LAC LA BICHE
WATERSHED MANAGEMENT PLAN

May 2021

PREPARED FOR:

Lac La Biche County
welcoming by nature.

PREPARED BY:

MUNICIPAL PLANNING SERVICES

CPP ENVIRONMENTAL

TECHNICAL SUPPORT:

Alberta Environment and Parks

RECOMMENDED CITATION

Lac La Biche Watershed Management Plan Steering Committee. 2021. *Lac La Biche Watershed Management Plan* (www.laclabichecounty.com).

PLAN ADOPTION AND SUPPORT

[Resolution or Bylaw number to be added in when LLBWMP is adopted]

LAND ACKNOWLEDGEMENT

The Lac La Biche watershed is within Treaty 6 territory, the ancestral and traditional territory of the Cree, Dene, Blackfoot, Saulteaux, and Nakota Sioux, and Treaty 8 and 10 territory, the ancestral and traditional territory of the Cree and Dene, as well as the ancestral and traditional lands of Métis Peoples. We acknowledge the many Indigenous Peoples whose footsteps have marked these lands and waters for generations. We are grateful for the traditional Knowledge Keepers and Elders who are with us today and those who have gone before us. As an act of reconciliation and gratitude, we respectfully acknowledge the land of those whose territory we reside and work in.

Watershed planning recognizes the interconnected nature of water systems and human culture. Responsible land use and resource management of the Lac La Biche watershed did not begin with this watershed management plan; Indigenous Peoples have been and continue to be stewards of the land and water.

Indigenous Peoples of the area first referred to Lac La Biche as 'Elk Lake'; **Wâwâskesiwisâkahikan** in the Plains Cree language and **tzalith tway** in the Chipewyan language. (Fromhold, 2011)

ACKNOWLEDGEMENTS

STEERING COMMITTEE

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The Lac La Biche Watershed Management Plan (LLBWMP) was prepared by the **Steering Committee** and **Plan Authors.**

EXECUTIVE SUMMARY

In 2019, Lac La Biche County initiated the preparation of an updated Lac La Biche Watershed Management Plan (LLBWMP). The plan will replace the 2009 WMP. The preparation of the updated plan was guided by a Steering Committee, with representation from Lac La Biche County Council and Administration, Alberta Environment and Parks, local and regional non-governmental organizations, Indigenous communities, local organizations, and the forestry and oil and gas industries.

The updated LLBWMP is an adaptable, comprehensive, evidence-based plan that includes recommendations and actions to protect and improve water quality, reduce algal bloom frequency, and support lake and watershed health, while balancing environmental, economic and community needs within the watershed. The LLBWMP is intended to serve as a guidance document and planning tool for decision makers (municipalities, local authorities, and government agencies), non-governmental and community organizations, industry, other stakeholders, and the public.

The development of the LLBWMP recommendations were based on comprehensive technical information, which is summarized in the Summary of the Science included in Appendix B. The LLBWMP was prepared with the understanding that as new information becomes available the plan can be updated to reflect the most current data.

The recommendations and actions in the LLBWMP are organized into three geographic areas and one overarching area:

- The Watershed Lands: recommendations address land cover and biodiversity, land use and phosphorus management, clean runoff, and groundwater quality.
- The Shoreline: recommendations address the shorelines of Lac La Biche and its tributaries.
- The Lake: recommendations address the waters of Lac La Biche.
- Working Together: recommendations address plan implementation, plan updates, regional strategies, monitoring, and outreach.

The recommendations are intended to support the plan goals through the identification of specific regulatory, technical and voluntary actions. To support the successful implementation for the plan, the LLBWMP includes a "Working Together" section which encourages the formation of an Implementation Committee to oversee the administration of the WMP, support continued relationship building, communication, collaboration, grass roots education, monitoring and annual reporting on the implementation and effectiveness of the plan. Successful implementation of the LLBWMP will support the plan vision "to protect and restore the lake and watershed by leading in knowledge sharing, research, policy, and action".

The **LLBWMP objectives and corresponding recommendations** are organized by three geographic locations:

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The Appendices are included in a separate document:

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1. INTRODUCTION

1.1 PURPOSE

The Lac La Biche Watershed Management Plan (LLBWMP) is a comprehensive, science-based plan that will:

- Coordinate action for the protection and improvement of Lac La Biche, its shore lands, and watershed.
- Function as a guidance document and planning tool primarily for decision makers (municipalities, local authorities, and government agencies), non-governmental and community organizations, industry, other stakeholders, communities and the public
- Identify objectives, recommendations, actions for long-term management of land and water resources within the watershed.

1.2 VISION

Protect and restore the lake and watershed by leading in knowledge sharing, research, policy, and action.

1.3 GOALS

1. Reduce the frequency and intensity of algal blooms.

2. Improve the health of the watershed and the lake.

3. Improve the recreational value of the lake and economic viability of the region.

5. Strengthen collaboration, knowledge sharing and relationships between government, Indigenous Peoples, municipalities, non-governmental and local organizations, industry, and residents.

4. Engage the community and support plan implementation through coordinated, comprehensive education and outreach programs

LLBWMP Vision Statement:

Protect and restore the lake and watershed by leading in knowledge sharing, research, policy, and action.

1.4 GUIDING PRINCIPLES

Implementation of the LLBWMP will be guided by the following principles:

- The LLBWMP is consistent with the goals and strategies in *Water for Life*.
- Successful implementation of the LLWMP will be a collaborative process.
- Decision-making processes for land use and water management are made using an evidence-based decision making model.
- Planning is dynamic and constantly evolving. When additional information becomes available or new issues are identified, the LLBWMP should be updated.
- Public engagement will value local perspectives and community experiences and will recognize that respect and equitable processes foster trust and stronger relationships.
- Engagement with Indigenous communities is meaningful and respectful.

1.5 COMMON GROUND

The LLBWMP recognizes that a variety of perspectives and interests exist among the various municipalities, communities, and stakeholders of the Lac La Biche watershed. The LLBWMP focuses on topics and actions that are rooted in science, provide benefit, and represent common ground.

1.6 JURISDICTIONS

The boundary of the Lac La Biche Watershed is illustrated in the figure on the next page. Lands within the Lac La Biche watershed are administered by Lac La Biche County, Athabasca County, the MD of Bonnyville No. 87 (Cold Lake Air Weapons Range), Heart Lake First Nation #469 (IR 167 and 167A), and the Government of Alberta (Provincial Parks and Crown Lands). Lands within the watershed are also part of the traditional territories of the Cree, Dene, Blackfoot, Saulteaux, and Nakota Sioux, as well as the ancestral and traditional lands of Métis Peoples. The figure on the next page identifies jurisdictional areas but does not identify the extent of ancestral or traditional lands.

The LLBWMP is intended to be consistent with the goals and strategies in ***Water for Life.***

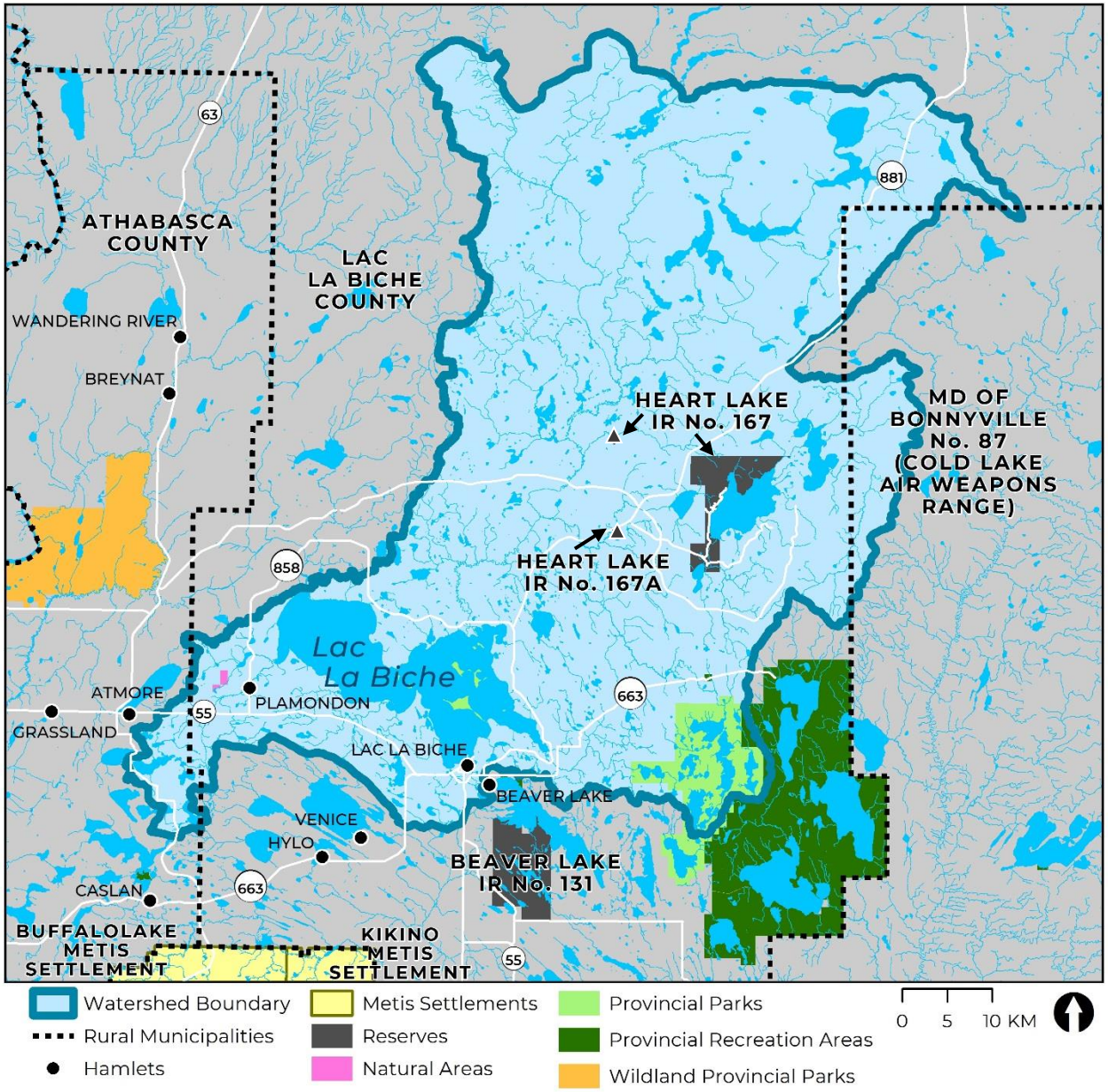


Figure 1. Lac La Biche Watershed Boundary and Plan Area

93% of the watershed is located within Lac La Biche County

4% of the watershed is within MD of Bonnyville No. 87 (includes Cold Lake Air Weapons Range)

2% of the watershed is within Athabasca County

1% is located within Heart Lake IR 167 and 167A

1.7 PLAN RECOMMENDATIONS

The LLBWMP includes recommendations for the watershed, the shore lands, and the lake itself that seek a balance between environmental, social, and economic interests. It provides guidance for land use and watershed management decisions for municipalities, local authorities, government agencies, non-governmental and community organizations, industry, other stakeholders, communities, and the public. The development of the LLBWMP recommendations was based on comprehensive technical information. It was prepared with the understanding that new information may become available and the document will need to be updated accordingly. Recommendations include:

- Policy changes (statutory plans, bylaws, agreements)
- Technical/scientific actions and monitoring
- Site-specific recommendations
- Community actions (advocacy, education, voluntary action, best management practices)

Timelines established for the recommendations in the LLBWMP will be based on the time horizon for the life of the LLBWMP.

1.8 PLAN ADOPTION

The LLBWMP is not a water management plan under the *Water Act*. This plan has been adopted by Lac La Biche County Council and is also intended to be approved by Alberta Environment and Parks under the *Water for Life Strategy*. Other municipalities, local authorities and governmental jurisdictions may also choose to adopt the LLBWMP.

Recommendations in the LLBWMP include:

Policy Changes

Technical/Scientific Actions and Monitoring

Site-Specific Recommendations

Community Actions

2. PLAN DEVELOPMENT

The LLBWMP was developed in collaboration with Lac La Biche County, Healthy Waters Lac La Biche, Alberta Environment and Parks, Indigenous Peoples, forestry and oil and gas industry stakeholders, local and regional non-governmental organizations, local organizations, and community residents and is based on an understanding of Lac La Biche's water resources and the environmental, economic, and social demands placed on them.

2.1 PROCESS

Nov – Dec 2019: Project Start-up and Information Session Individuals from various organizations, communities, and industry were invited to learn about the project and opportunities to participate on the Steering Committee.
Dec 2019 - Feb 2020: Steering Committee Established The Steering Committee was established with a diverse membership, consisting of members of County Council and Administration, Alberta Environment and Parks, local and regional non-governmental organizations, Indigenous communities and organizations, local organizations, and industry (forestry, oil and gas).
Mar – Sept 2020: Terms of Reference and the Summary of the Science The Terms of Reference (TOR) was prepared to guide the preparation of the LLBWMP. The Summary of the Science was prepared based on available data, studies, and reports for Lac La Biche and the watershed, and identified plan implications and recommendations for the LLBWMP.
Oct – Dec 2020: Terms of Reference Finalized and the Draft LLBWMP Prepared The Terms of Reference was finalized and adopted by Lac La Biche County Council. The draft LLWMP was prepared based on the plan implications and recommendations in the Summary of the Science and presented to the Steering Committee and County Council.
Jan – May 2021: Draft LLBWMP Review, Public Engagement and Plan Adoption The draft LLWMP was reviewed by the Steering Committee, Lac La Biche County, and Alberta Environment and Parks and was updated accordingly and then released to the public for review. The draft LLBWMP was presented to the public at the online open house in April 2021. Feedback received from the public was compiled and reviewed to determine the changes required. The draft LLBWMP was revised and presented to Council in May 2021.

The project began in late 2019 and was completed in mid-2021.

The Summary of the Science is a technical summary that provided a foundation for the preparation of the LLBWMP.

Using the plan implications identified in the Summary of the Science and guidance from the Steering Committee, **the evidence-based LLBWMP was prepared.**

2.2 COMMUNITY ENGAGEMENT

A key consideration of the plan preparation was engagement with the public, stakeholders and communities and providing opportunities to learn about the LLBWMP and provide feedback. Due to the COVID-19 pandemic, the engagement program was primarily conducted through online means and included a dedicated webpage on the County's website, social media posts and e-newsletters, local media releases, online surveys, newsletter mail-outs, and an online open house.

