or IOs have been established for watercourses in the watershed to protect low flow conditions, except for the Beaver River in the Master Agreement on Apportionment (1969) (AEP, pers. comm.), and for select lake water levels in the CLBR WMP (Alberta Environment 2006a) (Table 5).

In the absence of a Ministerial Order, water management plan, water conservation objective, or an environmental management framework, the Surface Water Allocation Directive (SWAD) (GOA 2021) is applied and provides water allocation and use guidance for all new water licences across all sectors, including Temporary Diversion Licenses (TDLs), under the *Water Act.*

Consistent application of the SWAD (GOA 2021) in the Beaver River watershed is recommended to address the uncertainty of future water use (e.g., additional withdrawals) and its impact on low flow conditions (Table 6). An additional target related to natural variation is recommended to address high flow conditions that may impact lakeside communities where local infrastructures have been built on the floodplain (Table 6). Refer to Section 9.6.2.2 for the SWAD target related to wildlife.

Table 6. Application of the Surface Water Allocation Directive target to achieve low flow condition objectives, and recommended targets to maintain natural flow variation in the Beaver River watershed.

Condition	Target	Objective
Low Flow	In the absence of a Ministerial Order, consistently apply the Surface Water Allocation Directive (GOA 2021) where: i) A streamflow threshold of Q80 for headwater streams (Order 1-4) would be applied prior to approving temporary diversion license applications. Use mean annual discharge where possible as determined by the Alberta Flow Estimation Tool for Ungauged Watersheds and/or an evaluation of flow conditions at key WSC gauging stations. ii) When streamflow falls below Q80, withdrawal from the upstream smaller creeks (stream orders 1-4) are suspended. If flow at the key station continues to decrease below Q95 then stream orders 5 and 6 will be closed for diversion until sustainable flows are observed. iii) Water can be diverted from stream orders 7 and 8 with limitations to a cumulative diversion of 5%.	Future withdrawals should not impact the aquatic environment. Protection of water quality and aquatic life.
	A net increase in hydrologic connectivity where possible.	
Natural Variation	The number of unregulated streams and lakes in the watershed is maintained or increased.	Natural variability in streamflows and lake water levels support watershed health.
	A net decrease in flood damage from high water due to improved floodplain management.	Land use strategies are in place to minimize flood impacts on infrastructure.

9.2.3 Recommendations

9.2.3.1 General

a) In the absence of a Ministerial Order (specific advice or objectives), the Surface Water Allocation Directive (GOA 2021) should be used to provide consistent, predictable provincial water allocation guidance in the Beaver River watershed (Table 6).

b) No new dams (as described in the CLBR WMP) should be constructed for water storage and multiple uses in the planning area (Alberta Environment 1985; Alberta Environment 2006a).

c) As much as practicable, maintain hydrologic processes and connectivity in the watershed to minimize the potential to isolate lakes and wetlands from their catchment. Where water level drivers are understood, effort should be made to remediate hydrologic processes.

   Naturalizing water levels and restoring connectivity through the removal of weirs, dams and dykes that were built by humans should be carefully considered, particularly at waterbodies that have been modified in other ways to accommodate infrastructure such as railways and highways. Beaver management and the removal of natural dams is discussed in Section 9.6.3.5.

9.2.3.2 Groundwater

a) Continue to refine groundwater models[7] in the CLBR area as information from the CLBR groundwater monitoring network becomes available. Future efforts should consider:
   i. An integrated modelling tool (including groundwater, surface water, land cover and climate) to assess long-term trends and predict cumulative effects on water resources in the future.
   ii. Subwatershed-scale groundwater models to refine the current understanding of hydrological processes near key surface water features. This could include a desktop assessment of groundwater availability and use for specific aquifers to provide insight into the local water balance.

b) Alberta Geological Survey in partnership with AER should complete the mapping for deep groundwater availability and non-saline water use (south of Cold Lake) in the CLBR Basin.[8]

[7] There are two regional groundwater models relevant to the Beaver River watershed: a model for the Cold Lake Beaver River Basin (that covers the footprints of the CLBR Basin), and a model for the South Athabasca Oil Sands Area (a newer model that only provides partial coverage of the CLBR Basin). The current groundwater models were developed at a regional scale and only provide high-level regional information. The existing regional models can provide guidance on the overall long-term capacity of the groundwater system for withdrawals, but localized models are needed to refine the current understanding of water balance, and groundwater-surface water interactions.

[8] The Alberta Geological Survey used available regional models to determine groundwater availability based on the regional water balance. AER used this information to report on total allocations relative to availability at the HUC8 watershed scale. The allocated volumes were provided separately for "shallow" groundwater allocations obtained from within 150 m of the ground surface (vs) deeper groundwater allocations obtained from depths greater than 150 m. Estimates of groundwater availability and the ratio of allocation to availability is reported. The availability of deep groundwater is not currently reported for the area south of Cold Lake in the CLBR Basin.

c) There are 17 Groundwater Observation Well Network (GOWN) wells in the watershed (http://environment.alberta.ca/apps/GOWN/#). Most wells used to monitor water level and water quality are north of the Beaver River and east of the Sand River. Continue to monitor these wells, by collecting continuous water level data and annual water quality data. In addition to data storage in an online, interactive map that is publicly available, report on long-term trends and disseminate findings to the community every five years.

9.2.3.3 Lake Water Levels

a) Improve understanding of hydrological processes and drivers of fluctuating water levels for lakes and associated catchments to aid land use decision-making and stewardship.[9] Based on a preliminary assessment of available data (Appendix D), current trends show:
   - Declining water levels at: Mann, Skeleton, Manatokan, Charlotte, Jessie, and Muriel lakes
   - Increasing water levels at: Kehewin, Pinehurst, and Touchwood lakes
   - High variability in water levels at Mann, Marie, and Muriel lakes

b) Lake water levels on First Nation lands and Métis Settlements are generally not monitored. Explore opportunities to implement collaborative lake level monitoring programs with First Nations and the Métis, as well as at other lakes in the watershed, particularly those proposed for increased recreational use (GOA 2012a; GOA 2022a), and/or where fish habitat restoration is a priority.

9.2.3.4 Flood Mapping

Municipalities have observed that the magnitude of floods identified in maps that are submitted as part of the development application process (i.e., at the Area Structure Plan stage) tend to be underestimated. Flood maps that are developed using consistent methods are an important planning tool for municipalities.

a) Flood maps should be created for watercourses and lakes where development is occurring or planned using methods consistent with Provincial standards and include the full extent of the floodplain. The flood maps should be used as an early planning tool for municipal planners, to inform infrastructure design (ditch/culvert sizing), and to educate landowners and land managers about the risk of development in the floodplain. Priorities may include Crane (Moore) Lake, Moose Lake (due to many subdivisions), and Marie Creek.

[9] Lake water levels can vary depending on lake characteristics, interaction with groundwater, surrounding land cover, tributary characteristics, stream connectivity (impacted by anthropogenic and natural disturbance), climate change and climate variability. Fluctuating lake water levels are a concern for communities. While there is limited ability to manage natural flood and drought events, other factors impacting lake water levels may be managed.

9.2.3.5 Water Conservation

In 2003, the *Water for Life* strategy set a target to improve efficiency and productivity of water use in Alberta by 30% from 2005 levels by 2015. Since 2004, the Alberta Water Council (AWC) collaborated to evaluate and report on the contributions of Alberta's water-using sectors to water conservation, efficiency, and productivity (CEP) goals (AWC 2017). Alberta's seven major water-using sectors improved water use efficiency and productivity by 32% during the reporting period, exceeding the *Water for Life* target of 30% (AWC 2017).

a) Continue to encourage water conservation by all sectors to achieve *Water for Life Strategy* goals for CEP and to report progress. Consider summarizing progress related to CEP sector plan implementation for each major watershed to facilitate planning and reporting by Watershed Planning and Advisory Councils.

b) Encourage actions that can reduce household water use through the Keep Our Lakes Blue campaign (LICA 2019). A few actions include:
    - Water lawn or garden in the morning or evening to minimize evaporation
    - Landscape with native plants that will not need irrigation once established
    - Install a rain barrel to collect runoff from rooftops to use for watering gardens
    - Fix leaking faucets or pipes

c) Consider a study to investigate actual water used through Household Statutory Rights and Traditional Agricultural Use to inform water conservation efforts.

9.2.4 Implementation Table for Water Quantity

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.2.3.1 Low streamflows and lake water levels			
a) Consistently apply the SWAD	AEP	Consistently apply the SWAD when considering applications for new water licenses or the temporary diversion of water.	H
b) Water storage and the creation of new dams	AEP	Consider existing water supplies to meet the needs of water users in the Beaver River basin as demand increases.	H
c) Hydrologic processes and connectivity	AER; Alberta Transportation; CLAWR; Municipalities; Oil and Gas Industry; Agriculture Industry	Assess watercourses to determine where streamflow has been disconnected and the cause (e.g., roads, ditches, culverts, other). Determine the scale of impact on hydrology.	M
		Prioritize projects to restore hydrologic processes where the impact on hydrology and aquatic life is highest. Develop a site remediation plan and seek funding opportunities to restore connectivity.	
9.2.3.2 Groundwater			
a) Refine groundwater models	Alberta Geological Survey; AER; AEP; Industry; LICA; CLFNS; Municipalities	AEP should consider this recommendation as the regional Groundwater Management Framework is developed. Refer to existing groundwater numerical models where available (e.g., models for Muriel and Skeleton lakes (2008-2010), developed to understand declining lake water levels at that time).	H
		Identify priority lakes where groundwater-surface water interactions are of interest (e.g., Crane Lake).	M
		Establish specific objectives for the modelling efforts.	
		Gather additional data from stakeholders to support groundwater modelling efforts (e.g., industry seismic/reports mapping the groundwater, Environmental Impact Assessment work, local studies (e.g., Muriel Lake basin).	
b) Deep groundwater availability mapping	Alberta Geological Survey; AER	Continue with the provincial effort to map deep groundwater availability by completing the work for the Beaver River watershed.	M
c) GOWN wells	AEP	Continue to collect continuous water level data and annual water quality data at GOWN wells. Report on long-term trends and disseminate findings to the community every five years.	M
9.2.3.3 Lake Water Levels			
a) Improve understanding of hydrologic processes	AEP; LICA	Assess available water level data (preliminary assessment in Appendix D), and report on historic and current water level trends.	H

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
b) Monitor lake water levels of interest to First Nations and Métis	First Nations; Métis; AEP; LICA	Determine FN and Métis interests in lake and stream monitoring. First, identify culturally significant lakes[10]. Establish appropriate indicators to address interest, including lake water levels and water quality (Section 9.3).	H
9.2.3.4 Flood Mapping			
c) Flood mapping	AEP	Collaborate with partners (e.g., municipalities, LICA) to determine the need for floodplain maps at waterbodies and watercourses in the Beaver River watershed. Prioritize the list and systematically work to delineate floodplains and high-water marks.	H
	Municipalities	Establish flood mapping priorities for the watershed.	
		Submit a letter from all municipal Councils in the watershed to AEP's Technical Staff and River Engineers requesting mapping support. Note that AEP's River Engineers only complete floodplain mapping for watercourses, and do not establish high water marks at lakes. However, AEP hydrologists should be able to assist.	
9.2.3.5 Water Conservation			
a) Encourage water conservation by all sectors.	AWC; Industry; Agriculture	The AWC should continue to publish and disseminate the water conservation and efficiency performance reports to all sectors and LICA every five years.	H
b) Reduce household water use	Municipalities; LICA	LICA and municipalities should collaborate to establish water conservation performance targets for municipal water users as part of the Keep Our Lake Blue campaign (refer to Section 9.3.3.3). A 'friendly competition' could be struck among municipalities to help encourage participation.	M
	Residents and Landowners	Implement actions outlined in the Keep Our Lake Blue Campaign.	H
c) Household and agricultural water use reporting	AWC; Municipalities, LICA	Explore strategies for water use monitoring and reporting for household water users, and for agricultural water users.	L

[a]H=High Priority (implement in 1-3 years); M=Medium Priority (implement in 4-6 years); L=Low Priority (implement in 7-10 years)

[10] A lake may be viewed as culturally significant because it has been or is a source of subsistence fishing, where medicinal plants were or are grown and gathered, where a certain language is spoken, and/or has been or is being used as sacred traditional ceremonial grounds for the community.