A summary of the engagement plan and initiatives is outlined in Appendix D.

Due to the COVID-19 pandemic, the engagement program was primarily conducted through online.

3. BACKGROUND

3.1 OVERVIEW

Lac la Biche is a highly eutrophic (fertile) lake, and its fertility has increased since the 1950s. Excessive nutrients have been linked to algal blooms during the summer months and reduced oxygen during the winter months, affecting winter habitat for fish and other aquatic life.

In 2009, a State of the Watershed Report (SOW) was produced to support the development of the 2009 Lac La Biche Watershed Management Plan (2009 LLBWMP). Water quality and healthy ecosystems were the most important topics discussed in the SOW. The 2009 LLBWMP was developed to address the following issues that affect public health and recreational opportunities:

- Cases of toxic algae outbreaks,
- Excessive concentrations of sewage related bacteria, and
- Taste and odour problems in drinking water which were reported from locations across the County.

Significant improvements have been made within the watershed as a result of concrete actions taken by government, industry, community members and organizations to implement recommendations made in the 2009 LLBWMP. The 2021 LLBWMP will build on these successes and continue to work towards improving lake water quality and resolving the issues identified in the 2020 Summary of the Science. The Summary of the Science was prepared to provide a summary of the current research and evidence-based recommendations to improve current lake quality issues.

The table on the following pages highlight some of the key issues that currently and historically have impacted the water quality of the lake. Actions that were taken to improve these issues have been identified in the outcome column of the chart on the following page.

Significant improvements have been made within the watershed as a result of concrete actions taken by government, industry, community members and organizations to implement recommendations made in the 2009 LLBWMP.

Table 1. Overview of Current and Historical Issues Impacting the Water Quality of Lac La Biche

ISSUE	DESCRIPTION	CURRENT STATUS
Nutrient Loading of the Lake from Red Deer Brook	Nutrients have been added to Lac la Biche via Red Deer Brook (the watercourse that drains Field Lake). Evidence of treated sewage from the Town of Lac La Biche, diverted to Field Lake since 1983, was found in Red Deer Brook where it discharges to Lac La Biche.	In 2012 the County, as part of a P3 project, began construction of a Biological Nutrient Removal (BNR) wastewater treatment facility, lift station and force main. The facility was opened in 2014 and ensures that harmful nutrients and bacteria are removed before treated wastewater is returned to the environment. Monitoring of the treated wastewater effluent is conducted daily prior to its discharge to the natural environment. Lac La Biche County also monitors water quality in Red Deer Brook voluntarily every year to confirm nutrient and fecal coliform levels. This data has shown that, since the treatment plant was commissioned, the concentrations of phosphorus and fecal bacteria have decreased. Thus, the BNR plant is proving to be effective.
Conveyance of Nutrients, Fertilizer, and Sediment from Runoff	Runoff from developed areas can contain pollutants such as nutrients, sediment, pesticides, oil and grease, metals, salts, and bacteria which ultimately enter Lac la Biche. Changes to land cover types that generate more pollutants per hectare, without the proper Beneficial Management Practices, are an ongoing concern.	The County commissioned a stormwater management plan, which has been implemented through the installation of oil grit separators on existing outfalls. A stormwater oil grit separator is an underground device that captures oils and sediment from stormwater runoff and snowmelt, and therefore intercepts them prior to water entering the lake. Education and public awareness initiatives by Lac La Biche County and Healthy Waters Lac La Biche are ongoing to provide information to residents and the public.
Disturbance of Environmentally Sensitive Areas: Shoreline and Riparian Areas	Nearshore areas such as the shoreline and riparian areas play a critical role in capturing nutrients prior to entering the lake. They are also locations with high biodiversity and wildlife occupation. These areas have been degraded, resulting in loss of these important attributes. Most of the lake's shoreline is in a natural state, with under 15% being disturbed. However, some areas, such as an important stretch of the Owl River, the lake's major tributary, have historically been fair or poor.	Through a partnership with the Alberta Conservation Association, a large riparian restoration initiative has recently been completed along a stretch of the Owl River that has critical walleye spawning habitat. Through these efforts, 59% of the riparian areas of the Owl River are considered to be in good health, particularly where livestock exclusion fencing was installed in collaboration with local landowners. In 2016, Living Lakes Canada, the Stewards of Lac La Biche (now Healthy Waters Lac La Biche) and Lac La Biche County initiated the Sensitive Habitat Inventory Mapping (SHIM) to characterize the physical and biological features of the Lac La Biche shoreline. In 2010, Lac La Biche County implemented the Riparian Setback Matrix Model to establish a science-based approach to determine the reserve dedication at time of subdivision in order to protect riparian areas. In 2020 and 2021, Lac La Biche County has been preparing an Environmental Reserve Bylaw to address the natural preservation of these lands, public safety, and to prevent pollution of adjacent water bodies, in addition to providing public access to and beside the bed and shore of adjacent water bodies.

ISSUE	DESCRIPTION	CURRENT STATUS
Blue-green Algae Blooms and Water Quality	Lac La Biche is highly eutrophic, which can result in blue-green algae issues. This is due to a combination of factors, including phosphorus inputs from both human and natural sources, very long water residence time and internal recycling of phosphorus. Eutrophication particularly accelerated in the east basin after about 1950, and after 1970 in the west basin. Both the East and West basins of the lake exhibit the necessary factors that promote algae growth. These factors include a stable water column, warm water temperatures, high epilimnetic nutrient concentrations, low N to P ratios, high pH, low available CO2 concentrations, and reduced grazing by large zooplankton. Lac La Biche has a long-recorded history of algal blooms dating back to the 1920s (Chipeniuk 1975). A trend analysis on water quality data from the east basin of Lac La Biche using data from 1983 to 2004 has showed no statistically significant change in water level, total phosphorus, or algal biomass (chlorophyll-a); however, a trend analysis of recent water quality data has not been conducted. Additionally, there has been a significant decrease in water transparency (Casey 2011), meaning that the water became cloudier historically.	The County monitors the water quality of Lac La Biche including nutrients (nitrogen, phosphorus), blue-green algae, fecal coliforms, heavy metals, suspended solids, etc. There have been various actions undertaken by the County and other stakeholders to improve the water quality of Lac La Biche and blue-green algae issues, including those described in this table. There is no one action that can improve water quality; it is the culmination of many actions, including those identified in this plan, that aim to help improve water quality. There is lag time between implementation of actions and water quality improvements, which are gradual and long-term. In April 2021, Lac La Biche County amended Bylaw 15-001 Waterworks Connection Bylaw to require inspection of private sewage disposal systems in the Water/Sewer Connection Area outside a hamlet where connection to the regional system is available but property owners opt not to connect.
Poor State of Fish Populations	The lake supports both Indigenous and recreational fisheries for burbot, walleye, northern pike, yellow perch, and lake whitefish. The lake has had commercial fishing historically, which had led to overharvesting, but was closed in the province in 2014. Walleye has nearly disappeared from the lake and pike is very low in abundance. At the same time, the cormorant population increased dramatically, which partially prevented the recovery of walleye.	A Lac La Biche Fisheries Restoration Program was initiated in 2005 because important fish species such as walleye, pike, and whitefish experienced population decline and previous efforts to recover the populations were unsuccessful. Fish and cormorant populations will continue to be monitored in the foreseeable future. Research is being done to determine the causes of walleye mortality in the lake. In the last fishing season (May 2020 – March 2021), walleye over 55cm were permitted to be caught and harvested and northern pike were not permitted to be harvested.

3.2 PROGRESS TO DATE

In addition to the implementation actions identified above, the LLBWMP is also informed by a considerable number of studies and prior initiatives already in place for the Lac La Biche watershed. These efforts have been lead and funded by many organizations including: the municipality, the non-governmental organizations, the Government of Alberta, the Government of Canada, the University of Alberta, and the Alberta Biodiversity Monitoring Institute. The following works are either underway (u/w) or completed (✓), or ongoing.

SCIENTIFIC STUDIES

STATUS	AUTHOR / PROPONENT	TITLE	DATE
Ongoing	Lac La Biche County	Water Quality Report Lac la Biche – East Basin	Annually
Ongoing	Lac La Biche County	Water Quality Report Lac la Biche – West Basin	Annually
✓	Hopkins, D., et al.	"Learning Together": Braiding Indigenous and Western Knowledge Systems to Understand Freshwater Mussel Health in the Lower Athabasca Region of Alberta, Canada	2019
✓	Alberta Environment and Parks	Lac La Biche FIN Summary	2018
✓	Fenson, S., T. Johns, and B. Schmidt	Owl River Riparian Restoration and Enhancement Project: Monitoring report II	2018
✓	Hutchinson Environmental Sciences Ltd.	Foreshore Inventory and Mapping Report	2017
✓	Hutchinson Environmental Sciences Ltd.	Lac la Biche Sensitive Habitat Index Mapping and Shoreline Management Guidelines	2017
✓	Stantec Consulting, Ltd.	Red Deer Brook 2011-2016 Sampling Program	2017
✓	Alberta Environment and Parks	Lac La Biche FIN Summary	2016
✓	North Saskatchewan Watershed Alliance	A Compilation of Stream Nutrient Data for Alberta	2015

STATUS	AUTHOR / PROPONENT	TITLE	DATE
✓	McGregor, A.M., C.L. Davis, C.J. Walters, and L. Foote	Fisheries restoration potential for a large lake ecosystem: using ecosystem models to examine dynamic relationships between walleye, cormorant, and perch	2015
✓	McGregor, A.M.	Lac La Biche Fisheries Restoration Program Summary Report	2014
✓	Aquality Environmental Consulting Ltd.	Red Deer Brook Water Quality Monitoring Lac La Biche County, Alberta	2013
✓	McGregor, A.M.	Of Fur and Fins: Quantifying Fur Trade Era Fish Harvest to Assess Changes in Contemporary Lake Whitefish (Coregonus clupeaformis) Production at Lac La Biche, Alberta	2013
✓	Aquality Environmental Consulting Ltd.	Red Deer Brook Water Quality Monitoring Results from Initial two Sampling Events	2011
✓	Casey, R.	Water Quality Conditions and Long-Term Trends in Alberta Lakes	2011
✓	Schindler, D.W., et al.	The Cultural Eutrophication of Lac La Biche, Alberta, Canada: A Paleoecological Study	2008

STATUS	AUTHOR / PROPONENT	TITLE	DATE
✓	Bleackley, D. S.	Trophodynamics of organochlorine pesticides in the aquatic food web of Lac La Biche	2007
✓	Kimmel, E. I.	The Preservation of Wetland Ecological Goods & Services: An Evaluation of Land Conservation Techniques for the Lac La Biche Watershed, Alberta	2007
✓	Morrissey, J.	Chiral PCBs in the aquatic food web of Lac La Biche, Alberta, Canada	2007
✓	Aquality Environmental Consulting Ltd.	Red Deer Brook 2006 "Phase 1" Water Quality Summary Report	2006
✓	Crowe, A. M.	The role of silica depletion in the eutrophication of Lac La Biche, Alberta	2006
✓	Neufeld, S.D.	Effects of Catchment Land Use on Nutrient Export, Stream Water Chemistry, and Macroinvertebrate Assemblages in Boreal Alberta.	2005
✓	Mills, B (Alberta Conservation Association)	An assessment of the health and integrity of riparian management zones of Moose Lake and Lac La Biche	2005
✓	Aquality Environmental Consulting Ltd.	Caffeine in the Surface Waters of Lac La Biche and Tributaries	2004
✓	Aquality Environmental Consulting	State of Lac La Biche Watershed: Summary of Current Information	2004
✓	Alberta Lake Management Society	Lakewatch: The ALMS Volunteer Lake Monitoring Program for Lac La Biche Lakes	2004
✓	Schindler, D.W., et al.	Water Quality of Lac la Biche: A Preliminary Assessment of Past and Present Conditions.	2004
✓	Gill, M., Olsen, S. and Sinclair, P.	Proposed Forest Ecosystem Network for the Lac La Biche Watershed	2002
✓	Mitchell, P.	Effect of Field Lake outflow on water quality in Red Deer Brook	2000
✓	Mitchell, P.	The impact of aerated sewage lagoon effluent on water quality in Field Lake	1998
✓	Schwalme, K.	A Review of Winterkill Remediation Techniques for Alberta	1995
✓	Lac La Biche Technical Committee	Lac la Biche Causeway Investigation	1993
✓	Mitchell, P.	Impact of Water Level Stabilization on Water Quality of Lac La Biche	1993
✓	Mitchell, P., and Prepas E.E.	Atlas of Alberta Lakes	1990
✓	Bothe, R. A., Davies F. D., DeBoer A., and Mustapha A. M.	Impact of the Sir Winston Churchill Provincial Park Causeway on the circulation of Lac La Biche	1990
✓	Babin, J., and E.E. Prepas	Modelling Winter Oxygen Depletion Rates in Ice-Covered Temperate Zone Lakes in Canada	1985
✓	Mitchell, P.	Trophic Status of Lac La Biche	1980
✓	Chipeniuk, R.C.	Lakes of the Lac La Biche District	1975
✓	Pinsent, M. E.	A comparative limnological study of Lac La Biche and Beaver Lake, Alberta	1967

STATUS	AUTHOR / PROPONENT	TITLE	DATE
✓	Robertson, M. R.	Certain limnological characteristics of the La Biche and Wandering Rivers	1967
✓	Greenbank, J.	Limnological Conditions in Ice-Covered Lakes, Especially as Related to Winter-Kill of Fish	1945

COMMUNITY/STAKEHOLDER ENGAGEMENT

The table below outlines recent engagement conducted regarding the watershed and other environmental matters.

STATUS	PROPONENT	TITLE	DATE
Future	Healthy Waters Lac La Biche	Speaker Series / Open Houses	2021
✓	Lac La Biche County	Environmental Reserve Bylaw	2021
u/w	Lac La Biche County	McArthur Beach Redesign	2020
✓	Healthy Waters Lac La Biche	Speaker Series (webinars)	2020
Ongoing	Lac La Biche County	Lake Monitoring Program	Annually
Ongoing	Lac La Biche County	Environment Week	Annually
Ongoing	Lac La Biche County	Mad About Science Program (kids day camp)	Annually

PLANS, LEGISLATION, AND BENEFICIAL PRACTICES GUIDANCE

The table below outlines key bylaws, policies, plans, guidance documents and initiatives related to the Lac La Biche watershed. Appendix C contains a comprehensive list of legislation, policies, plans, guides, and initiatives relevant the LLBWMP.