9.3 Water Quality

Current and historic land cover and land use were examined to identify and explain the human influence on spatial and temporal patterns in water quality during the development of the Cold Lake-Beaver River Water Management Plan (Alberta Environment 2006a). The differences in productivity among lakes were attributed to the amount of disturbance in each lake's watershed. Increasing land disturbance was correlated with increased lake productivity as indicated by high total phosphorus concentrations (Alberta Environment 2006b). Water depth was also significantly correlated with lake productivity (as indicated by total phosphorus concentration); as water depth increased, productivity decreased (Alberta Environment 2006b).

In 2013, CPP Environmental (2013) identified potential suitable watershed-scale indicators that influence lake water chemistry. Relationships were derived between water quality of 25 lakes and lake morphometry, natural watershed metrics and land cover, and land use. Natural landscape features (e.g., lake depth) and indicators of human disturbance (e.g., agricultural intensity and disturbance associated with land use cover) were significantly related to nutrients, ions, and metals in lakes. Key findings:

- Nutrient concentrations and algal biomass tend to be higher in shallower lakes (Alberta Environment 2006b; CPP Environmental 2013)
- Landscape position influences salts and minerals; the higher the landscape position the more evaporation and climate are factors; the lower the landscape position, groundwater influences become the greater factors (CPP Environmental 2013)

Current water quality conditions of concern:

- Low dissolved oxygen in winter months (Beaver River)
- Elevated nutrient concentrations during the summer months (streams and lakes)
- Water quality impacts due to recreation (e.g., shoreline erosion, debris left behind from ice fishing activities)

9.3.1 Goals and Objectives (from Section 6.2)

Goal: Surface water and groundwater quality that is protected from contamination, maintained within the range of natural variability, and meets end-use criteria.

Objective 1. Establish Water Quality Objectives that are compatible with the Surface Water Quality Management Framework for watercourses having sufficient data available.

Objective 2. Establish Water Quality Objectives for major recreational lakes.

Objective 3. Identify stormwater management targets and Low Impact Development strategies to minimize development impacts on water quality (and quantity).

Objective 4. Identify appropriate land use, management, and stewardship strategies to maintain and/or improve water quality. (Also refer to Section 9.7)

9.3.2 Targets and Thresholds

9.3.2.1 Beaver River

General provincial water quality guidelines are established for livestock water, irrigation water, contact recreation and the protection of aquatic life for many physical, chemical, and biological parameters (GOA 2018a) (Table 7). These guidelines can be used to determine if water quality is meeting the quality necessary for irrigation, contact recreation and protection of aquatic life when site-specific water quality objectives are not available. Although the Cold Lake-Beaver River planning area was included in the Lower Athabasca Regional Plan (GOA 2012a), the Surface Water Quality Management Framework did not establish water quality objective triggers and limits for either the Beaver River or its major tributaries (GOA 2012a).

Site-specific water quality objectives for the Beaver River are defined by the Prairie Provinces Water Board (PPWB) in Schedule E of the 1969 Interprovincial Master Agreement on Apportionment. These objectives were last updated in 2021 (PPWB 2021) and apply to the Beaver River reach "Beaver Crossing to the Border" (Table 7; Appendix F.1).

9.3.2.2 Tributaries

Tributaries to the Beaver River: There is limited data available for tributaries of the Beaver River. Much of the data available is historic, and/or limited to a few samples per year. Historic data for the Sand River at the confluence with the Beaver River is available for the period 2003, 2010 and 2013 which represents the open season (April-October). The closed season (November-March) is represented by data collected in 2003, 2004, and 2014. This data was summarized in Table 8 and can be used to compare the historic conditions to current conditions if new monitoring programs are implemented.

Lake Tributaries: There is limited data available for streams that discharge to lakes in the Beaver River watershed with the exception of a few recent monitoring programs. A summary of existing water quality data for tributaries to Moose Lake is provided in Appendix F.3.

Data collected in future water monitoring programs at the Beaver River and main tributaries may be compared to the benchmark data, as well as to other applicable water quality guidelines to identify spatial and temporal trends (e.g., improving, stable or degrading). The results of the future water monitoring program should be used to establish comprehensive site-specific water quality objectives for tributaries not currently monitored by AEP, PPWB or LARA.

Table 7. Existing provincial guidelines (GOA 2018a) and water quality objectives (PPWB 2021) for select water quality indicators.

Indicator	Significance	Provincial Guidelines	Beaver River WQOs	
			Open	Closed
Physical/Routine				
Water Temperature, °C	Influences biochemical processes and metabolism of micro-organisms. Thresholds are important to various life stages of fish (See Section 9.6.2.1).	-	-	-
Dissolved Oxygen, mg/L	Indicator for aquatic life.	Acute: ≥5.0 Chronic: ≥6.5 Mayfly Emergence: ≥8.3; mid-May to the end of June	≥5.0	No Objective
pH, pH Units	Influences biochemical processes and has implications for aquatic life.	≥6.5 and ≤9.0	≥6.5 and ≤9.0	≥6.5 and ≤9.0
Total Dissolved Solids, mg/L	Indicator of ions in water.	Irrigation: 500 to 3500 Livestock: 3000	≤500	≤500
Specific Conductance, µS/cm	Can interfere with plant growth. An indicator of ions in water.	≤ 1,000: safe for irrigation >1,000 to <2,000: Possibly Safe ≥2,000: unsafe for irrigation	-	-
Total Suspended Solids, mg/L	Can transport nutrients and contaminants downstream, can bury fish spawning habitat, impact wear-and-tear of equipment, and reduce water treatment efficiency. May have regulatory requirements.	Maximum increase of 25 mg/L from background levels for short-term exposure (<24 hours). Maximum increase of 5 mg/L from background levels for long-term exposure (24 hours to 30 days).	3.0-48.8	3.0-48.8
Nutrients				
Total Phosphorus, mg/L	Stimulates plant growth in aquatic systems, implications for conveyance, recreation, and aquatic life.	**Where site-specific nutrient objectives do not exist:** Nitrogen (total) and phosphorus concentrations should be maintained to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen concentration, and recreational quality.	0.171	0.127
Total Dissolved Phosphorus, mg/L			0.060	0.060
Total Nitrogen, mg/L	Can stimulate plant growth. Nitrogen fractions can be a concern for potable water.		1.140	1.862
Nitrate as N, mg/L	Concern for potable water and can stimulate plant growth.	3 (chronic 30-d average) 124 (acute instantaneous maximum)	3	3
Bacteria				
Enterococcus spp. (qPCR), cce/100 mL	Bacterial contamination can impact human health via drinking water, irrigation and contact recreation.	<300 (Geometric Mean (30-d interval) <1,280 (Statistical threshold value, no more than 10% of samples should exceed over a 30-d interval)	-	-
Fecal Coliform Bacteria, cfu/100 mL		≤100	≤100	≤100

Table 8. Summary of historic water quality data for select parameters at the Sand River. Red text indicates that the value did not meet the provincial water quality guideline (Table 7).

Indicator		Sand River	
Parameter	Statistic	Open (N=8)	Closed (N=6)
Water Temperature, °C	Median	18.66	0.01
	Min	4.33	-0.33
	Max	21.75	0.09
Dissolved Oxygen, mg/L	Median	9.11	3.88
	Min	8.38	2.43
	Max	11.83	5.24
pH, pH Units	Median	8.14	7.29
	Min	7.87	7.03
	Max	8.57	7.55
Total Dissolved Solids, mg/L	Median	103	215
	Min	88	183
	Max	160	227
Specific Conductance, µS/cm	Median	188	329
	Min	162	202
	Max	291	406
Total Phosphorus, mg/L	Median	0.083	0.035
	Min	0.022	0.022
	Max	0.098	0.045
Total Dissolved Phosphorus, mg/L	Median	0.019	0.013
	Min	0.012	0.008
	Max	0.025	0.024
Total Nitrogen, mg/L	Median	1.000	1.000
	Min	ND	ND
	Max	ND	ND
Nitrate as N, mg/L	Median	0.002	0.019
	Min	0.002	0.002
	Max	0.019	0.200
Total Suspended Solids, mg/L	Median	31	2.5
	Min	1	0.5
	Max	58	3
Fecal Coliform Bacteria, cfu/100 mL	Median	-	-
	Min	20	-
	Max	70	-

9.2.3.3 Lakes

The provincial water quality guidelines provide a general target for nitrogen and phosphorus concentrations for lakes in Alberta (Table 7). Site-specific objectives can be established by assessing the trophic status of lakes to indicate productivity. Values associated with lake productivity indicators are reported by Nurnberg (1996) (Table 9). Chlorophyll *a* is an indicator used to measure phytoplankton (algae) suspended in water. The visibility of a Secchi disk at depth measures water transparency in a lake that is partly influenced by the presence of algae (Noton 1998).

Table 9 summarizes water quality targets for lakes. Site-specific targets should be developed for lakes that have a need for increased management and where sufficient water quality data is available. Table 10 lists the trophic status of lakes that have historically been monitored.

Table 9. Water quality targets for lakes in the Beaver River watershed (GOA 2018a and Nurnberg 1996).

Source	Target		
GOA 2018a	No increase in total phosphorus (or nitrogen) above historic conditions should occur at all lakes in the Beaver River watershed. Where nitrogen and/or phosphorus have increased due to human activity, develop lake-specific nutrient objectives and management plans where warranted.		
Beaver River IWMP	A reduction in external phosphorus load: Where a current nutrient budget exists and indicates anthropogenic impacts to water quality from external sources (e.g., from point-source discharge, recreational activity, other), efforts should be made to reduce the external phosphorus load.		
Water quality associated with trophic classes (Nurnberg 1996)			
Trophic Class	**Chlorophyll *a* (mg/m³)**	**Total Phosphorus (mg/L)**	**Secchi Depth (m)**
Mesotrophic	3.5-9.0	0.010-0.030	4 - 2
Eutrophic	9.0-25.0	0.030-0.100	2 - 1
Hyper-Eutrophic	>25	>0.100	<1

Table 10. Baseline trophic status condition of lakes in the Beaver River watershed (ALMS reports; AEP Trophic Graph). An asterisk indicates the lake is of community interest as identified during engagement.

Sub-Watershed	Oligotrophic	Mesotrophic	Eutrophic	Hyper-Eutrophic
	Increasing Productivity →			
Amisk		Amisk Lake North Buck ***Skeleton Lake North**** Whitefish Lake	***Long Lake**** ***Skeleton Lake South**** Floating Stone Lake Garner Lake Goodfish Lake ***Upper Mann Lake****	***Lower Mann****
Cold Lake		Cold Lake Primrose Lake - S Basin	Primrose Lake - N Basin	
Lower Beaver River		Angling Lake		
Manatokan/Jackfish		Bourque Lake	Tucker Lake	
Marie Creek		***Crane (Moore) Lake - ALMS**** Ethel Lake Hilda Lake ***Marie Lake****		
Moose Lake		Chickenhill Lake	Minnie Lake ***Moose Lake****	***Kehewin Lake****
Muriel Creek		Beartrap Lake Garnier (Bluet) Lake	***Muriel Lake****	Jessie Lake
Sand River - Lakeland		Pinehurst Lake Touchwood Lake Wolf Lake		
Upper Beaver		Elinor Lake	Beaver Lake Fork Lake Kinosiu Lake	

9.3.3 Preliminary Recommendations

9.3.3.1 Maintain, Improve and Protect Water Quality

a) Maintain and/or improve the water quality condition in lakes and streams by reducing external nutrient[11] and sediment inputs through BMP implementation and land use strategies appropriate to each sector (refer to Section 9.7).

b) Adopt riparian health targets and apply riparian setbacks to maintain functioning riparian areas and wetlands that contribute to improved water quality, stable streambanks, and reduced erosion in the watershed (refer to Section 9.4.2).

c) Retain wetlands. Mitigate loss or degradation of wetlands, and replace wetlands according to the Alberta Wetland Policy to maintain water quality (refer to Section 9.5.3.2).

d) Assess septic and sewage discharges to the Beaver River, tributaries, and lakes; upgrade systems that contribute to external nutrient loading to surface water using incentives where possible. Consider upgrading systems that connect with municipal infrastructure.

e) For new developments, municipalities should strongly consider municipal sewer and water for properties adjacent to lakes, as opposed to septic tanks or fields (similar to infrastructure upgrades at Lac La Biche).

f) Assess the need and interest for community source water protection plans to protect the quality and quantity of local water supplies as land use and climate changes.

9.3.3.2 Monitoring and Evaluation

Currently, AEP monitors three sites at the Beaver River: At Gravel Pit U/S AB_SK Border, At Hwy 892, and At Hwy 28 Near Beaver River Crossing. These sites satisfy the needs of the PPWB's WQO assessments. In addition to the lower reach of the Beaver River (downstream of Hwy 28), there is interest in water quality at the Beaver River upstream of the confluence with the Sand River to the headwaters. Additional water quality data collected at major tributaries to the Beaver River (e.g., the Sand River) and recreation lakes would help determine sources of nutrients or other parameters of concern.

In 2016, AEP established a Tributary Monitoring Network to sample surface water in smaller tributaries of major rivers to better understand environmental change associated with activities such as forestry, agriculture, urbanization, resource extraction, and climate change (GOA 2022b). However, none of the tributaries of the Beaver River are currently included in the program.

a) Implement a water monitoring program for major rivers that includes the mainstem Beaver River upstream of Hwy 28, and its major tributaries. Monitoring locations should correspond with Water Survey of Canada gauging stations where possible. Recommended sites are:

[11] At Ethel Lake, the external sources of phosphorus contributed about 32% of the load (12% attributed to residential areas, 15% to atmospheric deposition, and 5% to the inflow from other lakes. At Moose Lake (2017-2019), 80% of the P load originated from external sources; internal loads represented a large proportion (60-70%) of phosphorus loads during summer for the bays without large tributary inflows: Vezeau, Bonnyville Bay and Island Bay (Associated Environmental 2021).

- Upper Beaver River, including at Hwy 881
- Sand River
- Amisk River
- Martineau (Primrose) River
- Medley River

Objectives of the major river monitoring program should include to

i. Establish baseline conditions
ii. Evaluate current water quality conditions with respect to established guidelines and objectives
iii. Maintain long-term records to examine trends in the relationship to land cover, land use and climate change and climate variability
iv. Report and disseminate findings to the public to encourage stewardship

Water quality should be reported annually, and the monitoring program reviewed every three-to-five years.

b) Continue to monitor lake water quality in the watershed. Consider expanding the monitoring program to include lakes not currently monitored and where community interest is high (e.g., Fishing Lake). Integrate the Indigenous Lake Monitoring Program[12] and other ways of knowledge generation into the monitoring programs (refer to Recommendation 9.3.3.2 f).

Lake characteristics should be used to help refine monitoring programs. Consider unique features of individual lakes to identify parameters that reflect local geology, and/or historic and current land use that may influence water quality (e.g., sulphate resulting from fertilization of lakes with sulphur in the 1930s to increase fish production; lake mixing and internal nutrient sources – iron, sulphur, and phosphorus cycles).

Where possible, group similar lakes based on

- Lake depth (shallow (mixed) lakes vs. deep (stratified) lakes)
- Water residence times to indicate sensitivity (long residence time higher sensitivity, short residence time less sensitive)
- Landscape position: headwaters tend to be more productive
- Internal vs. external loading processes

c) Implement a lake tributary monitoring program with the objectives to:

- Establish baseline conditions
- Detect changes in water quality
- Inform lake nutrient budgets

Discharge (streamflow) measurements should accompany tributary water quality monitoring programs to better understand the nutrient load and flux.

d) Alberta Health Services should implement consistent monitoring programs and increase monitoring frequency at public beaches. Strive to disseminate the monitoring results to the community in a timely way, particularly when algae blooms are observed and cyanobacteria is a concern.

[12] The Indigenous Lake Monitoring Program was developed in response to Indigenous community concerns about the quality of lakes of local importance (AEP 2019a). Cold Lake First Nations and Whitefish (Goodfish) Lake First Nation #128 were part of this program at Cold Lake and Utikumasis Lake, respectively, in 2017-2018.

e) In addition to water chemistry, monitoring programs should consider other water quality indicators, including fish and benthic invertebrates. Explore the use of the Canadian Aquatic Biomonitoring Network (CABIN) protocol[13] for tributaries in the basin.

f) First Nations and Métis knowledge, gathered through cultural practices, lived experiences and observations (including multigenerational observations), lessons and skills can inform water monitoring programs and water quality condition reporting for lakes and streams in the watershed. Consider sharing this knowledge to better inform programs and stewardship activity in the watershed.

9.3.3.3 Lake Stewardship

a) Explore opportunities to support lake stewardship initiatives that improve and maintain water quality with residents and rural landowners. Keys areas of focus may include:
   i. Adopting programs such as Keep Our Lake Blue to encourage participation from all stakeholders.
   ii. Winter recreation impacts, including management of the input of debris from winter recreation activities.
   iii. Hosting Septic Sense Workshops.
   iv. Tree planting or shoreline restoration using bioengineering techniques.
   v. Promoting the use of BMPs by all sectors (refer to Section 9.7).

9.3.3.4 Groundwater

a) Consider monitoring water quality parameters that pose the highest risk to human health (e.g., arsenic).

b) Explore opportunities to create a community-based groundwater monitoring program for areas in the watershed where water level and/or water quality data is limited.

c) Assess the number of domestic abandoned water wells in the watershed and develop a plan to decommission sites with incentives.

d) Host 'Working Water Well' workshops. As part of the program, teach rural residents how to properly maintain and/or abandon water wells.

e) Industrial remediation and reclamation activities should meet end-use criteria according to current requirements outlined in the Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines (AEP 2019b; AEP 2022) (refer to Section 9.7.3.4.2).

   If the contamination levels in soil and groundwater exceed levels in the remediation guidelines, the company must remediate to meet the levels in the guidelines. Soil remediation is not limited to the surface; contaminants at any depth must not exceed the levels in the guidelines.

[13] The Canadian Aquatic Biomonitoring Network is a monitoring program developed by Environment and Climate Change Canada that provides a standardized sampling protocol and recommended approach to assess aquatic ecosystem conditions, which includes benthic macroinvertebrates.

9.3.4 Implementation Table for Water Quality

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.3.3.1 Maintain and Improve Water Quality			
a) Reduce external nutrient and sediment inputs	AEP; AER; AAF	Encourage the use of beneficial management practices and monitor and report compliance with existing regulations on Crown Land.	H
	Municipalities	Minimize the potential for erosion at stormwater discharge locations. See 9.3.3.5.	
		Develop integrated stormwater management policies that support low impact development.	
	Industry	Apply industry best practices as recommended and/or according to regulation. See 9.3.3.2 Agriculture, 9.3.3.3 Forestry, 9.3.3.4 Oil and Gas.	
	Landowners	Manage shoreline property to reduce impacts on lakes.	
b) Adopt riparian targets and setbacks	GOA	See Section 9.4.	H
	Municipalities; Industry	Incorporate riparian health targets and setbacks into land use bylaws.	
c) Retain wetlands, mitigate loss	GOA; Municipalities; All Industry	See Section 9.5.	H
d) Assess septic and sewage discharge	Alberta Health Services	Collaborate to understand and document the occurrence of septic/sewage discharge or leakage to surface water. Establish an incentive program to upgrade old systems that may be leaking. Inform landowners of the impact leaking septic systems have on water quality.	H
	Municipalities		
	LICA		
	Landowners	Prevent septic leakage and/or nutrient rich runoff water from fertilized lawns from reaching surface water.	
e) Municipal services in new developments	Municipalities	Determine the feasibility of supplying municipal water and sewer infrastructure to new developments, particularly those developments that are adjacent to lakes.	H
f) Source water protection plans	AWC	Share information with WPACs regarding the web-based system being created to support small communities develop source water protection plans.	H
	AWC; LICA	Work with LICA to host training workshops and share information with communities in the Beaver River watershed.	
	Municipalities; First Nations; the Métis	Explore opportunities to complete source water protection plans. Participate in training workshops if possible.	
9.3.3.2 Monitoring and Evaluation			
a) Monitoring the Beaver River and its tributaries	PPWB	Continue to monitor three sites on the Beaver River, and to report on discursions and trends. Share results with LICA and other watershed stakeholders.	H
	AEP	Include Beaver River tributaries in the provincial Tributary Monitoring Network.	
	LICA; AEP, WSGs; All Industry; Academia	Coordinate partners to secure funding for the monitoring program. Funds may be sought through grant programs or partner contributions.	

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
		Identify and prioritize sites to include in the program.	H
		Establish a list of parameters and other indicators that should be monitored.	
		Implement the program.	
		Refer to the water quality objectives and historic water quality summaries in Table 6, Table 7, and Appendix F when evaluating and reporting on water quality conditions.	
b) Lake water quality	ALMS; AEP; LICA; WSGs; Academia	Continue to monitor lake water quality in the watershed. Host a meeting with the community to present results, and discuss additional program opportunities (e.g., other lakes, water quality indicators, etc.).	H
c) Lake tributary water quality	LICA; AEP; WSGs; Industry; Academia	See actions for 9.3.3.2 a.	H
		Prioritize lake tributary monitoring programs using the criteria established in (Appendix E), considering available historic water quality data.	
	AEP; WSC; LICA; WSGs; Academia	Access Water Survey of Canada (WSC) streamflow data to use in the assessment of water quality at major tributaries to the Beaver River. Where WSC does not collect streamflow data, consider measuring streamflow either at the time of sampling or continuously using appropriate instruments.	H
d) Monitoring public beaches	Alberta Health Services	Identify priorities for beach monitoring in the Beaver River watershed with stakeholders. Follow the Alberta Safe Beach Protocol[14] to monitor beaches and disseminate results to the community.	H
	LICA; Municipalities	Collaborate with Alberta Health Services to communicate the results of the beach monitoring to the community. Consider reporting updates on websites and social media.	
e) Water quality indicators	LICA; AEP; WSGs; Industry; Academia	Coordinate partners in a meeting to discuss water quality indicators to use in the long-term monitoring program.	H
f) Knowledge sharing	First Nations; the Métis	Consider sharing knowledge with watershed stakeholders, landowners, and residents to help inform water monitoring programs and watershed conditions reports.	H
9.3.3.3 Lake Stewardship			
a) Support stewardship initiatives	LICA	Host a meeting with Partners to discuss the implementation of the Keep our Lakes Blue campaign. Present an annual report to the public regarding the successes of the program. Identify actions that could increase the success of the program (e.g., contests, awards, etc.).	H
	Municipalities; Summer Villages; WSGs	Participate in planning meetings to discuss lake stewardship programs.	
		Encourage residents and landowners to be lake stewards.	