STATUS	PROPONENT	TITLE	DATE
u/w	Lac La Biche County	Environmental Reserve Bylaw	2021
u/w	Athabasca Watershed Council	Athabasca Integrated Watershed Management Plan	2021
u/w	Government of Alberta	Cold Lake Sub-regional Plan	2021
✓	Athabasca Watershed Council	State of Athabasca Watershed: Summary Report	2018
✓	Lac La Biche County	Lac La Biche County Land Use Bylaw	2017
✓	Lac La Biche County	Lac La Biche County Land Municipal Development Plan	2013
✓	Government of Alberta	Lower Athabasca Regional Plan (LARP)	2012
✓	Al-Pac/Government of Alberta	Al-Pac Forest Management Agreement and Plan	2011
✓	Lac La Biche County	Lac la Biche County Policy: Riparian Setback Matrix. Policy No. PI-63-003	2010
✓	Aquality Environmental Consulting Ltd. Lac La Biche County	Lac La Biche Watershed Management Plan	2009
✓	Genivar	Stormwater Management Master Plan for Lac La Biche County	2008
Ongoing	Government of Alberta	Lac La Biche Fisheries Restoration Program	2005

4. THE WATERSHED AND LAKE

4.1 ABOUT THE WATERSHED

A watershed is an area of land, bounded by topographic features, where precipitation, groundwater, watercourses (such as streams, creeks and rivers) and bodies of water (such wetlands and lakes) drain into a larger body of water. A watershed is made up of a number of sub-watersheds.

The Lac La Biche watershed is located in northcentral Alberta, approximately 220 kilometers northeast of Edmonton. The entire watershed is located within the Athabasca watershed, as shown in the figures on the left.

The Lac La Biche watershed is approximately 4,040 km^2, the majority of which is east and north of Lac La Biche. The area of the watershed is approximately 17 times the size of the lake.

The major inflow to Lac La Biche is the Owl River and its tributaries: the Logan, Clyde, and Piche Rivers and Gull Creek. A small watercourse, Plamondon Creek, flows into the western side of Lac La Biche and two unnamed watercourses flow into the south shore at Mission Bay. Several unnamed watercourses also flow into the southeast and north shores and intermittent watercourses are located all around the shore. Lac La Biche has a natural outlet into the La Biche River, which flows into the Athabasca River. The figures on the following pages shows the Lac La Biche watershed, the lake, main tributaries, and sub-watersheds.

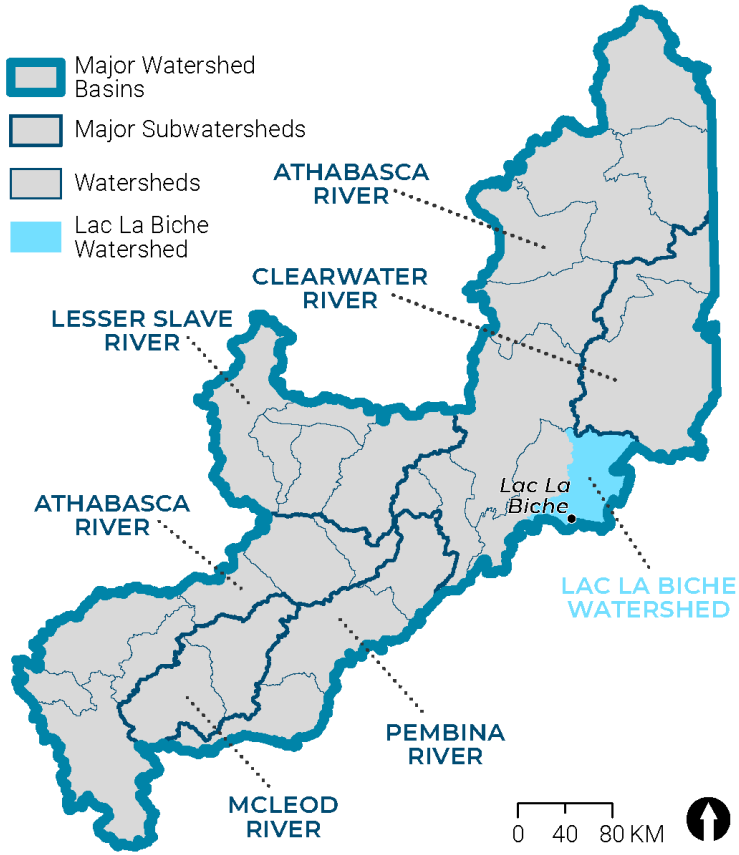


Figure 2. Athabasca Watershed

Figure 3. Major Watershed Basins of Alberta

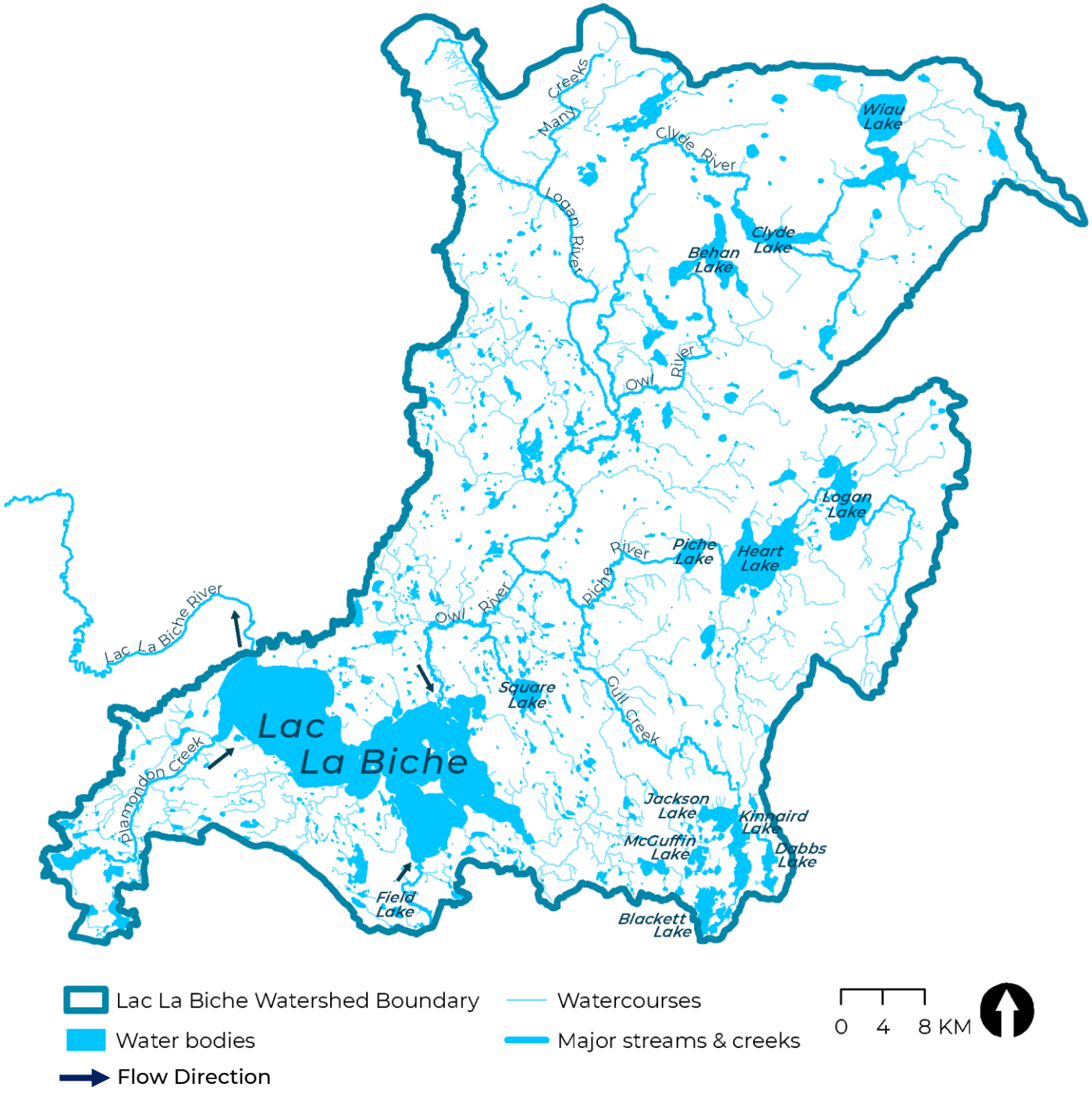
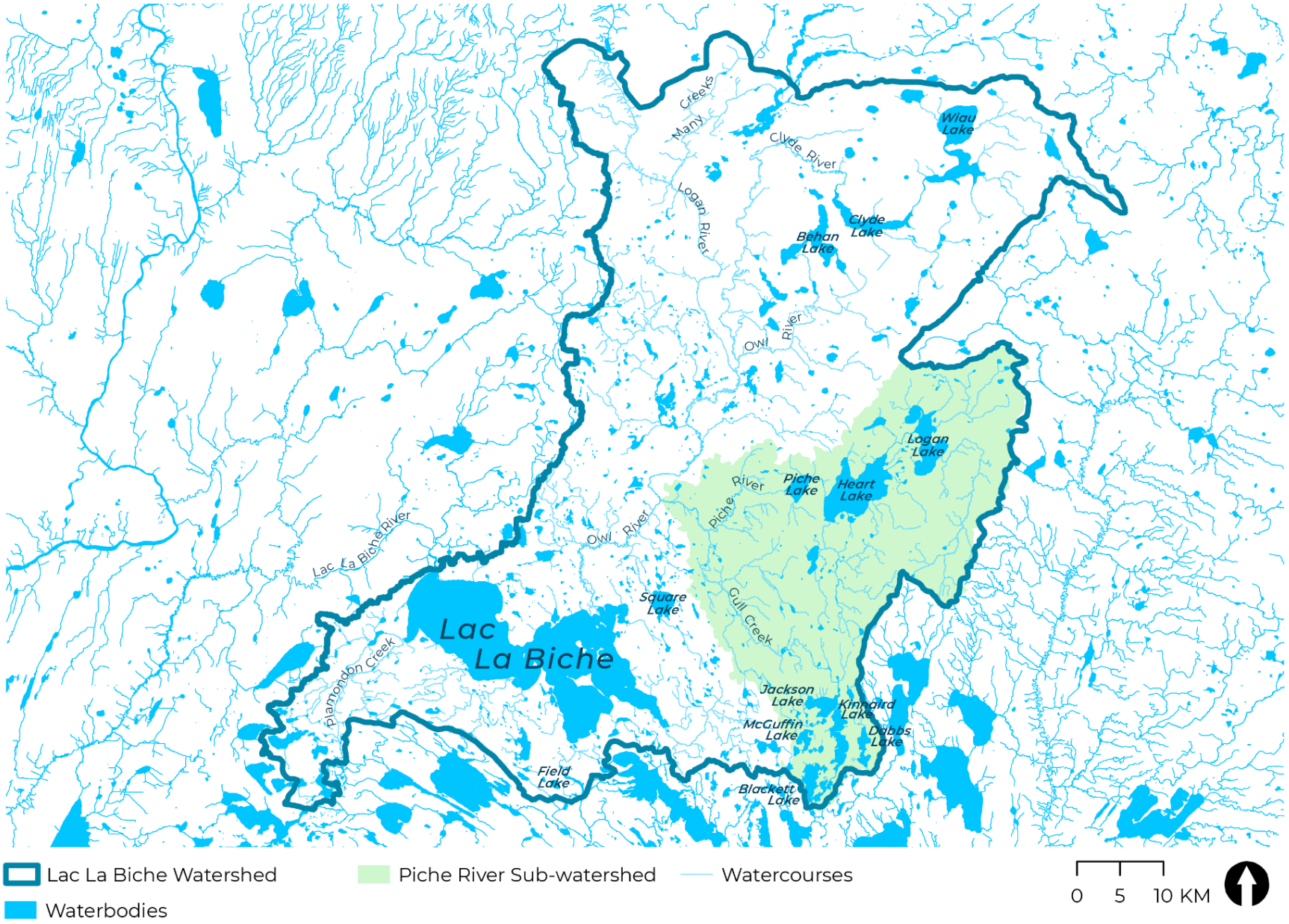


Figure 4. Lac La Biche Watershed



Hydrologic Unit Code (HUC) watershed provided by AEP. Additional work is required to identify the other sub-watersheds of the tributaries to Lac La Biche lake.

Figure 5. Sub-watersheds of the Lac La Biche Watershed

4.2 LAC LA BICHE

Lac La Biche is the seventh largest lake in Alberta, with a surface area of approximately 234 km^2. Lac La Biche is provincial tourist destination and a recognized biologically significant area for water birds. The lake comprises two main basins: the west and east basin. In the east basin, there are several islands (including Birch Island and Currant Island), which comprise Sir Winston Churchill Provincial Park. The main island, Big Island, is accessible by a 2.5 km causeway.

Snapshot of the Lake

LAC LA BICHE PHYSICAL FEATURES	PHYSICAL PROPERTIES
Lake Surface Area	234 km^2
Lake Water Volume	1,960,000 m^3
Maximum Depth	21.3 m
Mean Depth	8.4 m
Shoreline Length	167 km
Mean Annual Lake Evaporation	702 mm
Mean Annual Precipitation	524 mm
Mean Annual Inflow	3,160,000 m^3
Mean Residence Time	7 to 30 years
Watershed Land Drainage Area	4,040 km^2
Watershed to Lake Area Ratio	17:1

Water Levels

With a maximum depth of 21.3 m, the west basin is relatively deep, as compared to the east basin which has a maximum depth of 12.2 m.

During sudden storms, which occur fairly frequently on Lac La Biche, the water level at the east end of the lake can increase by as much as 0.3 m and the waters can become rough and dangerous for boaters. Due to the presence of islands and sub-basins in the east basin, large waves are funnelled onto localized areas, such as along the north shore of the provincial park. Areas exposed to heavy wave action in the west basin are the northeast shore of the basin and the east side of Mission Bay. Heavy wave action can uproot aquatic vegetation and increase turbidity levels. In the spring, ice jams and floods are common along the eastern shore of the east basin.

Lac La Biche is the 7th largest lake in Alberta with a surface area of approximately 234 km^2.

Sir Winston Churchill Provincial Park is located in the east basin.