[14] The Alberta Safe Beach Protocol outlines the provincial program to assess and manage the public health risks associated with recreational waters throughout Alberta. It specifies recreational water quality standards designed to protect bathers primarily from microbiological risks and, where applicable, from physical and chemical risks.

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.3.3.4 Groundwater			
a) Groundwater water quality indicators	Oil and Gas Industry; AHS; Academia; LICA	Collaborate to identify a list of groundwater parameters to monitor in support of community-based programs.	M
b) Community-based monitoring	Academia; LICA; Industry; LICA	Lead the development of a community-based monitoring program.	M
c) Industrial reclamation	Industry	Refer to Section 9.7.3.4.2.	-
d) Abandoned water wells	LICA (Partners: AEP; AAF; AHS; municipalities; watershed stewardship groups)	Host groundwater working well workshop(s).	H
		Coordinate partners and create an inventory of abandoned water wells using community surveys.	M
e) Working water well workshops and well decommissioning		Secure funding from federal and provincial programs to properly decommission abandoned water wells. Prioritize those wells that may be located in vulnerable aquifer areas. Promote a water well abandonment program.	M

[a]H=High Priority (implement in 1-3 years); M=Medium Priority (implement in 4-6 years); L=Low Priority (implement in 7-10 years)

9.4 Riparian Areas

Riparian areas are the transition zones between upland and aquatic environments. As such, they provide critical hydrologic, ecologic, social, and economic functions in watersheds. Riparian areas trap and store sediment; build and maintain banks and shores; store water and energy; recharge aquifers; filter and buffer water and moderate water temperatures; reduce and dissipate energy, and support biodiversity. Riparian areas have significant value to First Nations as they support a variety of plants that are spiritually and culturally important, as well as primary habitat for many wildlife species.

Three common methods to assess riparian health have been used in the Beaver River watershed: riparian health inventory, aerial videography, and riparian intactness assessment[15] (Table 11). All methods rely on riparian health indicators to determine the status of the condition. Indicators, including vegetative cover, tree and shrub establishment, and human disturbance are used to indirectly evaluate the ability of a site to perform ecological functions. Although riparian condition reporting varies between methods, riparian areas rated 'unhealthy, poor, or low intactness', or 'healthy, good or high intactness' tend to have similar characteristics. Refer to Appendix G.1 for a list of indicators and their significance in riparian health assessment, as well as a summary of the current riparian conditions in the watershed.

Table 11. Summary of riparian condition assessment methods used in the Beaver River watershed.

Method	Description	Best Condition	Impacted	Degraded
Riparian Health Assessment	Ground-based field assessment	Healthy	Healthy but with Problems	Unhealthy
Aerial Videography	Photo interpretation	Good	Fair	Poor
Riparian Intactness Assessment	GIS-Based Assessment	High Intactness	Moderate Intactness	Low Intactness

9.4.1 Goals and Objectives (from Section 6.2)

Goal: Healthy riparian areas and wetlands contribute to watershed resiliency with respect to flood and drought, quality water, and critical habitat.

Objective 1. Establish riparian management indicators, targets and thresholds that are recognized and applied consistently throughout the watershed.

Objective 2. Recommend actions that contribute to healthy riparian areas and wetlands.

9.4.2 Targets and Thresholds

There is evidence that increasing land use disturbance results in poorer water quality and fewer recreation opportunities in lakes, among other lost benefits. Targets and thresholds are used to minimize degradation and maintain key riparian functions to maintain water quality and recreation opportunities. Targets and thresholds identified in Table 12 were established using literature and available data, including the riparian intactness assessment to develop targets for riparian **extent** (% intactness).

[15] Intactness ratings are intended to support a screening-level assessment of management priorities across broad geographic areas. The GIS-based assessments should be used along with more detailed, site-specific field assessments of riparian conditions (Fiera Biological 2021b).

Table 12. Proposed targets and thresholds to manage riparian areas in the Beaver River watershed. A combination of riparian extent, condition and setback measures should be applied.

Measure	Method	Watershed-Wide Target	Watershed-Wide Threshold
Federal, Municipal, First Nations and Métis Lands			
Extent (% Intactness)	Riparian Intactness Assessment	≥75% of the assessed riparian area at watercourses and waterbodies is rated 'high intactness' [a]	≤10% of the riparian area at watercourses and waterbodies rate 'very low + low intactness'
Condition (Score)[b]	Riparian Health Assessment and Inventory	Riparian areas rate healthy (Score ≥80)[c]	Riparian areas rate healthy but with problems (Score ≥60); ≤10% of riparian areas score unhealthy or poor (<60%)
Setbacks (Buffer Width)[d]	Cold Lake Subregional Plan (GOA 2022)	New permanent footprint is not permitted within 250 m of the bed and shore of named waterbodies and the valley break of named watercourses in the planning area (including the Beaver River).	
	Fixed-Width	≥50 m minimum [e]	30 m [h]
	Setback Guidelines (GOA 2012b)	20 m to 60 m + Slope qualifier [f]	
	Riparian Setback Matrix Model (Aquality 2012)	Variable based on site conditions [g]	
Pressure[i]	Riparian Intactness	No net increase in the pressure score of local catchments adjacent to streams.	
		A net increase in the cover of natural vegetation (e.g., forest) and/or wetlands adjacent to streams within High Pressure catchments.	
Industry			
Extent, Condition, Pressure	See Above	Apply Extent, Condition and Pressure targets and thresholds.	
Setbacks	Industry Requirements/Standards	Adhere to industry provincial requirements and standards (Appendix H). Generally, a minimum 100 m setback from waterbodies and watercourses applies to the oil and gas and forestry industries on Crown Land.	

[a] Environment Canada (2013)

[b] Function Score: Riparian areas that score ≥ 80 are not pristine; the target accounts for minor disturbance.

[c] Riparian Health Inventory Scores: Healthy (Score>80); Healthy but with Problems (Score 60 to 79); Unhealthy (Score <60) (Fitch et al. 2001).

[d] Industry should abide by standards set out in relevant legislation (refer to Appendix H.3 for agriculture, Appendix H.4 for Forestry, and Appendix H.5 for Oil and Gas

[e] City of Cold Lake (Appendix H.2); Note that industry has requirements for fixed widths that differ.

[f] Stepping Back from the Water (GOA 2012b)

[g] Requires a Professional Biologist or QWAES to apply the model, a land surveyor and others as required.

[h] A minimum environmental reserve setback of 30 m from either the top of the bank of a river or stream or the high-water mark of a lake applied as established in the MD of Bonnyville's Municipal Development Plan (2007).

[i] Pressure scores may be assigned that broadly characterizes the existing condition of local catchments as it relates to type of land cover and intensity of land use present. These catchments and their associated scores provide general measures to assess and track land use and land cover changes through time (Fiera 2021a).

9.4.3 Recommendations

9.4.3.1 Riparian Area Condition

a) Adopt the riparian area **extent** and **condition** targets presented in Table 12. Efforts should focus on decreasing the percentage of riparian areas in the 'very low + low intactness' and 'unhealthy' categories and increasing the percentage of sites in the 'high intactness' and 'healthy' categories in priority areas through time.

b) Establish a riparian condition monitoring strategy that includes:
   - The completion of a riparian intactness assessment for each of the main subwatersheds in the Beaver River watershed.
   - Periodic re-visits to monitor riparian health at previously assessed sites to determine progress in achieving watershed goals.

9.4.3.2 Riparian Protection

a) At the time of subdivision, development setbacks should be applied consistently to waterbodies and watercourses (e.g., lakes, rivers, creeks) to maintain important riparian functions in the watershed (Table 12). Setbacks should be applied to new developments at the time a development permit is issued by the municipality.

   A minimum setback of 50 m should apply from the top of the bank of waterbodies and watercourses. This should consist of 30 m Environmental Reserve (ER) dedication (as required by the MDP), with the balance of 20 m taken as Environmental Reserve (ER), Municipal Reserve (MR) and/or conservation easement.
   - The 30 m should commence from the 1 in 100-year flood line unless a discernable top of bank exists beyond this.
   - The embankment is often geotechnical containment and therefore the 50 m setback shall commence beyond this.
   - To enable the determination of top of bank setbacks, a top of bank survey for the subject watercourse is a condition of a development permit.[16]

b) Development in the floodplain should be discouraged.[17] Consider developing flood maps (refer to Section 9.2.3.4), that includes a GIS overlay delineating the ER and MR at the lakeshore to support application review processes and decision-making.

c) Municipalities should develop riparian policies to maintain functioning (healthy) riparian areas in the watershed. Riparian policies should indicate activities that may be permitted or restricted in riparian areas. Consider the following permissible activities in the riparian setback[18]:
   - Existing uses, buildings, and structures
   - Existing roads and pathways
   - Public utility installations and facilities

[16] City of Cold Lake LUB 382-LU-10

[17] Existing municipal bylaws state: No development shall be permitted within the 1 in 100-year flood line of any lake, river or creek as established by AEP (City of Cold Lake LUB 382-LU-10; MD of Bonnyville MDP 2007).

[18] Adapted from the Town of Cochrane's Watershed Protection and Water Management Bylaw 2005.

- Maintenance and repair of existing infrastructure
- Existing recreational facilities and associated surface parking
- Existing parks and playgrounds
- Passive recreational uses (e.g., walking); pathways constructed from hard surfaces should be avoided where possible
- Natural areas
- Interpretive signage
- Existing agricultural operations, provided they comply with existing regulations (e.g., runoff regulations); agricultural BMPs should be applied (see Section xx)
- Approved water supply wells or wells and associated technology used for livestock watering

d) Except permitted activities, no further development (including stormwater ponds) or site alteration should be permitted within the riparian setback, thus maintaining riparian lands in their natural state. In a natural state, riparian functions are preserved.

e) Setbacks related to agricultural activities, including manure storage, manure application, and seasonal feeding and bedding sites, are established and regulated through the *Agricultural Operations Practices Act* (*AOPA*). The application of Inorganic fertilizer is indirectly regulated by the *Environmental Protection and Enhancement Act* and pesticide use, application, and storage or washing of equipment is regulated through The *Environmental Code of Practice for Pesticides* and administered by AEP. The agricultural industry should abide by provincial setbacks and established application regulations and Codes of Practice. Refer to Appendix H.3 for agricultural related setbacks.

f) Timber harvest is regulated by legislation (*Forests Act* and Timber Management Regulation). The forestry industry should abide by the setbacks outlined in the Alberta Timber Harvest Planning and Operating Ground Rules (GOA 2022b). Refer to Appendix H.4 for forestry-related setbacks.

g) The oil and gas industry is regulated by the Alberta Energy Regulator. The oil and gas industry should abide by the setbacks outlined in the Integrated Standards and Guidelines: Enhanced Approval Process (GOA 2012c) and apply industry respected practices (IRPs). Refer to Appendix H.5 for oil and gas related setbacks.

h) Continue to seek clarification regarding the implementation of the CLSRP (GOA 2022a) setbacks.

i) At the lake or stream level, a shoreline protection policy should be implemented that protects ≥75% of the shoreline according to Table 12.

j) At the lot level, a shoreline protection policy and regulation should be implemented to protect trees and other natural vegetation on ≥75% of the land area within a 30-metre shoreline setback (or other recommended width) on new residential lots. Encourage this practice on existing residential lots.