Water levels in Lac La Biche have been recorded since 1930, although there are many data gaps in the time series (mostly between 1930 and 1974). As such, a continuous daily water level data record was available starting in the mid 1970's (see figure below). Over the historical data recording period (1930-2018), the average water level was 543.38 metres above sea level (masl). The total water level fluctuation over this period was 2.38 m, based on a historic maximum level of 545.00 masl and a historic minimum level of 542.62 masl. Water levels changed over time in response to climatic factors: a gradual decline occurred from the mid-1970's to the early 1990's, followed by an increase in the mid- to late-1990's, another decline around the early 2000's, and then water levels have remained slightly above the long-term average up to the present day.

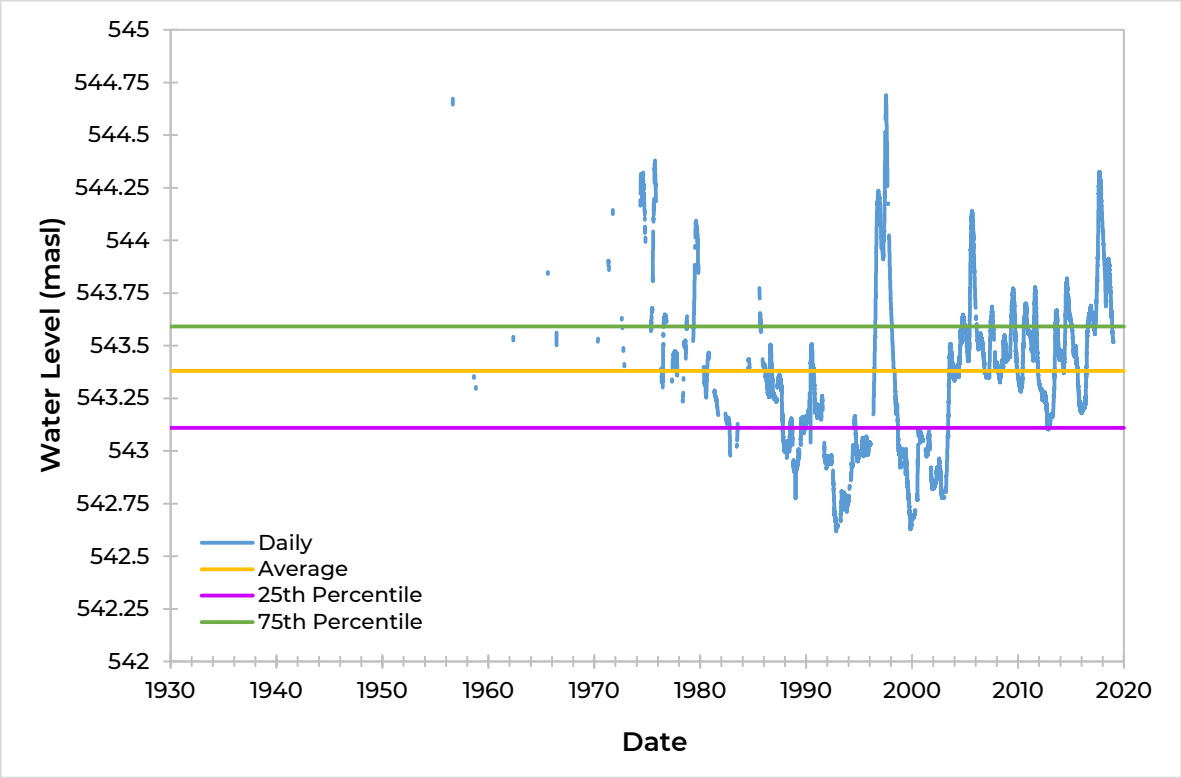


Figure 6. Daily Water Levels for Station 07CA004 (Lac La Biche at Lac La Biche), 1930-2018

The figure on the next page shows the historic water level ranges for Lac La Biche over the open water period (April-October). The grey shaded area indicates the range of water levels where the bulk of the historic values have occurred. Generally, there is an increase in water levels from early April until mid-July, where the water levels are at their highest before declining beginning in mid-August. Within a given

Over the historical data recording period from 1930 to 2018, the **average water level was 543.38 metres above sea level (masl).**

year, there may be some deviation from these general patterns. Lake level data for 2021 to date indicate that water levels are currently historically high, being above the upper quartile (i.e., greater than 75% of the historical data for those dates).

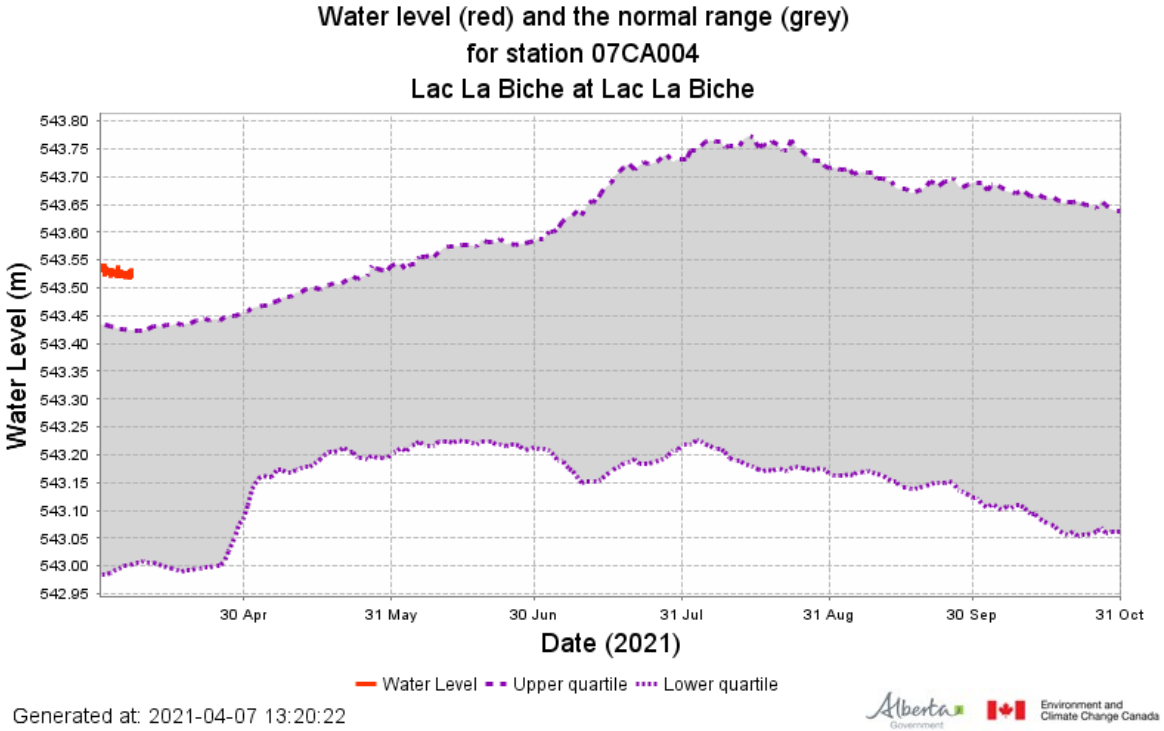


Figure 7. Water Level and Normal Range for Station 07CA004 (Lac La Biche at Lac La Biche)

Algae Blooms

An important driver of the LLBWMP is the presence of algal blooms In Lac La Biche, which this plan promotes the reduction of. Algal blooms can produce dangerous toxins, affecting human and ecological health, as well as recreation. Blooms and related health advisories have caused economic, environmental, and social impacts. Algal blooms can also negatively affect aquatic vegetation growth and the health of fish and wildlife. Fish kills can be a common occurrence in Alberta lakes (especially shallow, highly productive lakes), and are typically caused by low levels of oxygen, which can occur in both summer and winter (Schwalme 1995).

The **reduction of algal blooms** is an important consideration of the LLBWMP.

Lac La Biche is highly "eutrophic", meaning it contains high nutrient concentrations. This is due to a combination of factors, including nutrient inputs from both human and natural sources, very long water residence time and efficient internal loading of phosphorus. Eutrophication has increased since the 1950s. Excessive nutrients cause algal blooms during the summer months and reduce oxygen during the winter months, affecting winter habitat for fish and other aquatic life. Specifically, concentrations of phosphorus, which is a type of nutrient, greatly influence bloom formation. Managing phosphorus within the lake is important to controlling overgrowth of algae.

The figure below illustrates how phosphorus enters the lake. During ice-free conditions, phosphorus enters the lake from the surrounding watershed and the atmosphere, which is known as external loading. This phosphorus is taken up by algae in the water column. Over time, phosphorus settles onto the lakebed and then is later released from the lakebed sediments, which is know as internal loading. The phosphorus coming from the lakebed can contribute a large proportion of the phosphorus in the water column, where it is again available to algae.

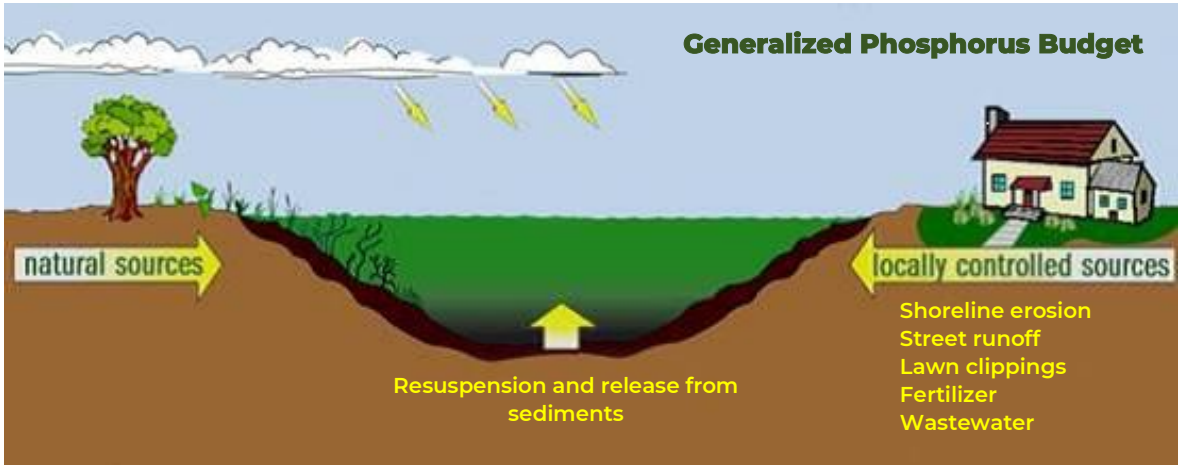


Figure 8. Origins of Phosphorus Entering the Lake (lakeaccess.org)

Phosphorus comes from a variety of human and natural sources. The movement of phosphorus in and out of a lake's water column from these various sources can be calculated in a "phosphorus budget." The figure on the next page shows phosphorus loading data from external sources, which was compiled in the late 1980s (AEP 1984, Mitchell 1989). Although forested lands export relatively low amounts of phosphorus, the majority of phosphorus input to Lac La Biche comes from forested lands since the majority of the watershed is forested. In 2003, Schindler et al noted that on an annual basis,

Lac La Biche is highly eutrophic. The total phosphorus input into the lake is approximately 37,866 kg/year or 0.16 g/m^2 of lake surface.

Alberta Environment (1984), Mitchell (1989)

32% of the phosphorus that enters the lake is deposited within the lake, while only 17.5% of it leaves via the outflow, representing a net gain in phosphorus.

Calculating a phosphorus budget helps us understand where the phosphorus is coming from so that its sources can be targeted for management. Managing phosphorus sources from the watershed is a key priority of the LLBWMP.

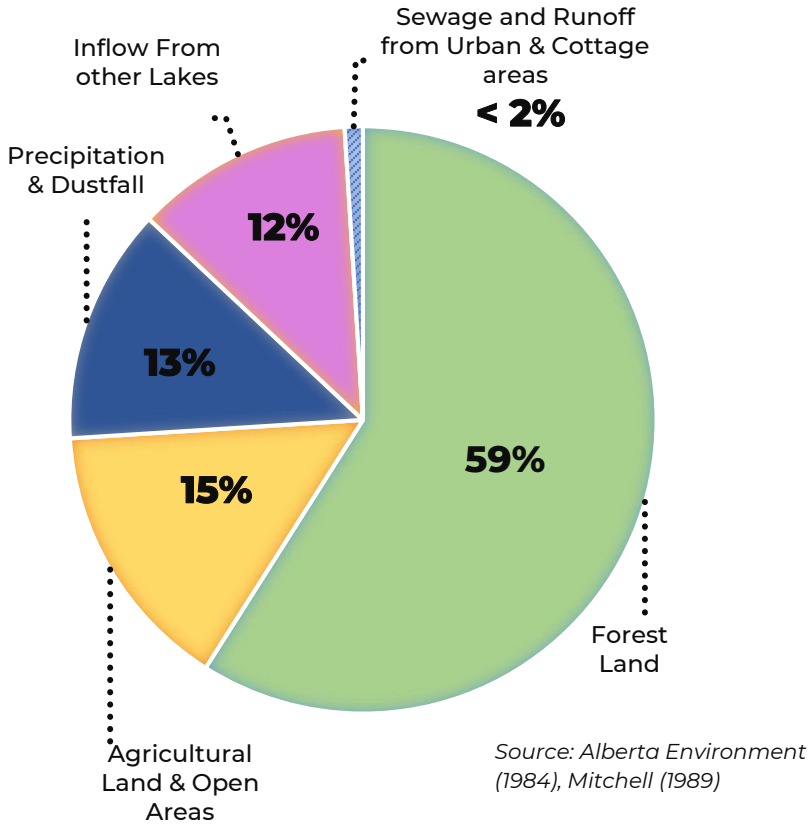
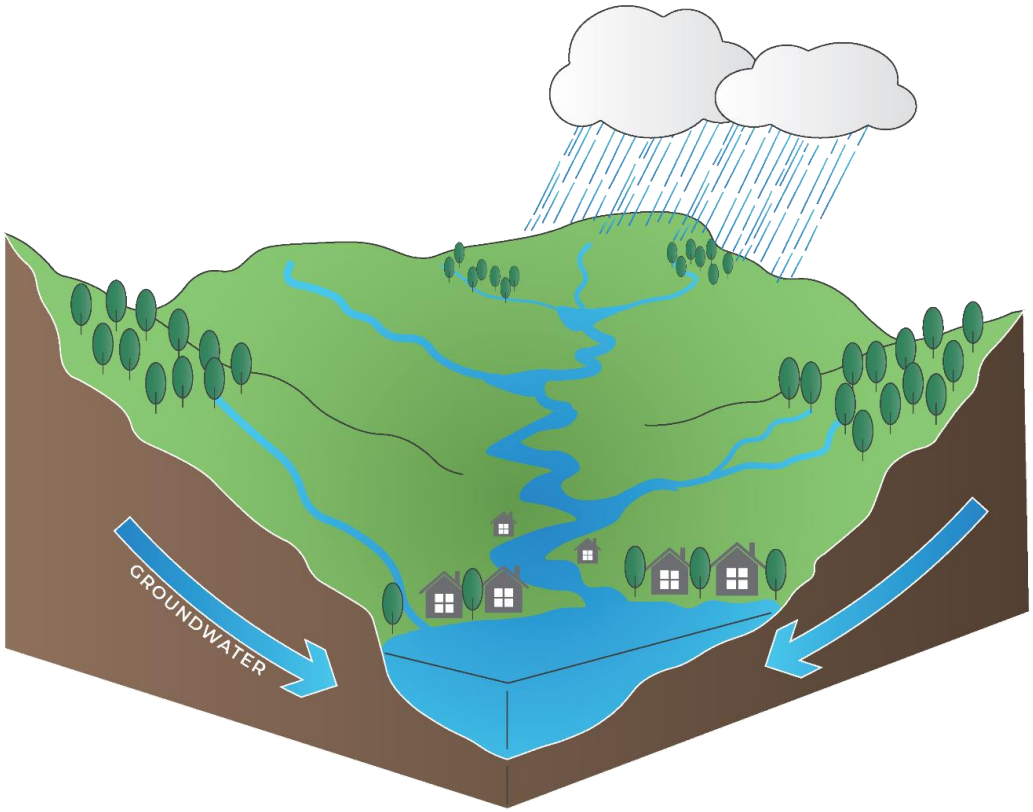


Figure 9. Theoretical Total Phosphorus Loading to Lac la Biche from External Sources (1989)

Managing phosphorus sources from the watershed is a **key priority** of the LLBWMP.