9.4.3.3 Riparian Conservation

a) Riparian conservation opportunities exist for all lakes in the Beaver River watershed. Consider policy, planning and conservation measures to conserve high quality riparian areas (where intactness scores are ≥90%). Consider the following conservation recommendations (from Fiera 2021a):
   i. Incentivize voluntary conservation of riparian habitat on private land through payment for ecosystem services, changes to tax regimes, or other BMP programs,
   ii. Develop education and outreach programs to encourage stewardship and conservation of riparian habitats on private land,
   iii. Secure high conservation priority riparian habitats through purchase or through other land securement mechanisms available to conservation groups, land trusts, or municipalities,
   iv. Develop provincial, municipal and/or First Nation development setback and riparian land management policies,
   v. Create a municipal habitat conservation and restoration fund to allow for the securement of high priority riparian conservation areas.

b) Unnamed Lakes (located on Crown Land) generally have high riparian intactness[19]. These lakes should be mapped in provincial and municipal planning documents and provided special designation through planning, policy, and conservation tools.

c) Explore Ecological Goods and Services Programs to encourage riparian area and wetland conservation (e.g., Alternative Land Use Services (ALUS) program, Land Trusts, conservation easements) in agricultural areas.

9.4.3.4 Riparian Restoration

Natural and anthropogenic pressure within local catchments was evaluated to identify riparian areas that may be functionally impaired due to surrounding land use activities (Fiera Biological 2021a). A low level of intactness was attributed to hardened shorelines and was most often associated with shoreline development within urban municipalities and highly valued recreational lakes. In the Upper Beaver watershed, increased pressure was noted in catchments dominated by human disturbance related to agriculture, forestry, and resource extraction activities (Fiera Biological 2021b).

a) For existing developed areas, explore opportunities to restore shorelines to meet the riparian intactness target and threshold (Table 12).

b) Measures should be taken to improve streambank and shoreline vegetation at priority lakes and watercourses, particularly those that did not meet the riparian intactness target and threshold (Table 13). Consider the following criteria to further refine priorities for restoration:
   i. Riparian areas that are of spiritual or cultural significance to First Nations and support the exercise of Treaty Rights (e.g., gather plants, trap)
   ii. Riparian areas or littoral zones that support key fish habitat (i.e., spawning areas)

[19] For the Jackfish-Muriel sub-basin, 14 of 15 unnamed lakes had "high intactness" (100%) (Fiera Biological 2021a). Similarly, in the Upper Beaver watershed 38 of 54 unnamed lakes had "high intactness" ratings (≥90%) (Fiera Biological 2021b).

iii. Degradation of the riparian area is a known contributor to poor lake water quality
iv. Riparian areas that do not meet the target (≥75% high intactness) AND the threshold value (≤10% low + very low intactness)
v. Resource availability

c) Use field validation methods such as the riparian health inventory (Fitch et al. 2001; Ambrose et al. 2004) to determine site details contributing to low condition ratings at priority sites.

d) Explore the use of the following tools to achieve restoration goals:
   i. Incentives for riparian habitat restoration on private land through payment for ecosystem services, changes to tax regimes, or other BMP programs (Fiera 2021a).
   ii. Education and outreach programs to encourage private land restoration, particularly for landowners located upstream of flood prone areas.
   iii. Partnerships with conservation organizations to promote and encourage restoration on private lands.
   iv. Creating a municipal habitat conservation and restoration fund to pay for riparian habitat restoration on public lands, with a specific focus on restoring areas identified as Very Low or Low Intactness.

e) Industry should consider the list of restoration priorities in Table 13 and support community initiatives to restore sites.

Table 13. Summary of sites assessed in the riparian intactness assessments that did not meet the target and/or threshold (≥75% High Intactness and ≤10% Very Low + Low Intactness; Table 12) (modified from Fiera Biological 2021a, 2021b). Sites shaded grey may be considered priorities for restoration, with those shaded green being the highest priority. Note that priorities may differ by stakeholder and their affiliation to the waterbody or watercourse. Refer to Appendix G.2 for additional site assessments (e.g., unnamed lakes) and site details.

Waterbody or Watercourse	Length Assessed (km)*	Proportion (%) of Shoreline in Each Intactness Category			High Restoration (%)
		Very Low + Low	Moderate	High	
		%	%	%	
Allday Lake	3.6	48	4	49	47
Amisk River	207.9	15	10	75	11
Amisk River-01	96.4	18	11	71	15
Amisk River-04	15.7	28	1	71	25
Amisk River-05	7.8	3	30	66	1
Beaver River	285.3	23	20	57	17
Beaver River-01	11.5	29	9	62	29
Bunder Creek	76.5	18	25	58	17
Bunder Creek-01	8.7	31	29	39	27
Bunder Creek-02	9.5	33	28	39	23
Bunder Lake	30.5	14	15	72	10
Chappell Lake	8.2	15	6	80	15
Cole Lake	9.2	58	0	41	16
Columbine Creek	80.5	31	24	45	31
Denning Lake	8.2	30	11	59	22
Floatingstone Lake	17.4	18	7	74	13
Floatingstone Lake-01	10.5	46	33	21	46
Garner Lake	16.6	28	11	61	28

Waterbody or Watercourse	Length Assessed (km)*	Proportion (%) of Shoreline in Each Intactness Category			High Restoration (%)
		Very Low + Low	Moderate	High	
		%	%	%	
Greenstreet Lake	7.9	12	20	68	0
Little Garner Lake	4.1	72	1	27	72
Lone Pine Lake	8.3	22	6	73	14
Long Lake-03	3.9	12	2	85	2
Mooselake River	0.2	0	41	59	0
Owlseye Lake	6.7	38	20	42	38
Reed Lake	20.1	68	9	24	67
Skeleton Lake	24.8	13	18	69	5
Snail Lake	6.7	30	2	68	30
St. Lina Creek	89.4	20	30	50	19
St. Lina Creek-01	7.3	14	13	74	13
St. Lina Creek-02	20.6	55	22	24	55
St. Lina Creek-03	13.3	70	22	8	70
Victor Lake	4.6	25	0	75	25
Victor Lake-01	21.7	26	9	65	13
Whitefish Creek	54.0	12	13	75	10
Whitefish Creek-01	4.8	56	24	19	43
Whitefish Creek-02	74.7	14	2	84	7
Whitefish Creek-03	14.4	17	11	72	14
Whitefish Lake	26.9	11	5	84	7
Jackfish Creek	131.4	16	7	77	14
Ethel Lake	11	11	17	72	
Manatokan Lake	12.8	24	9	66	23
Osborne Creek	32.3	7	20	72	3
Jessie Lake	16.6	33	35	33	36
Kehewin Lake	25.2	18	12	69	12
Moose Lake	67.5	20	13	66	15
S. Trib of Kehewin Lake	13.3	8	27	65	
S. Trib of Kehewin Lake-01	10.6	27	53	20	28
Charlotte Lake	27.3	73	23	4	70
Landry Lake B	1.9	32	37	32	
Muriel Creek	88	52	12	36	51
Muriel Lake	51.5	13	19	68	10
Reita Creek		16	7	77	14

9.4.4 Implementation Table for Riparian Areas

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.4.3.1 Riparian Area Condition			
a) Adopt targets and thresholds	AEP; AAF; AER	Adopt riparian area condition targets for Crown Land and integrate targets in industry codes of practice and/or operating standards and guidelines.	H
	Municipalities	Adopt the riparian area condition targets and include them in applicable policy and planning documents.	
b) Riparian condition monitoring	LICA	Develop a strategy to prioritize riparian health assessment work in the watershed.	H
	LICA; Municipalities; WSGs;	Host a workshop with shoreline owners to present riparian health assessment methods and encourage them to complete a self-assessment using incentives.	
9.4.3.2 Riparian Protection			
a) Development setbacks b) Development in the floodplain	Municipalities	Determine the potential impact of riparian setbacks on landowners adjacent to recreation lakes and watercourses.	H
		Specify and apply development setbacks to lakes, rivers, creeks, and ephemeral and intermittent streams at the time of subdivision .	
		Develop a tool that clearly shows the riparian setback delineation.	
	Municipalities; Realtors; Lawyers	Establish a communication strategy for development setbacks to ensure they are implemented and respected in developments.	
		ER and MR provide community access to the lake and should be disclosed at the time of sale/purchase. Explore opportunities to educate lawyers and real estate agents of ER and MR that exist on private lands (e.g., place ER and MR on land titles so the buyer is aware).	
	Landowners	Identify riparian setbacks on all site plans submitted to the appropriate jurisdiction for permitting. A development permit should only be approved after the delineation of the riparian setback is completed.	
c) Riparian policy	Municipalities	Develop a riparian policy, if one has not been created, to guide planning and manage future development on municipal riparian lands.	H
d) Permitted activities in riparian areas	Municipalities	Consider the list of permitted activities in riparian areas. Update applicable land use bylaws to include permitted activities.	H
e) Agricultural setbacks	AAF	Develop and share resources related to agricultural responsibilities outlined in *AOPA*.	H
	Agricultural Industry	Adhere to established agricultural setbacks regulated by *AOPA* (Appendix H)	
f) Forestry setbacks	AAF	Monitor harvest practices to ensure setback compliance.	H
	Forest Industry	Adhere to forestry setbacks established in Northeast Alberta Timber Harvest Planning and Operating Ground Rules (GOA 2018a) (Appendix H).	
g) Oil and gas setbacks	AER	Monitor oil and gas activities to ensure setback compliance.	H
	Oil and Gas Industry	Adhere to oil and gas activity setbacks established in the Integrated Standards and Guidelines: Enhanced Approval Process.	