Land Cover and Land Use

The quantity and quality of water in Lac La Biche are influenced by the land cover types in the watershed, as well as how the land is managed. Runoff occurs mainly during spring snowmelt, following large storms, or after smaller back-to-back rainfall events. Nutrients from fertilizers, manure, and loosened soil particles are transported by the runoff, which will ultimately enter Lac La Biche.



Unfortunately, sources of pollution resulting from runoff, precipitation or atmospheric deposition are difficult to pinpoint. These sources of pollution are called non-point (or diffuse) and are mainly influenced by the type of land cover (e.g., agricultural activities, urban areas, or natural vegetation cover) and the human activities in the watershed (e.g., pesticides and nutrients from lawns and gardens).

Fortunately, large portions of the Lac La Biche watershed are undisturbed. Less than 10% of the watershed is disturbed as crops, pasture, or developed land. However, the southern portion of the

Large portions of the Lac La Biche watershed are undisturbed.

Less than 10% of the watershed is disturbed as crops, pasture, or developed land.

watershed is highly altered due to clearing for pasture, crop production, industrial activities, and human settlement. (See the figures on the following pages). Such altered lands supply a large portion of the pollutants entering the lake. That is because altered land can produce much more pollution per hectare, as compared to natural lands.

While the direct impact of land alteration and use on water quality is challenging to quantify, some portion of the nutrient loading to Lac La Biche is caused by human activities in two main ways:

1. Increasing nutrient quantity in the watershed:
    - Nutrient additions related to lawn fertilizers and agricultural operations
    - Release of some portion of sewage and pollutants produced from cottages, campgrounds, and day-use areas
2. Facilitating the introduction of nutrients into the lake:
    - Removing vegetation, wetlands and riparian buffers, which hold back nutrients and other pollutants
    - Increasing the amount of hard surfaces, which decreases infiltration, increases the overland flow, and transports pollutants
    - Land disturbances that release sediment containing phosphorus and other pollutants

Land cover, land use and nutrient export are related, with natural lands producing the lowest amount of nutrients. Therefore, maintaining or improving the coverage and ecological condition of natural land cover (e.g., forests, grasslands, and wetlands) in strategic locations is a key priority of the LLBWMP. For example, riparian areas along critical walleye spawning habitat in the Owl River have been identified as prime importance. Of all the tributaries, the Owl River is the most important to the hydrology and water quality of Lac La Biche. Building off the tremendous success of the Owl River riparian restoration project, riparian restoration along the Owl River will be a top priority moving forward.

Maintaining or improving the coverage and ecological condition of natural land cover, such as forests, grasslands, and wetlands, in strategic locations is a key priority.

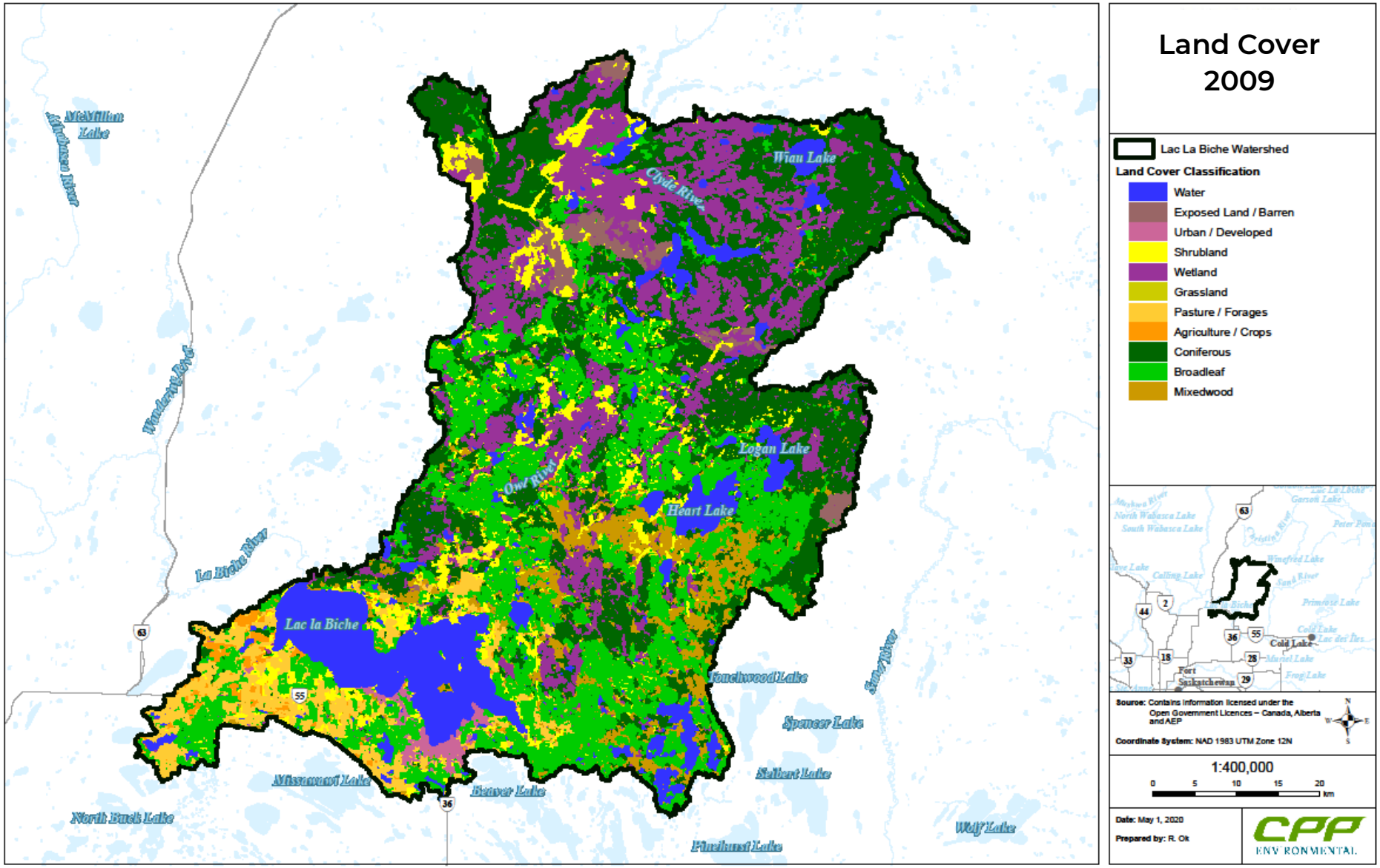


Figure 10. 2009 Land Cover

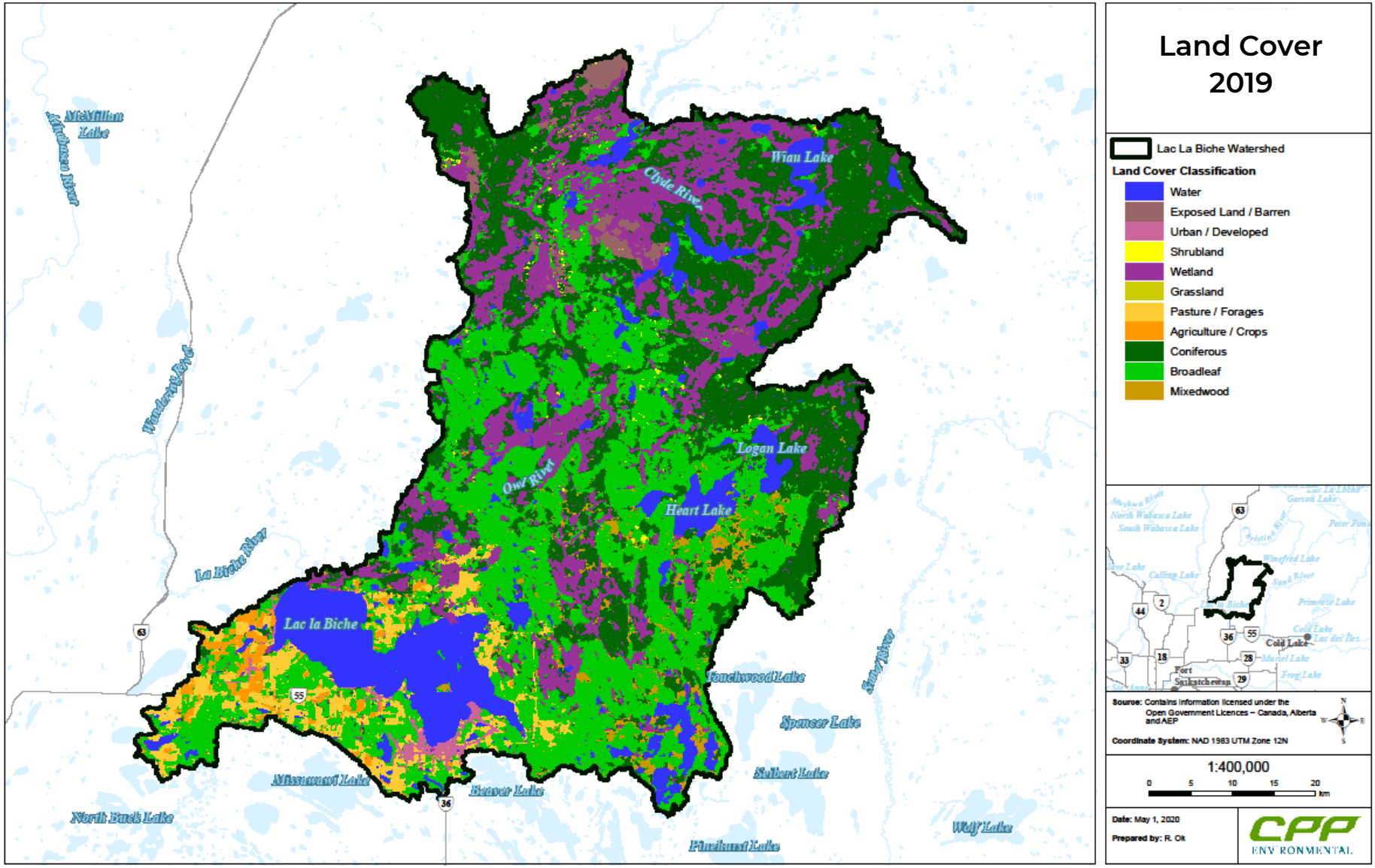


Figure 11. 2019 Land Cover

5. PLAN IMPLICATIONS

From the preceding section and the best available evidence, key considerations affecting the overall strategy and perspective of the plan are:

- Multiple strategies will be required to improve the health of Lac La Biche. No one strategy exists that will address the blue-green algae issue.
- The LLBWMP identifies three geographic areas where management actions can take place:
    - The Watershed Lands
    - The Shoreline
    - The Lake
- The summary of the science about Lac La Biche continues to evolve. Significant knowledge gaps remain, especially related to nutrient and blue-green algae behavior throughout each season of the year. The LLBWMP has a built-in mechanism for updates over time.

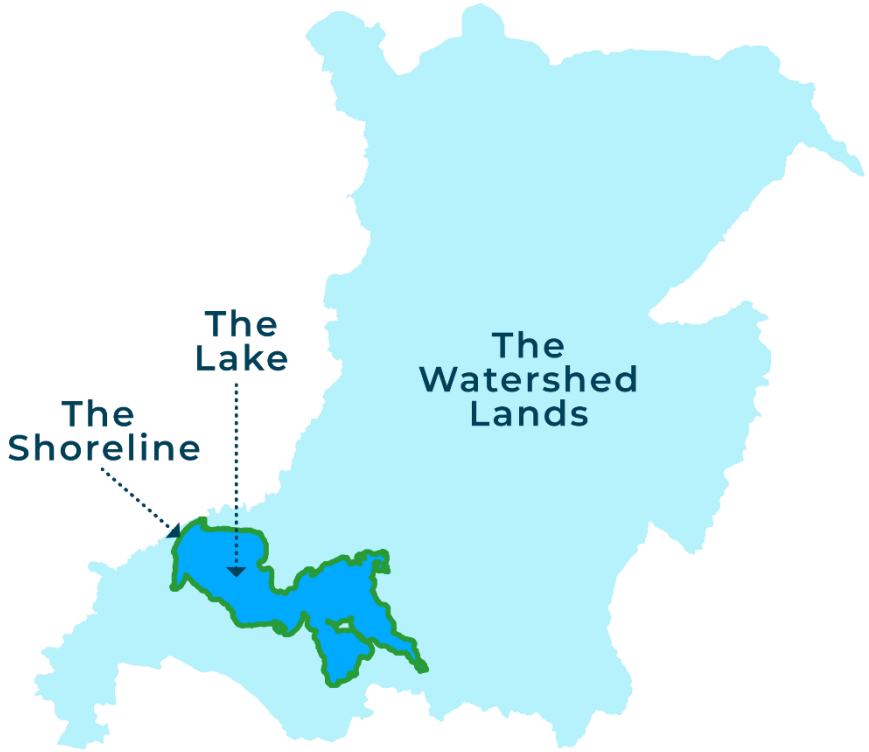


Figure 12. Geographic Areas of the LLBWMP

The LLBWMP identifies three geographic areas where actions can take place:

The Watershed Lands

The Shoreline

The Lake

6. PLAN STRUCTURE

6.1 ROAD MAP

The LLBWMP is organized into four main areas:

- **The Watershed Lands:** Lac La Biche watershed up to the height of land surrounding the lake
- **The Shoreline:** Lac La Biche's shoreline, including the bank and near shore waters.
- **The Lake**: Lac La Biche itself, and
- **Working Together:** improving our collaboration and organizational capacity

For each of these four key areas objectives, recommendations, and actions have been identified. Each of these four is structured in the following manner:

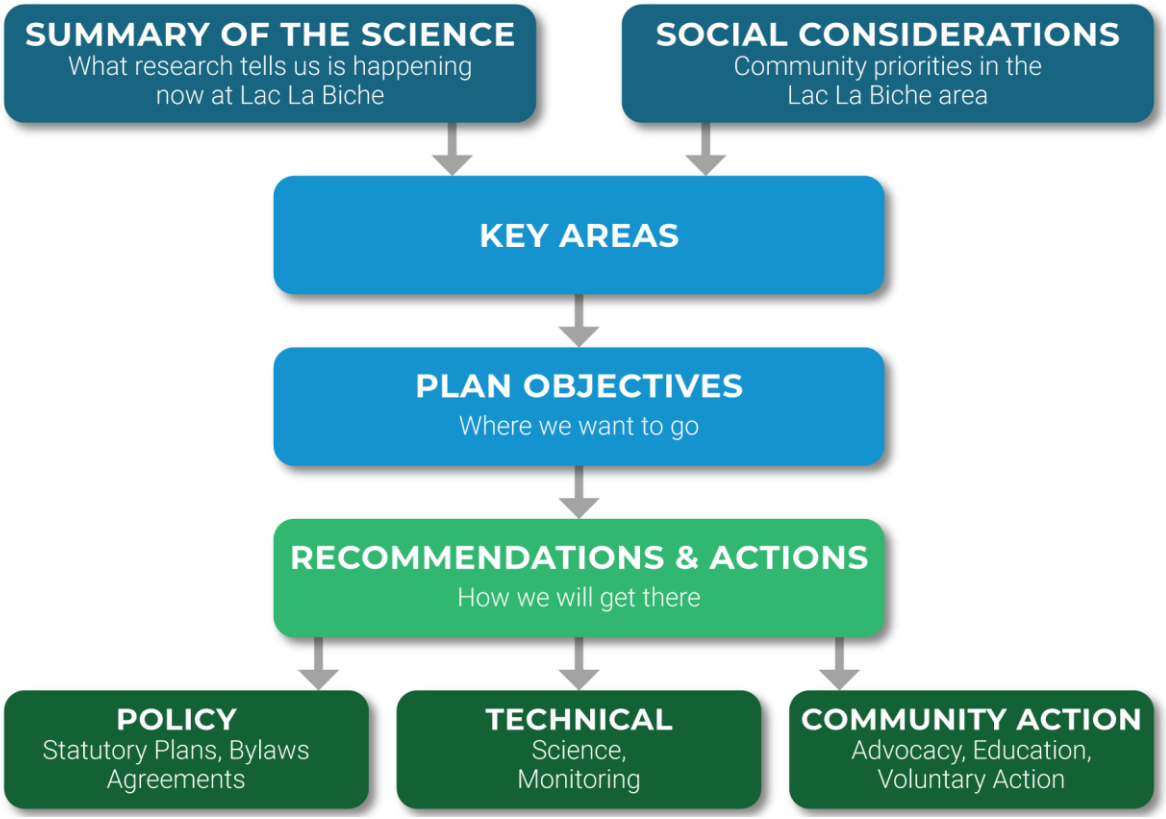


Figure 13. LLBWMP Road Map

The recommendations and actions in the LLBWMP are organized into four main areas:

The Watershed Lands

The Shoreline

The Lake

Working Together

6.2 OBJECTIVES

The Objectives are statements about the desired outcomes for the LLBWMP. They provide clear direction pertaining to the purpose of the LLBWMP as it relates to the each of the identified issue areas.

6.3 RECOMMENDATIONS AND ACTIONS

The purpose of the recommendations and actions are to provide solutions to the issues identified in the LLBWMP. The LLBWMP includes three types: Policy, Technical, and Community Action.

Policy

Policy and regulatory guidance to control development and implement conservation and restoration strategies. Policy, statutory plans, and land use bylaws are how municipal governments implement watershed management planning to improve the health of the lake and watershed.

Technical

Technical refers technical actions on the part of experts and agencies to improve the state of knowledge and support stewardship activities. This may include studies, reports, guidelines, monitoring programs, etc.

- Planning and Land Use Controls: statutory planning, drainage/water quality/engineering guidelines.
- Research: ongoing basic and applied research and monitoring to address information gaps to help make better management decisions (e.g., lake water quality, riparian health assessments, etc.).
- Mapping and Plan Monitoring: mapping to support implementation and monitoring LLBWMP recommendations, monitoring programs to evaluate LLBWMP recommendations, etc.

Community Action

Community Action refers to stewardship and outreach actions on the part of individuals and organizations to make changes. The volunteer actions of local residents, businesses, recreation, agriculture, and oil and gas operators, etc. are very important. Organizations and communities such as Healthy Waters Lac La Biche, municipalities, First Nations, Métis Settlements and other Indigenous communities/organizations, and agriculture and industry associations play a key role in promoting beneficial practices and providing information, education, and support. The LLBWMP asks all individuals and organizations to:

- Seek out information and beneficial practices relevant to their situation.

The recommendations and actions in the LLBWMP are categorized into three types:

Policy

Technical

Community Action

- Assess their own properties and operations.
- Make beneficial changes incrementally.
- Encourage others and Councils to make appropriate changes.
- Support volunteer watershed groups such as Healthy Waters Lac La Biche.

6.4 IMPLEMENTATION AND ACCOUNTABILITY

The recommendations and actions are presented in a tabular form to show how the LLBWMP will be implemented. Alongside of each recommendation are listed the roles, time frames and success indicators/measures.

Roles

Identification of organizations with primary and support roles in the implementation of the tasks. Roles are allocated into two types: Lead and Support.

Being a "Lead" means that this agency or group is best suited to track and organize resources to make progress on the recommendation. Achieving outcomes with Lead organization internal resources is not necessarily expected or required. A Lead agency needs to work with organizations or resources that can accomplish the identified outcomes. The abbreviations to be used in the recommendation tables are as follows:

LLB	Lac La Biche County
HW	Healthy Waters Lac La Biche
GoA	Government of Alberta
MUN	Municipalities
NGO	Non-Governmental Organization
TS	Technical Specialist/Researcher
LA	Local Authorities
IN	Indigenous Communities (First Nations, Métis Settlements, other Indigenous organizations)
O	Operators (aggregate, forestry, farms, golf course, oil and gas, etc.)

Time frame

The anticipated length of time to accomplish progress on each identified recommendation. Lead time is often needed for movement on a given recommendation.

Roles for the recommendations and actions are allocated into two types:

Lead

Support

Success Indicators/Measures

Metrics to assess the level of success of specific recommendations and actions. Two different kinds of indicators will be provided in the LLBWMP:

1. Performance indicators (e.g., rating systems, numeric levels, progress status, etc.),
2. Milestone indicators (e.g., specific event or achievement).

7. THE WATERSHED LANDS

Most of the lands within the LLBWMP plan area are considered "watershed lands". Watershed lands encompass all lands, water bodies and watercourses that are not directly adjacent to the legal bank of Lac La Biche.

Key findings from the Summary of the Science have been organized into four Focus Areas:

- Land Cover and Biodiversity
- Land Use and Phosphorus Management
- Clean Runoff
- Groundwater Quality

Plan Objectives have been identified for each of the focus areas with supporting recommendations and actions to provide an action plan with clear, achievable steps to support the plan objectives. For the Objectives in The Watershed Lands as well as The Shoreline and The Lake, there are recommendations that are relevant to multiple Objectives. Where there is overlap, duplication of recommendations was minimized where possible.

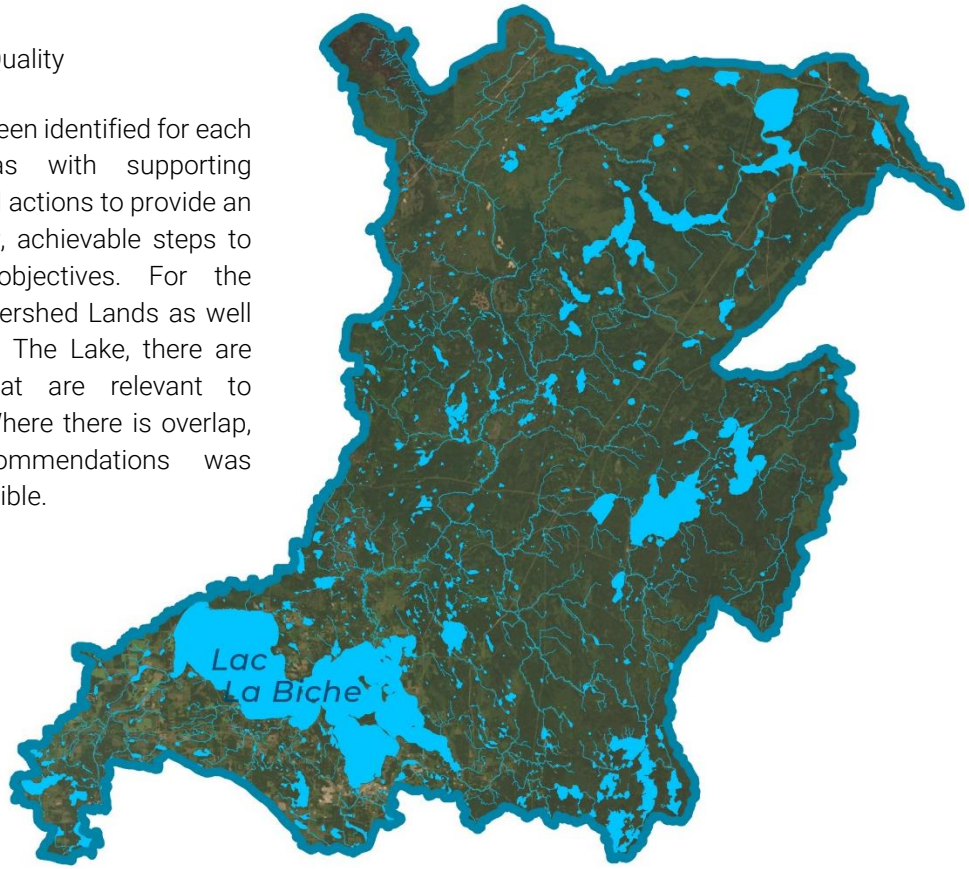


Figure 14. The Watershed Lands

The Watershed Lands is organized into four focus areas:

1. **Land Cover and Biodiversity**
2. **Land Use and Phosphorus Management**
3. **Clean Runoff**
4. **Groundwater Quality**

7.1 LAND COVER AND BIODIVERSITY

Key findings identified in the Summary of the Science are outlined below, which informed the recommendations outlined the tables on the subsequent pages.

7.1.1 Key Findings

- Land cover is directly related to the sources and quantity of phosphorus affecting the lake. 32% of the phosphorus that enters the lake is deposited within the lake, while only 17.5% of it leaves via the outflow, representing a net gain in phosphorus. This indicates that it is important to minimize the amount of new phosphorus entering the lake.
- Due to their tremendous importance, key natural lands such as wetlands and forested riparian buffers next to tributaries should be targeted for restoration. Land use activities should also be limited in these areas.
- The coverage and ecological condition of land cover types with low phosphorus (e.g., forests grasslands and wetlands) should be maintained and/or improved in strategic areas.
- A significant function of wetlands is their ability to trap and retain nutrients. Furthermore, wetlands provide necessary habitat for countless species. To increase these functions in the Lac La Biche watershed, wetlands should be conserved and restored.
- Promoting natural forest buffers will add to biodiversity (species diversity) important to the ecosystem health of the watershed.
- The Owl River restoration program is ongoing and efforts in the short-term should capitalize on this initiative to maintain and restore riparian cover in the watershed.
- With a range of landscapes and habitats, a variety of wildlife species are documented within the Lac La Biche watershed.
- Lac La Biche is designated as a Provincial Game Bird Sanctuary to protect waterfowl and their nesting locations, many of which are found in Lac La Biche's riparian areas and on the lake's islands.
    - Lac La Biche has been part of Important Bird Areas (IBA) Canada since 1996 based on its habitat biodiversity and colonial nesting history. IBA sites support specific groups of birds: threatened birds (e.g., Western Grebe), large groups of birds, birds restricted by range or by habitat.
- There are identified nesting sites within the watershed for Great Blue Herons, American White Pelicans and Trumpeter Swans.
- There are two ranges for Boreal Caribou within the watershed.
- There is a Key Wildlife Biodiversity Zone that follows the Owl River, which is important for the viability and productivity of wildlife populations.

The coverage and ecological condition of **land cover types with low phosphorus, such as forests grasslands and wetlands,** should be maintained and improved in strategic areas.

OBJECTIVE 1: LAND COVER AND BIODIVERSITY

Increase land cover types that have lower nutrient release rates, trap nutrients and promote biodiversity.