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
h) CLSRP setbacks	AEP	Clarify expectations regarding riparian setbacks in the CLSRP and communicate these to municipalities, industry and landowners in the watershed.	H
i) Regional shoreline protection policy	AEP; Municipalities	Develop a policy to maintain ≥75% of shoreline habitat.	H
j) Lot level shoreline protection policy	Municipalities	Explore opportunities to maintain ≥75% of shoreline at the lot level using policy and incentives. Tools available to municipalities include: i. Environmental Reserve ii. Conservation Easements (refer to Greenaway 2017 for more information regarding Conservation Easement as a tool for municipalities) iii. Incentives for voluntary conservation including payment for ecosystem services, changes to tax regimes, or other BMP programs	H
9.4.3.3 Riparian Conservation			
a) Riparian conservation	GOA; Municipalities	Update Figure 10 in the CLSRP (GOA 2022) to include names of the named waterbodies and watercourse where the 250 m setback applies.	H
b) Unnamed lakes	GOA	Explore the use of Protected Notation and/or Consultative Notation to protect and/or conserve critical shoreline habitat on Crown Land.	M
c) Ecological Goods and Services	LICA	Organize a forum with Municipalities, GOA and non-government organizations to explore opportunities to provide incentives for riparian management.	M
9.4.3.4 Riparian Restoration			
a) Restoration to achieve targets and thresholds	AEP	Resource managers should prioritize restoration activities on Crown Land where riparian intactness scores are <75%. Consider popular Crown Land recreation areas.	M-H
	LICA; Municipalities; WSGs;	Use available riparian condition data (e.g., the riparian intactness assessment, riparian health inventories/assessments) to further prioritize sites for restoration.	M-H
		Identify partners interested in restoring riparian function on private lands.	H
	First Nations; Métis	Share information with LICA regarding restoration priorities.	M-H
b) Refine restoration priorities	LICA; Municipalities; WSGs	Use field validation methods (e.g., riparian health assessments) to refine priorities and establish restoration plans for priority sites. On private lands, field technicians may interact with landowners and residents to heighten awareness and increase riparian literacy.	H
c) Riparian health assessment/inventory	Cows & Fish; LICA; WSGs	See 9.4.3.1 b.	H
d) Explore administrative tools	LICA; Municipalities	Evaluate administrative tools that could help to restore riparian areas.	H
e) Industry support for community restoration projects	LICA; LICA's Industry Steering Committee	Develop a list of restoration priorities in collaboration with stakeholders, First Nations and the Métis, and seek support for projects.	M-H
	All Industry	Seek opportunities to collaborate in restoration projects.	

[a]H=High Priority (implement in 1-3 years); M=Medium Priority (implement in 4-6 years); L=Low Priority (implement in 7-10 years)

9.5 Wetlands

About 33% of the Beaver River watershed is considered wetland, with ecologically significant areas of poorly drained fens and swamps found in the northern part. Ducks Unlimited Canada classified the water and wetland features: Fens comprised 46.5% of wetland area; swamps represented 23.5%, marshes represented 4.5%; bogs 3%; and open water 22.5% of wetlands (BRWA 2013).

9.5.1 Goals and Objectives (from Section 6.2)

Goal: Healthy riparian areas and wetlands contribute to watershed resiliency with respect to flood and drought, quality water, and critical habitat.

Objective 2. Recommend actions to conserve intact riparian areas and wetlands, and to restore areas that rate unhealthy or poor condition or have low intactness.

9.5.2 Targets and Thresholds

All wetlands contribute to the health of the Beaver River watershed and should be retained. Efforts should be made to retain wetlands, avoid impacts to all wetlands through design, and to mitigate impacts where avoidance is not possible.

9.5.3 Recommendations

9.5.3.1 Wetland Inventory and Valuation

The Alberta Wetland Policy defines wetland values based on functional groups (Table 14). The Alberta Wetland Evaluation Tool (ABWRET-A) provides guidance regarding wetland values, however, assigning values to wetlands remains a challenge for land managers. In the boreal ecosystem, many wetlands are interconnected below ground and the hydrology of these systems is not well understood. Carbon storage potential should also be valued as an important wetland function.

Table 14. Wetland value functional groups based on the Alberta Wetland Policy (AEP 2013).

Wetland Value Functional Groups		Value Category
Biodiversity and Ecological Health	Wetlands are dynamic, complex habitats that contribute to biodiversity and other ecological functions.	A (High)
Water Quality Improvement	Wetlands improve water quality by facilitating sedimentation and filtering pollutants.	B (Moderate)
Hydrologic Function	Wetlands help reduce flooding and soil erosion by storing runoff and slowing its downstream release. They are also important as areas of groundwater recharge and discharge.	C (Moderately Low)
Human Uses	Wetlands support multiple human activities (e.g., recreation, and education) and have varying degrees of cultural significance.	D (Low)
Relative Abundance	The relative abundance of wetlands in an area strongly affects the sensitivity of an area to the effects of further wetland loss.	

a) Complete a detailed wetland inventory for the watershed using the enhanced wetland classification method.

b) Identify tools to assist with wetland valuation, considering the Alberta Wetland Policy and criteria established in the ABWRET-A. Establish a comprehensive inventory of high-valued wetlands in the watershed based on hydrological, ecological, and cultural values.

c) Consider the Biodiversity Valuation Calculation Matrix (DUC 2017) to examine the biodiversity value of specific wetland types to species-at-risk in the watershed.

9.5.3.2 Wetland Retention

a) To maintain high valued wetlands (Category A and B based on wetland value functional groups in Table 14), adopt a policy to avoid impacts to wetlands (through project redesign or relocation). If avoidance cannot occur, minimize impacts to the greatest extent possible using mitigation strategies (BMP implementation during planning and operation). Replacement should apply when wetlands are permanently lost according to the Alberta Wetland Mitigation Directive (GOA 2018b).

   To the extent possible and as highest priority, encourage that wetland replacement is applied in the same sub-watershed relative to where the loss occurred (GOA 2018b).

b) Similar to riparian areas, apply appropriate development setbacks in the watershed to maintain hydrologic function (flood and drought protection), water quality, and biodiversity functions on the landscape. Refer to Appendix H for industry related setbacks.

c) Explore opportunities to establish a carbon credit system as a tool to retain wetlands on the landscape.[20]

9.5.3.3 Wetland Mitigation

a) Consider resource road construction and maintenance practices that mitigate impacts on wetland environments (Ptartington et al. 2016), including but not limited to:
   i. Size and space culverts to promote hydrologic connectivity
   ii. Apply minimal disturbance practices by crossing wetlands when soils are frozen
   iii. Use wide tires on gravel trucks to reduce compaction and improve load-bearing capacity
   iv. Source fill materials from outside wetlands to maintain wetland hydrology
   v. Monitor and repair roads (e.g., rutting, perched/sunken culverts, excessive erosion)

b) In agricultural areas, minimize impacts to wetlands:
   i. Retain temporary wetlands in pastures and cropland to provide early spring breeding habitat for wildlife
   ii. Maintain or restore permanent cover (e.g., perennial forages for hay) in low-lying (wet) areas to provide habitat

[20] Wetlands remove more carbon dioxide from the atmosphere and incorporate it into vegetation and soil compared to forest or upland prairie ecosystems. A study by The Conservation Fund found that wetlands store 81 to 216 metric tons of carbon per acre, depending on their type and location. Carbon credit generally refers to a certificate or permit that allows the purchaser to offset their greenhouse gas emissions through the capturing or sequestering of carbon in the trees and soil, rather than it being released into the atmosphere. One carbon credit represents the reduction of one metric tonne of carbon dioxide or its equivalent in other greenhouse gases.

iii. Avoid cultivating near the edge of wetlands
iv. Maintain, restore, or enhance riparian vegetation for flood and drought mitigation, water quality, and wildlife habitat
v. Delay mowing and haying of grassed waterways and other wet areas until mid-July to reduce nesting losses and fawn mortality. Use a flushing bar when haying
vi. Provide alternative water to livestock to deter the use of wetlands by livestock and to prevent soil compaction in low-lying areas. Use temporary or permanent fencing around wetlands.

9.5.4 Implementation Table for Wetlands

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.5.3.1 Wetland Inventory and Valuation			
a) Detailed wetland inventory	LICA; AEP; DUC	Access the Alberta Merged Wetland Inventory data layer and create the detailed wetland inventory map for the watershed.	H
	Lac La Biche County	Share the local wetland inventory data with LICA, and others as requested, to support the creation of a detailed wetland inventory for the watershed.	
b) Wetland valuation	CLAWR; AEP; AAF; LICA	Collaborate to develop a detailed wetland valuation. Apply the Alberta Wetland Policy methodology to assign values to wetlands. Generate a map that shows wetland values as a decision support tool for use by municipalities and industry.	H
	AEP	Assist LICA and municipalities to assign values to wetlands in the watershed according to the Alberta Wetland Policy and Alberta Wetland Rapid Evaluation Tool	
	Municipalities	Consider the wetland valuation early in the planning process. Note that the value of wetlands may change, and wetlands may need to be re-evaluated closer to the application date.	
c) Biodiversity Valuation Calculation Matrix	DUC	Apply the Biodiversity Valuation Calculation Matrix to the Beaver River watershed.	H
9.5.3.2 Wetland Retention			
a) Maintain high-valued wetlands	AEP	*Any work within a water body requires Approval under the Water Act. Wetland retention and compensation are considered in AEP's decisions.*	H
		Review MDPs at an earlier stage so opportunities to retain wetlands are not lost. Consider if the wetland is provincially "Crown claimable" or if decisions can be deferred to the local authority.	
		Address the timeliness of the application review process for wetland restoration projects under the *Water Act* where clear benefits to the watershed were identified (e.g., ecological health, biodiversity, water quality improvement, hydrologic function, and human uses).	
	Municipalities	Develop policy, procedures, and strategies to ensure that wetland management is integrated into urban planning and development, and water resource management.	H

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
	LICA; Municipalities	Collaborate with Land Trust organizations, Ducks Unlimited Canada, Nature Conservancy Canada, and others who have an interest in the preservation of wetlands.	H
b) Development and industry setbacks	All	See implementation actions 9.4.3.2 Riparian Protection	H
c) Carbon credit system	Industry	Explore opportunities to offset carbon production by investing in carbon credits through federal and/or provincial programs, or programs aimed at preservation of ecological goods and services (e.g., ALUS).	L
9.5.3.3 Mitigation			
a) Road construction	GOA; Industry; Municipalities	Refer to available guidance to mitigate the impacts of road construction on wetlands.	H
b) Agricultural activity	Agricultural Industry	Apply grazing and cropping BMPs to maintain wetlands on agricultural land.	H

[a]H=High Priority (implement in 1-3 years); M=Medium Priority (implement in 4-6 years); L=Low Priority (implement in 7-10 years)

9.6 Biodiversity

The watershed is a significant recreational fishery for the province, accounting for 25% of the annual provincial harvest (BRWA 2013). Fish are vulnerable to lake level fluctuations and the effects on shoreline vegetation, which provide spawning and feeding habitat for adults and rearing habitat for young fish. Low lake levels can result in loss of habitat that increases the risk of fish kills in summer and winter. Lake fisheries can also be impacted by surrounding land use in the watershed, particularly where nutrients and other contaminants drain uncontrolled into lakes (BRWA 2013). In the Beaver River, fish diversity and abundance are impacted by poor habitat conditions that include low streamflow velocities, poor water quality (low dissolved oxygen and high nutrient concentrations), and poor riparian conditions.

Fish communities in the Beaver River watershed are summarized in Table 15. Key lake fishes important to First Nations, the Métis and recreational fishermen include Lake Whitefish, Northern Pike, and Walleye.

Marie Lake: Poor translation of the Cree word for the place *methai*, pronounced merai, which translates as a fish (Harrison 1994).

Moose Lake: Known to early French-Canadian fur traders as lac d'Orignal, meaning Moose Lake. This may have been a direct translation of the local Cree name of the same meaning, Mōswa sākahikan (Atlas of Alberta Lakes).

Table 15. Fish community in the Beaver River watershed.

Waterbody/Watercourse	Fish Community
Lakes (general)	Cold-water Fish: Lake Cisco, Lake Trout and Lake Whitefish, with Lake Trout only found in Cold Lake Cool-water Fish: Burbot, Northern Pike, Walleye and Yellow Perch.
Upper Beaver River	Fish species tolerant of degraded habitat (i.e., White Sucker and a few minnow species). It is thought that more sensitive species (i.e., Walleye, Northern Pike and Spottail Shiner) may have been present in the Upper Beaver River in the 1950s
Lower Beaver River Upstream of the City of Cold Lake	Dominated by White Sucker and Lake Chub. Fish species diversity tends to be greater upstream of the City of Cold Lake and includes Burbot, Northern Pike, Walleye and Yellow Perch. There is likely an influx of better-quality water discharged from the Sand River to the Beaver River that supports these cool-water fishes.
Lower Beaver River – Downstream of the City of Cold Lake	Only species that are more tolerant of degraded habitat conditions were observed downstream (e.g., White Sucker, Brook Stickleback) (BRWA 2013). Fish captured furthest downstream had a higher prevalence of infection and parasites indicating habitat stress (BRWA 2013).

9.6.1 Goals and Objectives (from Section 6.2)

Goal: Fish, wildlife, and plants are healthy and resilient to changing environmental conditions. Their ecological, social, and cultural roles in the watershed are sustained.

Objective 1. Identify appropriate land use targets and thresholds (e.g., stream crossings and linear features) to better understand and track cumulative impacts on aquatic and terrestrial habitats.

Objective 2. Recommend best management practices and actions that improve wildlife habitat, health, and biodiversity.

Objective 3. Recommend appropriate actions to address the risks associated with invasive species.

9.6.2 Targets and Thresholds

9.6.2.1 Fish and Fish Habitat

9.6.2.1.1 Index of Biological Integrity (IBI)

The IBI was used to assess the condition of aquatic ecosystems at 47 locations on the Beaver River, Amisk and Sand rivers (Cantin and Johns 2012). Indicators used in the assessment included: fish composition and size, road density, riparian condition, and water quality. Many sites in the upper Beaver River were rated in poor condition. These results are consistent with riparian condition findings (see Section 9.4) where riparian health scored poorly in the same reaches. At the Sand River, ratings were somewhat better, generally ranging from average to good, with few areas rating fair (Cantin and Johns 2012). Sites at Amisk rated poor to fair. A high IBI would suggest that conditions were suitable for aquatic life. Table 16 identifies targets for IBI scores.

Table 16. Fish and fish habitat targets.

Indicator	Target
IBI Scores	>90% of IBI scores rate high for a given stream.
	Improve IBI scores at the Amisk and Beaver River.
Lake FSI Scores	Fish habitat is restored, and fish harvest is in balance with a sustainable fish population.
	No lakes have fish species listed as Functionally Extirpated (Refer to Table 17)
	A decrease in the number of lakes that have Northern Pike or Walleye populations listed as High or Very High Risk to sustainability (Refer to Table 17)
Species Composition	The Upper and Lower Beaver River support a sustainable, cool-water fishery.
	Maintain a sustainable Lake Trout population in Cold Lake.
	Consider smaller fish and other food sources for sportfish as indicators of the health of the system.
Water Temperature	Water temperature should be maintained within the optimum range described in Table 18 for select fish species. A general water temperature of ≤20°C is recommended. Refer to Section 9.3 for additional water quality targets.
Stream Connectivity	Achieve ≥90% stream connectivity in sportfish streams, with 100% connectivity in the mainstem reaches of third-order streams and higher.

9.6.2.1.2 Fall Index Netting and Fish Sustainability Index

Fall Index Netting methods are used by Alberta Environment and Parks to monitor the status of fish populations (i.e., Northern Pike and Walleye). Fall index netting typically occurs during late summer and fall when water temperatures are between 10 and 15°C when fish are known to be more evenly distributed within the lakes (https://www.alberta.ca/fall-index-netting-overview.aspx#).

Fish Sustainability Index (FSI) is the provincial fish-population assessment measure. It evaluates provincial fish status by assessing numerous metrics that are grouped into three main categories:

- population integrity
- productive potential of the habitat
- threats and their mitigation

Indicators are summarized into scores that are reported as a risk rating, from very low risk to very high risk to the fish population (refer to Appendix I for FSI index risk thresholds for Walleye and Northern

Pike). Scores for the most recent FSI assessments in the Beaver River watershed are summarized in Table 17. Targets for FSI scores are established in Table 16.

Table 17. Most recent risk sustainability rating for lakes monitored in the Beaver River watershed. A rating of 'Low' indicates a low risk to fish population sustainability, a rating of 'Very High' indicates a very high risk to the fish population.

Sub-Watershed	Waterbody	Northern Pike	Walleye
Amisk	Amisk Lake	High (2019)	Low-Moderate (2019)
	Goodfish Lake	Very High (2020)	Very High (2018)
	Long Lake	Low (2020)	Low (2020)
	Skeleton Lake	Moderate-High (2020)	Moderate-High (2020)
Manatokan / Jackfish Creek	Tucker Lake	Very Low (2019)	Not Reported
Marie Creek	Crane Lake	Moderate-High (2018)	Very High (2018)
	Ethel Lake	Low (2017)	Moderate (2017)
	Marie Lake	Very High (2020)	High (2020)
	May Lake	High (2019)	High (2019)
Moose Lake	Chickenhill Lake	Extirpated (2019)	-
	Kehewin Lake	High (2018)	High (2018)
	Moose Lake	Moderate-High (2020)	High (2020)
	Muriel Lake	Extirpated (2012)	Extirpated (2012)
Sand River-Lakeland Region	Pinehurst Lake	Very High (2020)	High (2020)
	Touchwood Lake	High (2019)	High (2019)
	Wolf Lake	High (2018)	-
Upper Beaver River	Beaver Lake	Very High (2016; 2018)	High (2016; 2018)
	Elinor Lake	High (2020)	Low (2020)
	Ironwood Lake	High (2019)	Moderate-High (2019)

9.6.2.1.3 Water Temperature

Continuous water temperature data is not available for the Beaver River or its tributaries. However, monitoring at the lower reach of the Beaver River (2016-2020) recorded an average maximum temperature of 22.87°C, with 10% of observations greater than 20°C (Average 90th percentile value of 20.2°C) (refer to Appendix F.2 for current Beaver River conditions). Water temperature targets are identified in Table 19.

9.6.2.2 Wildlife

The Surface Water Allocation Directive (SWAD) provides protection for wildlife sensitive to human disturbance and changing water levels (GOA 2021). For lakes and standing water bodies, important breeding sites for trumpeter swan, piping plover and colonial nesting birds (American white pelican and great blue heron) should be protected by consistently applying the timing restrictions identified in the SWAD or by using site-specific timing information where available (Table 18).

Table 18. Target restriction for wildlife species sensitive to human disturbance (GOA 2021).

Sensitive Wildlife Species	Breeding Season	Target Restriction
Trumpeter Swan	April 1 – Sep 30	No water diversions during the breeding season.
Colonial nesting birds	April 15 – July 31	
Piping plover	April 15 – July 31	

Table 19. Summary of water temperatures required for key sport fish species in rivers and lakes in the Beaver River watershed. Temperatures in **green** are optimum temperatures for growth. Temperatures in **black** are the tolerance range (sub-optimum growth at the lower and upper extreme temperature). Temperatures higher than the upper tolerance range may result in mortality for all life history components and cessation of spawning. Temperatures lower than the lower tolerance range may result in reduced growth for all components, cessation of spawning and increased mortality for incubating eggs and newly-emerged fry.

Species	Egg Incubation	Egg Incubation Timing	Fry	Juvenile	Adult	Spawning	Spawning Timing	Reference
Burbot (*Lota lota*)	**4 - 7°C** **1 - 7°C**	30 days: February to April	NA	**16 - 18°C** **8 - 23°C**	**16 - 18°C** **1 - 23°C**	**1 - 2°C**	February to March (under ice)	1, 2
Lake Trout (*Salvelinus namaycush*)	**5°C** **0.3-10°C**	100 - 150 days: September to January	**12°C**	**6 - 13°C** **0 - 18°C**	**<10°C** **0 - 18°C**	**10°C** **8 - 11°C**	September to October	1, 2, 3, 5, 10
Lake Whitefish (*Coregonus clupeaformis*)	**3 - 6°C** **0 - 12°C**	42 - 182 days: October to April	**14°C** **12 - 20°C**	**14 - 20°C**	**8 - 14°C** **0 - 22°C**	**3 - 6°C** **0 - 7°C**	late-September to January	1, 2, 3, 5, 10
Northern Pike (*Esox lucius*)	**6 - 15°C** **3 - 17°C**	14 days: mid-April to mid-May	**21 - 26°C** **6 - 26°C**	**26°C** **6 - 33°C**	**19 - 21°C** **0 - 29°C**	**6 - 12°C**	April to early-May	1, 5, 9
Walleye (*Sander vitreus*)	**9 - 15°C** **6 - 19°C**	17 - 21 days: mid-April to mid-June	**22°C** **13 - 28°C**	**22 - 28°C** **15 - 31°C**	**20 - 23°C** **0 - 28°C**	**6 - 12°C**	April to May	1, 2, 5, 6, 7, 8, 11
Yellow Perch (*Perca flavescens*)	**10°C** **7 - 20°C**	8 - 14 days: late-April to late-May	**3 - 28°C**	**19 - 24°C** **6 - 31°C**	**19 - 24°C** **6 - 31°C**	**7 – 12°C**	mid-April to early-May	2, 3, 4
Note: Where temperature data is not available for 'fry' component, use temperature data from 'juvenile'.								

References:

1 - Ford *et al.* 1995
2 - Joynt and Sullivan 2003
3 - Scott and Crossman 1973
4 - Krieger *et al.* 1983
5 - Nelson and Paetz 1992
6 - AEP 1996b
7 - Carlander 1997
8 - McMahon *et al.* 1984
9 - Inskip 1982
10 - McPhail 2007
11 - Clapp *et al.* 1997

9.6.3 Recommendations

9.6.3.1 Fisheries

a) Determine local and regional goals, and update fisheries management objectives for lake fisheries in the watershed through conversation with First Nations, the Métis, anglers, and the public. Design and implement effective regulations and management tools to achieve these goals.[21]

b) Implement effective sport fishing regulations, with goals of recovering fisheries and providing more sport fishing opportunities.[21] Consider the potential to develop a 'catch-and-keep' fishery at lakes to support tourism and recreation opportunities and the local economy.

c) Fall Index Netting program reports should include additional key species in lakes (e.g., Burbot, Yellow Perch, Whitefish) that are captured during the fishing effort.

d) Consider other methods to monitor fish populations. Complete angler effort surveys to understand angling pressure and harvest from key lakes of interest in the watershed (e.g., creel surveys), and consider electrofishing at streams.

e) Increase knowledge and understanding among land managers and lake users about the relationships between development, water quality and healthy ecosystems to support the conservation of clean water and healthy fisheries.[21]

9.6.3.2 Fish Habitat and Restoration

a) Continuous water temperature data should be collected at several locations in the Beaver River to assess current fish habitat conditions. Sites may be located downstream of the Amisk River, Downstream of Sand River, upstream of the City of Cold Lake, and downstream of the City of Cold Lake.

b) Identify key drivers of high-water temperature (e.g., lack of riparian vegetation, water diversion or discharge) and develop a strategy to mitigate the impact.

c) Conduct fish spawning surveys to identify lake areas that should be protected from future development, and/or recreation activity during critical spawning periods.

d) Lakes that have been closed to fishing should be assessed to determine the cause of the fishery decline and if the cause of impact has been resolved. Consider restoring a fishery at these lakes if habitat conditions are suitable (refer to 9.6.3.1 b), or enhancing habitat conditions where feasible.