The Objective aligns with these Goals:

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
1.1	Low Intensity Development: Encourage and facilitate low-intensity development to maximize the relative proportion of natural land cover by including regulations in municipal land use bylaws: • Encourage the retention of existing tree stands. • Require development permits for the clearing of vegetation (this does not include removal of dead vegetation). • Limit the maximum percentage of developed lots that are non-permeable surfaces. • Require landscaping plans to include minimum percentage of a developed lot as vegetative cover. • Development that occurs near or within wetlands should be consistent with the Alberta Wetland Policy. • Maintain and improve existing, identified riparian buffers within municipal land (ER and MR lands). • Development which would damage or destroy permanent wetlands shall be discouraged within the watershed. • When a wetland is permanently affected within the watershed, the wetland replacement should occur within the watershed.	Policy	**	**	**
1.2	Growth Areas: Where additional growth and higher density development is proposed, encourage the development to be located: • In areas where municipal services can be provided; • within hamlet growth areas, estate residential areas, or urban service areas as identified in the County's MDP.	Policy	**	**	**
1.3	Owl River Riparian Restoration: Continue the Owl River riparian area restoration project that is currently underway.	Technical	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
1.4	**High-priority Ecological Areas for Restoration and Protection:** Leverage current riparian restoration efforts on the Owl River by expanding the work to new areas along the Owl River and along other tributaries that discharge directly to Lac La Biche. Identify new high-priority ecological areas for water quality, water quantity, and fish and wildlife habitat (e.g., important headwaters, critical riparian areas, drainages to the lake, critical spawning areas) to support decision-making regarding which areas to focus additional naturalization protection and restoration projects.	Technical	**	**	**
1.5	**Wetland Restoration:** Collaborative work among Lac La Biche County, Indigenous communities, NGOs, and private landowners to identify damaged wetlands that could be restored, or sites appropriate for new wetland construction. Such sites could be used to retain water, sediment, and phosphorus prior to reaching the lake or one of its tributaries. Participate in the newly-established Wetland Replacement Program for funding.	Policy/Community Action	**	**	**
1.6	**Reforestation and Restoration:** Encourage the reforestation and restoration of wetlands and riparian areas on sites where the use that created the damage has been discontinued.	Policy/Community Action	**	**	**

*Policy, Technical, or Community Action

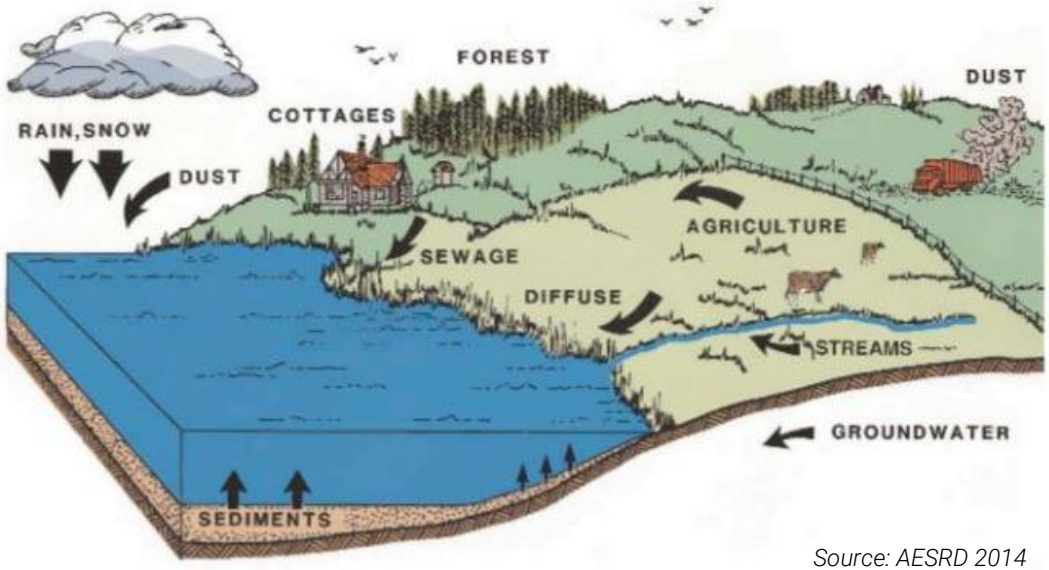
**Will be established by the Implementation Committee

7.2 LAND USE AND PHOSPHORUS MANAGEMENT

Key findings identified in the Summary of the Science are outlined below, which informed the recommendations outlined the tables on the subsequent pages.

7.2.1 Key Findings:

- In the 20th century, the forests of the southern and western parts of the lake's watershed have been gradually cleared.
- The main industry drivers are oil and gas, aggregate, forestry, agriculture, and tourism.
- Industrial operators such as for aggregates, forestry, and oil and gas, are regulated through the *Water Act, Public Lands Act, Forest Act* and/or the *Environmental Protection and Enhancement Act* (EPEA). These operators are allowed to operate under stringent regulatory requirements as stipulated in regulatory approvals. These requirements are consistent with those presented in the WMP. Environmental protection and enhancement measures above and beyond those listed in regulatory approvals can be implemented by operators on a voluntary basis. Other than through provincial legislation, decisions by provincial regulators on land and water use are influenced by Regional Land Use Plans/Integrated Land Management Plans/Access Management Plans (under the Land Use Framework) and Watershed Management Plans (as per the Alberta *Water for Life Strategy*).



Source: AESRD 2014

Figure 15. Typical Phosphorus Sources to Lakes

32% of the phosphorus that enters the lake is deposited within the lake, while only 17.5% of it leaves via the outflow, which represents a net gain in phosphorus. This demonstrates the importance of minimizing the amount of new phosphorus entering the lake by improving land use practices.

- Other land use activities in the watershed include urban development (hamlets, primarily located near the lake), rural residential development.
- On a large scale, the watershed is relatively undisturbed, however, at a smaller scale, disturbance to the land has been increasing in the last 10 years.
- Lac La Biche is a source of water for agriculture, forestry, oil and gas, recreation/tourism, and domestic and municipal users.
- Lac La Biche County implemented the Riparian Setback Matrix Model (RSMM) in 2010. The RSMM is used to determine the allocation of Reserves (e.g., Environmental Reserve) at time of subdivision to help protect riparian areas. Although the program has been very successful at the planning stage, the main challenge Lac La Biche County has encountered with the implementation of this policy is the confirmation that the ER/RDS has been implemented and respected at the time of construction. Another challenge is that it can be difficult to measure all parameters that are used to determine the setback.

OBJECTIVE 2: LAND USE AND PHOSPHORUS MANAGEMENT

Improve phosphorus management for all land use activities to achieve a net reduction in nutrient runoff and promote biodiversity.

The Objective aligns with these Goals:

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
2.1	Riparian Setback Matrix Model (RSMM): Complete a review of the effectiveness of implementation of Riparian Setback Matrix Model, focusing on the practical application of the approach and examining potential enforcement approaches.	Technical / Policy	**	**	**
2.2	Stormwater Best Management Practices: In residential areas, encourage the implementation of stormwater BMPs and low impact development (LID) practices in existing and new developments to reduce the export of phosphorus and other pollutants.***	Policy / Community Action	**	**	**
2.3	Septic Systems: Encourage the removal of septic fields, in addition to upgrades to sewage/septic infrastructure of cottages and public use areas (where antiquated or ineffective) to improve the water quality of Lac La Biche.	Policy	**	**	**
2.4	Septic Maintenance Education: Engage in public education of septic field maintenance and municipal inspection programs (voluntary or otherwise) to maximize septic field efficiency.	Policy / Community Action	**	**	**
2.5	Incentive Programs: Consider the development of incentive programs for property owners near water bodies and watercourses that implement stormwater management BMPs, LID, restoration of riparian area vegetation, etc.	Policy / Community Action			
2.6	Ranching and Hobby Farm Best Management Practices: Continue and encourage ranching and hobby farm BMPs including but not limited to: • Reducing the intensity of grazing and trampling near riparian areas and the shorelines of watercourses (e.g., Owl River) and water bodies (e.g., Lac La Biche); • Providing water alternatives away from watercourses (e.g., Owl River) and water bodies (e.g., Lac La Biche); Manure management near riparian areas, watercourses (e.g., Owl River) and water bodies (e.g., Lac La Biche).	Policy / Community Action	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
2.7	**Agriculture Best Management Practices:** Continue and encourage use of agriculture BMPs that promote soil health and responsible resource use including but not limited to: • Conservation tillage programs to reduce the erodibility of soils and the subsequent potential for export via runoff. • Precision agriculture approaches to avoid the export of excess nutrients off the land and into waterways by carefully controlling the application rate, timing, and placement of inorganic fertilizers or manure (e.g., encourage use of environmental farm plans). • Consider the preservation of low-intensity agricultural areas as a form of preserving natural land cover. • 4R nutrient management (right fertilizer source, right rate, right time, right place)	Policy / Community Action	**	**	**
2.8	**Low-Phosphorus Development Standards:** Incorporate low-phosphorus development standards in Land Use Bylaws, statutory plans and other bylaws such as: • Bylaws to restrict fertilizers and pesticides usage • Include phosphorus as a parameter of consideration in municipal approvals (e.g., stormwater management approvals)	Policy / Community Action	**	**	**
2.9	**Golf Course – Audubon Cooperative Sanctuary Program:** Pursue certification with the Audubon Cooperative Sanctuary Program for the Lac La Biche Golf and Country Club.	Policy	**	**	**
2.10	**Industry Operations:** Implementation of the LLBWMP should include meaningful engagement with industry operators and the provincial government to identify potential voluntary actions and potential regulatory tools that can be used moving forward.	Policy	**	**	**
2.11	**Industry Operations:** Encourage industry operators and Alberta and Environment and Parks to monitor the cumulative effects of industrial developments in the watershed.	Policy / Technical	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
2.12	**Monitoring Cumulative Effects:** Implementation Committee to pursue partnerships with other organizations to identify opportunities to monitor cumulative effects of industrial developments on air quality, ground water quality, drinking water quality and biodiversity within the watershed.	Community Action / Technical	**	**	**

*Policy, Technical, or Community Action

**Will be established by the Implementation Committee

***Principles and practices for implementing LID practices can be found in the 2020 Alberta Clean Runoff Action Guide (Alberta Low Impact Development Partnership 2020).

7.3 CLEAN RUNOFF

Key findings identified in the Summary of the Science are outlined below, which informed the recommendations outlined the tables on the subsequent pages.

7.3.1 Key Findings

- Stormwater may contain a significant quantity of toxic metals, salts, nutrients, oil and grease, bacteria, and other contaminants. These contaminants should be intercepted to reduce contamination from runoff.
- In 2008, the County commissioned a stormwater management plan that recommended improving the quality of stormwater prior to discharge into the lake by incorporating Oil Grit Separators (OGS) as part of the stormwater management system.
- Conserving and restoring wetlands enables water retention on the landscape, which will prevent downstream flooding and damage to infrastructure such as culverts and bridges.
- Maintaining intact riparian areas and wetlands can naturally intercept and retain pollutants.
- Of all the tributaries, the Owl River is the most important to the hydrology and water quality of Lac La Biche.
- Riparian areas leading up to and including walleye spawning habitat in the Owl River have been identified as prime importance.

Figure 16. Locations of Oil Grit Separators in the Hamlet of Lac La Biche

Stormwater may contain a significant quantity of toxic metals, salts, nutrients, oil and grease, bacteria and other contaminants. **These contaminants should be intercepted to reduce contamination from runoff.**

OBJECTIVE 3: CLEAN RUNOFF

Encourage clean runoff practices and design to reduce the transport of nutrients and sediment to Lac La Biche.

The Objective aligns with these Goals:

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
3.1	**Oil Grit Separators:** Determine other locations around the lake and its main tributaries (e.g., Red Deer Brook) where oil grit separators would be beneficial.	Technical	**	**	**
3.2	**Salt Usage:** Limit the use of salts on local shoreline roads and driveways to limit the increase in lake salinity via runoff where possible, while maintaining safety for people using the roads.	Policy	**	**	**
3.3	**ECO Plans:** Consider adopting Alberta Transportation's Environmental Construction Operations Plan framework (**ECO plans**) for construction activities to ensure that contractors systematically identify and mitigate environmental impacts that may result from bridge or culvert replacement projects, as well as any project in or adjacent to environmentally sensitive areas.	Policy	**	**	**
3.4	**Crossings:** When designing culvert or bridge capacity, design for larger flood events (e.g., 1:100 year flood or more), to take into account climate change and potential culvert damage that would add a significant amount of sediment to downstream environments.	Technical/Policy	**	**	**
3.5	**Crossings:** Collaborate with Alberta Transportation to explore the feasibility of designing crossings to accommodate major flood events.	Technical/Policy	**	**	**
3.6	**Emergency Management Plans:** Explore the feasibility of updating Emergency Management Plans to identify priority locations for installing oil booms to contain highway of rail spills to prevent leeching into water bodies or watercourses.	Policy	**	**	**
3.7	**Construction Activity Management:** Require construction activities to be carried out in such a manner that minimum suspended sediments are created (see ECO Plans above).	Policy	**	**	**
3.8	**Lot Grading and Drainage:** Develop and implement Standard Design and Construction Guidelines for lot grading and drainage in new and previously developed areas.	Technical	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
3.9	**Lot Grading and Drainage:** Require lot grading to be carried out in accordance with available Standard Guidelines for Design and Construction. Also, see ECO Plans above.	Policy	**	**	**
3.10	**Source Control:** Direct stormwater in such a way that it does not run onto surfaces where pollutants can be picked up (pavement, exposed soil, etc.). The following practices can be applied: • Sweep pavement and roofs rather than washing; • Control erosion by stabilizing exposed soils and banks with vegetation (riparian vegetation programs); • Carry out landscaping in accordance with the Land Use Bylaw; • Minimize the use of pesticides and fertilizers; • Ensure proper handling, disposal and recycling of toxic metals, organic compounds, oil, and grease.	Policy/Community Action	**	**	**
3.11	**Clean Runoff Awareness:** Improve awareness about the importance of clean runoff and improve information sharing practices regarding the consequences, implications, and mitigation measures that can be implemented.	Community Action	**	**	**
3.12	**Stormwater Management Plan:** Continue to implement BMP recommendations from the County's Stormwater Management Plan (Genivar 2008).	Policy	**	**	**
3.13	**Stormwater Management and LID:** Incorporate the principles of low impact development (LID) into stormwater management practices.	Policy	**	**	**
3.14	**Encourage Lot-Level BMPs:** These BMPs (includes LID strategies) on individual lots reduce runoff volumes and/or treat stormwater onsite before it reaches the conveyance system.	Policy	**	**	**
3.15	**Conveyance System BMPs:** Encourage the use of engineered temporary surface ponding in backyard, parking lots, and parking areas including bio-swales and linear drainage channels.	Policy/ Community Action	**	**	**
3.16	**Conveyance System BMPs:** Transport runoff from developed areas through more natural means (e.g., grassed swales) to reduce peak stormwater discharge volumes.	Policy	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
3.17	**Environmentally Sensitive Areas - Development and Subdivision:** New residential multi-lot subdivision and development should be designed to exclude environmentally sensitive areas. Where environmentally sensitive areas are present, utilize the RSMM to determine the environmental and/or municipal reserves between subdivided lots and the environmentally sensitive areas. Where environmentally sensitive areas are present, establish setbacks for development from the environmentally sensitive areas utilizing: a. Recommendations from qualified professionals; b. Government of Alberta's Stepping Back from the Water: A Beneficial Management Practices Guide for New Development Near Water Bodies in Alberta's Settled Region; or c. ESRD Recommended Guidelines for Setbacks chart (see Appendix E).	Policy	**	**	**
3.18	**Environmentally Sensitive Areas - Development and Subdivision:** When reviewing a proposed subdivision or development in or adjacent to environmentally sensitive areas, consider the increases to nutrient and sediment loading due to cumulative land cover change, not just due to the individual project itself.	Policy	**	**	**
3.19	**Setbacks from Wetlands:** Require no-disturbance buffers around wetlands to protect function, improve storage and control runoff.	Policy	**	**	**
3.20	**Fertilizers and Pesticides:** For residential uses, prohibit cosmetic fertilizers and pesticides in or adjacent to environmentally sensitive areas (this does not apply to agricultural uses).	Policy	**	**	**
3.21	**Groundwater Quality Data:** Compile existing groundwater quality data that is available, and partner with Alberta Health Services to map and monitor groundwater quality in the watershed.	Technical	**	**	**

*Policy, Technical, or Community Action

**Will be established by the Implementation Committee

7.4 GROUNDWATER QUALITY

Key findings identified in the Summary of the Science are outlined below, which informed the recommendations outlined the tables on the subsequent pages.