[21] Adapted from Northern Pike (Lakes) FSI, GOA website Northern Pike (Lakes) FSI | Alberta.ca, last accessed Sep 13, 2022.

9.6.3.3 Watercourse Crossings and Stream Connectivity

Studies have shown that as the number of stream crossings increase, fish habitat tends to degrade. Poorly constructed and/or poorly maintained watercourse crossings can result in habitat fragmentation, habitat degradation, and barriers to fish passage. Streams impacted by stream crossings tend to have poor water quality and increased sedimentation. There are an estimated 1,395 watercourse crossings in the Beaver River watershed (WorleyParsons 2012). To increase the availability of productive fish habitat, consider the following:

a) Limit new stream crossings, particularly culverts, and improve existing crossings to ensure fish passage (i.e., single-span bridges or open-bottom channels) according to the Watercourse Crossings Management Directive (AEP 2020).

b) Engage stakeholders and land users in the monitoring of watercourse crossings using the Alberta Watercourse Inventory (ABWCI) App to improve the inventory in the Beaver River watershed. Priority subwatersheds where additional assessment is warranted may be directed to those classified as having "Elevated Disturbance" in the previous watercourse crossing assessment (WorleyParsons 2012) and may include the Upper Beaver River, Moose Lake, Muriel Lake, Reita Creek and Redspring Creek subwatersheds (Appendix J).

c) Create and implement a watershed-wide stream crossing remediation plan including inspection and assessment output, fish passage ratings, sediment/erosion assessment, restoration/replacement priorities, planned remedial work, and timelines (AEP 2020).

   Prioritize sites for stream crossing restoration so stream crossings that fully impede fish movement with the highest sediment load are given a higher priority for remediation or replacement. Consider the hanging culvert assessment and inventory (Worley Parsons 2012) as a starting place.

9.6.3.4 Shoreline Management (Littoral Zone)

a) Shorelines (the littoral zone) provide critical habitat for fish and waterfowl. These shorelines should be inventoried and managed to maintain critical habitat, particularly spawning areas and identified Important Bird Areas. Consider key lakes of interest, including the Long Bay area of Cold Lake, the islands of Moose Lake, and French Bay.

b) Administrative tools should be identified and implemented to manage lakeside development and limit future loss of shoreline habitat. The location and type of development should be assessed alongside shoreline function. Tools may include:
   I. Master planning, shoreline zoning, and development plan review that considers dynamic shoreline processes and protects ecological functions provided by shores
   II. Development setbacks and vegetated buffers adjacent to streams, wetlands, and lakes (Refer to riparian recommendations in Section 9.4.3)
   III. Limits on continuous hard surfaces (e.g., retaining walls) to minimize erosion of neighbouring properties. Natural shorelines dissipate wave energy and minimize erosion.
   IV. Requirements for restoration of the littoral zone where necessary

V. Lot clearing criteria for new developments (e.g., limit lot clearing to improve views to 30% of the property area, in addition to maintaining ≥75% of lot shoreline at the lot level)
VI. Encourage yard management strategies that maintain shoreline functions
VII. Identify and promote best practices for marinas

c) Manage human-induced shoreline erosion by establishing wake-free zones and/or posting speed limits in areas most vulnerable (e.g., shallow water adjacent to the exposed shoreline). Maintain a near-shore speed limit to reduce the suspension of bottom sediments and shoreline erosion induced by wave action.

9.6.3.5 Beavers

Beavers are generally beneficial to watersheds as the dams they create store water in surface and groundwater reservoirs, increase open-water area, aid riparian vegetation, and slow water velocity to reduce streambank erosion and trap sediment. While beavers contribute to watershed health, they can be a nuisance when their activity impacts infrastructure. Efforts have increased in recent years to identify tools that can be used to mitigate the impacts of beaver activity on infrastructure, to allow humans to better coexist with them on the landscape. Tools include fencing of desired trees to prevent harvest, use of repellents/deterrents, and water level controls (Fitch 2016).

a) Determine the occurrence of beavers where there is community concern (e.g., Moose Lake).

b) Explore tools to manage beaver activity where it has impacted infrastructure and hydrologic connectivity (also refer to Recommendation 9.2.3.1 c). Prior to removal, beaver dams should be assessed by a qualified professional to understand potential impacts and recommend management strategies.

9.6.3.6 Cormorants

The double-crested cormorant (*Phalacrocorax auritus*) is a migratory bird that breeds in the northern hemisphere, nesting in trees or on the ground on islands at waterbodies across Alberta. Cormorants consume up to 20% of their body weight in fish per day (AEP 2021). These birds feed on fish species that are easiest to catch and will fly up to 30 – 60 km from their nesting colony to feed. Cormorants can negatively affect fisheries populations when the number of cormorants feeding exceeds the fish resources available in the area (AEP 2021). In the Beaver River watershed, concerns regarding cormorant populations and their impact on local fisheries vary by waterbody.

The following recommendations are modified from the current Cormorant Management Program Activities (AEP 2021):

a) Determine cormorant numbers in the Beaver River watershed (current program extent is the Bonnyville area) and establish a management program to reduce the population size in problem areas as needed.

b) Complete fish community assessments on waterbodies to determine the number and size of fish and any population trends (the current program is confined to the Moose Lake area) (also refer to Recommendation 9.6.3.1 d).

c) Strive to better understand cormorant population dynamics and life strategies in the Beaver River watershed:
   i. Complete movement surveys to determine where cormorants are coming from and where they are feeding.
   ii. Collect and analyze cormorant diet samples to determine what the birds are feeding on.
   iii. Identify other birds that co-nest with cormorants; inventory and implement mitigation measures to prevent disturbance to these species.

9.6.3.7 Key Wildlife and Biodiversity Zones

a) The Beaver River, Sand River and several other areas are indicated as key wildlife and biodiversity zones in the watershed (Figure 5). These areas should be managed to maintain quality habitat:
   i. Avoid development in key wildlife and biodiversity zones
   ii. Minimize and mitigate impacts from future development when it cannot be avoided
   iii. Plan future tourism and recreation to avoid sensitive areas (refer to 9.7.3.5 a)
   iv. Implement riparian and wetland management recommendations (Sections 9.4.3, 9.5.3)

b) Effort should be made to restore habitat where human footprint has already encroached on sensitive areas within key wildlife and biodiversity zones.

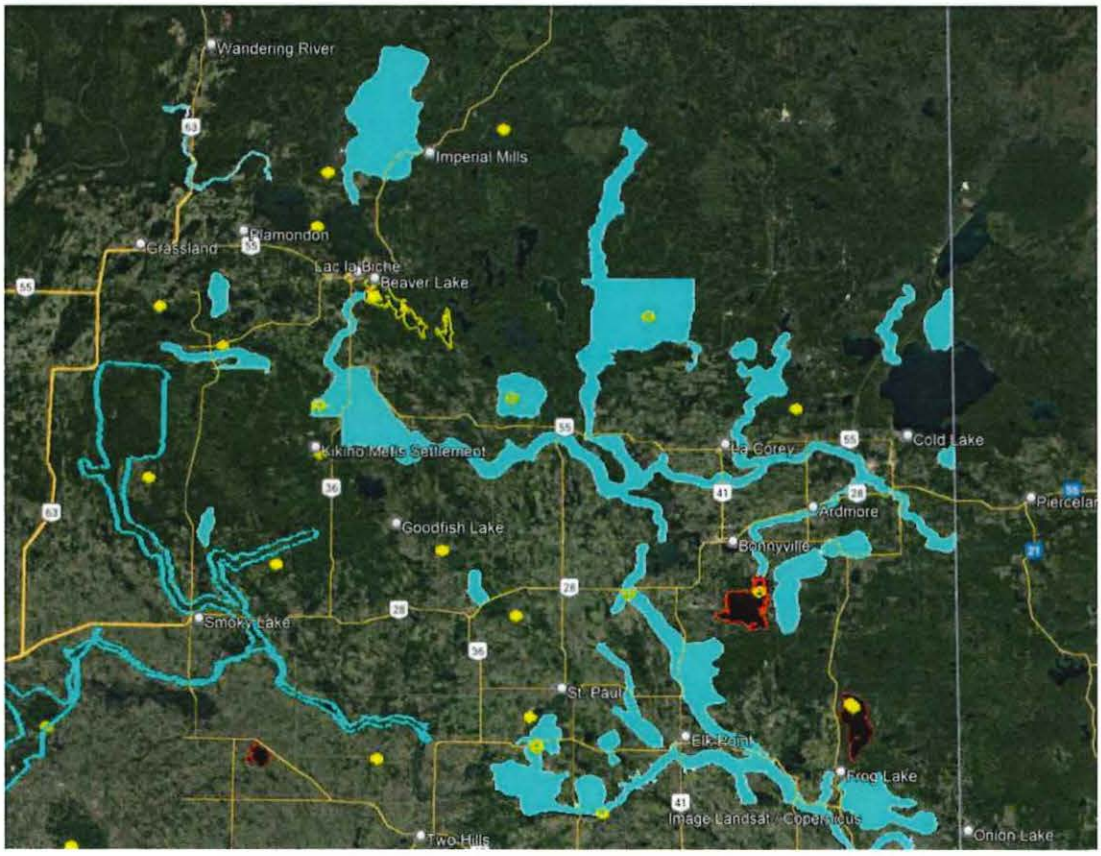


Figure 5. Key wildlife and biodiversity zones (turquoise polygons), including Piping Plover habitat (lakes outlined in orange: Muriel Lake, Frog Lake), important Trumpeter Swan habitat (lakes outlined in yellow: Beaver Lake, Elinor Lake), and colonial nesting bird habitat (yellow dots: e.g., great blue heron).

9.6.3.8 Aquatic Invasive Species and Disease

Himalayan balsam (*Impatiens glandulifera*) is a regulated plant under the *Alberta Weed Control Act* and listed provincially as Prohibited Noxious. It is a summer annual that reproduces by seed only. It is found in riparian areas and requires moist soils and some soil disturbance to establish (e.g., uprooted trees, flooding).

a) Spread of Himalayan balsam occurs mostly from the dispersal of seed from landscape plantings. Consider the following to help control its spread:
    i. Avoid the selling or purchase of Himalayan balsam for ornamental purposes
    ii. Minimize the potential to spread seed by minimizing soil disturbance and erosion in riparian areas
    iii. Himalayan balsam has a shallow root system. Hand-pulling is an effective way to control plants. Plant debris should be incinerated or bagged and sent to a landfill
    iv. Explore biological control options

Aquatic invasive species (AIS) pose an ongoing risk to Alberta's lakes and streams. Species of concern include zebra and quagga mussels, flowering rush, Prussian Carp, and Eurasian milfoil. Whirling disease is also a concern that is present in other watersheds (Oldman, Bow, Red Deer and North Saskatchewan rivers), but has not yet been detected in the Beaver River watershed (as of May 1, 2018).

b) To minimize the potential to spread AIS, consider:
    i. Posting signage at all access points to increase awareness regarding the threat of AIS
    ii. Making boat wash stations available at key access points, particularly during fishing tournaments and the peak summer season
    iii. Reinstating provincial highway inspection stations for watercraft
    iv. Reducing the number of unmanaged boat launches in the watershed where possible.