7.4.1 Key Findings

- In Alberta, much of the water moving through the watershed is in the form of groundwater. Groundwater can be a receptor of pollutants and can transport them to surface water such as watercourses, wetlands, and lakes. Water will move down in the landscape and collect in the lowest points, such as Lac La Biche.
- Septic fields are a source of nutrient release into groundwater and the nearby lake.
- Wastewater servicing is provided to residential areas around the lake: Nashim Drive, Airport, Pleasant Acres, LLB West, John Martin Subdivision, Mission Village Phase 1, Mcgrane Road, Spruce Bay, Clearwater Cove, Ulliac Beach, Bellevue Subdivision, Eagle Haunt, Summit Heights, Green Banks, Sunset Bay, Lakeview Estates, Claude Lake, Old Trail

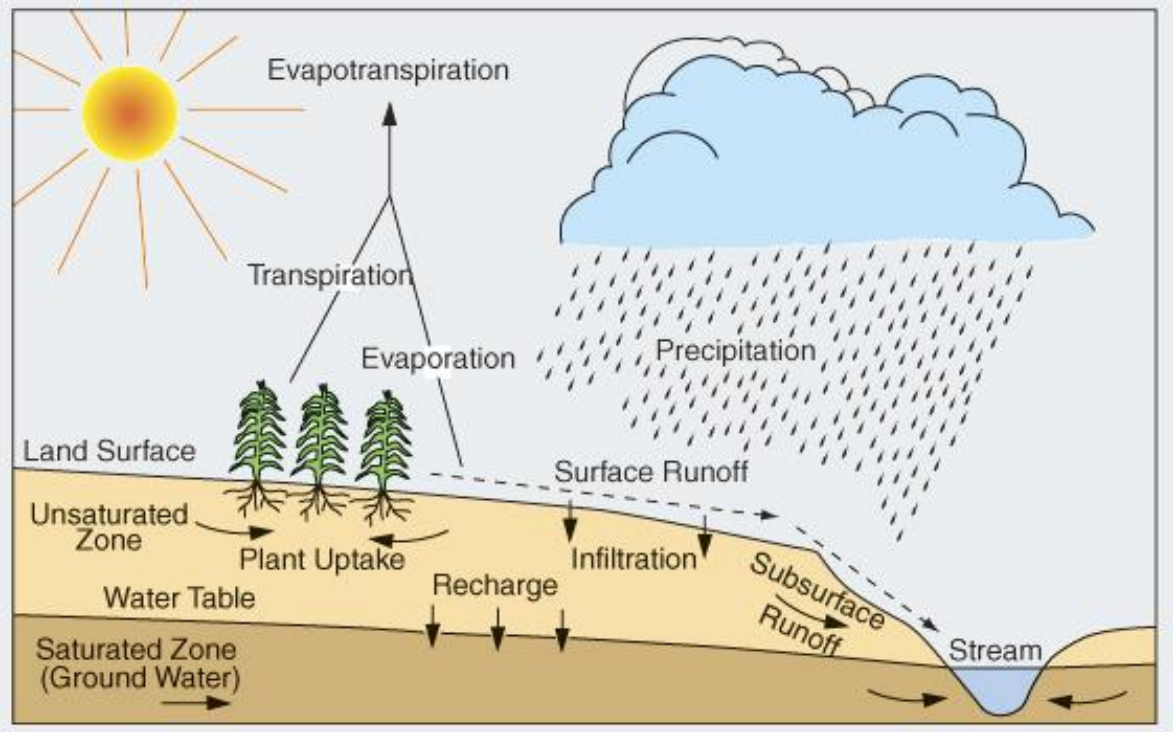


Figure 17. Movement of Runoff and Groundwater *Source: Kansas Geological Survey*

In Alberta, much of the water moving through the watershed is in the form of groundwater. **Groundwater can be a receptor of pollutants and can transport them to surface water such as streams, wetlands, and lakes.**

OBJECTIVE 4: GROUNDWATER QUALITY

Improve groundwater quantity and quality within the watershed to protect local drinking water and the water quality of Lac La Biche.

The Objective aligns with these Goals:

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
4.1	**Infiltration:** Implement on-lot infiltration systems and infiltration trenches for small basin areas only after evaluating the impact on groundwater.	Policy	**	**	**
4.2	**Statutory Plans and Land Use Bylaws:** Groundwater Conservation: Incorporate water conservation guidance tools into municipal statutory plans and development requirements.	Policy	**	**	**
4.3	**Wastewater Collection**: Support the extension of a regional wastewater system to lakeside communities including the Provincial Park campsites. Alternatively, investigate new local wastewater treatment technologies.	Policy	**	**	**
4.4	**Wastewater System Inspections**: Promote regular inspections of both private and communal wastewater systems for integrity and leakage. Systems that fail are to be reported and repaired.	Policy	**	**	**
4.5	**Wastewater Systems BMPs:** Encourage the adoption of wastewater (individual septic systems in particular) maintenance BMPs (e.g., septic sense workshops).	Community Action	**	**	**
4.6	**Water Wells**: Encourage homeowners to adopt water conservation and well maintenance practices (e.g., Government of Alberta Working Well program). Encourage organizations and municipalities to provide information and to host workshops, etc.	Community Action	**	**	**
4.7	**Industrial Groundwater Extraction**: Monitor permit applications and intervene where warranted on behalf of the watershed to maintain groundwater flows to the lake.	Policy/Community Action	**	**	**
4.8	**Peatlands and Recharge Areas:** Undertake a survey and inventory of peatlands and important recharge areas within the LLBWMP Area.	Technical	**	**	**

*Policy, Technical, or Community Action

**Will be established by the Implementation Committee

8. THE SHORELINE

The shoreline is a transitional zone between land and water, and it is affected by what happens on the land and in the water. For the purposes of the LLBWMP, the lands of the shoreline include both the riparian area and the wet near-shore (littoral) zone. The riparian area is the strip of moisture-loving vegetation growing along the edge of a water body or watercourse. The width of riparian areas can vary significantly. The littoral zone is the zone below the bank, and it includes the portion of the lake and its bed that is well lit by the sun and supports aquatic plants. A natural shoreline area protects against erosion and provides some of the most productive fish and wildlife habitat (Alberta Conservation Association).

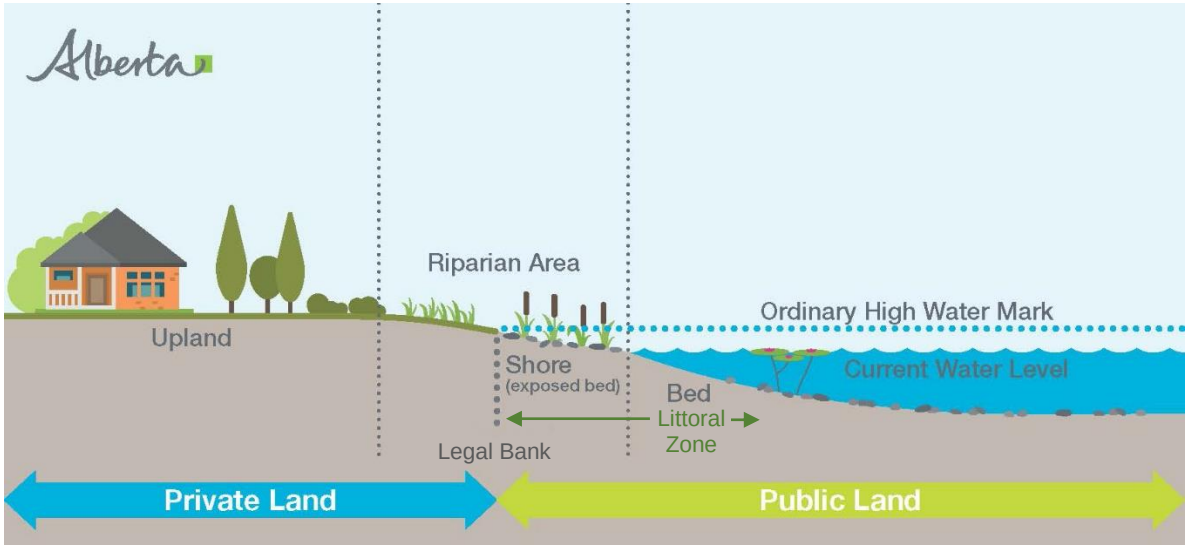


Figure 18. Cross section of a water body, riparian area, and upland area

Key findings identified in the Summary of the Science are outlined below, which informed the recommendations outlined the tables on the subsequent pages.

8.1.1 Key findings

- Riparian health surveys have been completed on a section of the lower Owl River but there is limited information on the health of other tributaries of Lac La Biche.
- The development footprint around the lakeshore is relatively small compared to total lakeshore area.

The Sensitive Habitat Inventory Mapping (SHIM) indicated **approximately 85% of Lac La Biche's shoreline was assessed as natural** in 2016.

- Perception that most aquatic plants are all “weeds”; educating the public on the ecological value of aquatic vegetation is important for the maintenance and improvement of these areas.
- Approximately 85% of Lac La Biche’s shoreline was assessed as natural in 2016 when the Sensitive Habitat Inventory Mapping (SHIM) was undertaken.
    - The lake shoreline segments range from 100% natural to 100% disturbed depending on the adjacent land cover and level of impact.
    - The most abundant land cover directly adjacent to the lake shoreline was natural areas, which occupied 65% of the shoreline, followed by commercial (12%), single family (12%), and natural park (11%). The remaining land covers were < 1% for agriculture, recreation and industrial.
    - Modified shorelines were most abundant along the southern shoreline of the eastern basin near the hamlet of Lac La Biche and adjacent to other areas of high-density development.
- The largest wetland was along the floodplain of the La Biche River fen area (northwestern basin).
- The shoreline was assessed using an Aquatic Habitat Index (AHI) in 2017, which is shown in the figure below:

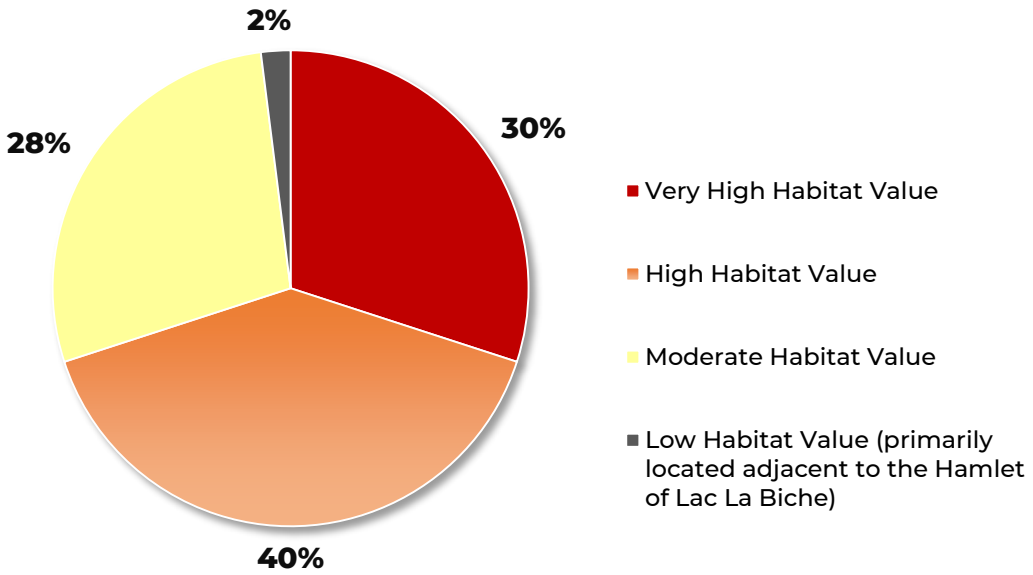


Figure 19. Habitat Value and Environmental Sensitivity represented by Aquatic Habitat Index Values for the Lac La Biche shoreline

The most abundant land cover directly adjacent to the shoreline was natural areas, **which occupied 65% of the shoreline.**

The Objective aligns with these Goals:

OBJECTIVE 5: THE SHORELINE

Improve the health and resilience of shoreline and near-shore areas.

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
5.1	**Riparian Vegetation:** Avoid and minimize, where possible, activities that involve the removal of riparian vegetation such as mowing, trimming, herbicide applications, cultivating, and land clearing.	Policy	**	**	**
5.2	**Shoreline Monitoring:** Engage in ongoing shoreline monitoring programs to prevent the infestation of aquatic invasive species and riparian invasive species.	Policy	**	**	**
5.3	**SHIM and Aquatic Habitat Index:** Incorporate SHIM Activity Risk Matrix and Aquatic Habitat Index for zones around Lac La Biche into municipal planning documents	Policy	**	**	**
5.4	**Conservation:** Conservation programs and measures should be focused on portions of the shoreline that have high to very high habitat value, as well as the four zones of sensitivity. These areas may be either put in reserve or have significant development restrictions.	Policy/ Technical	**	**	**
5.5	**SHIM:** Revisit SHIM ten years following the initial assessment to update the state of shoreline habitat and evaluate if restoration measures are increasing natural shoreline and habitat values.	Technical	**	**	**
5.6	**Riparian Health Survey for Tributaries:** Consider developing a riparian health survey for major tributaries in the watershed to address a gap in riparian health knowledge in the watershed.	Technical	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
5.7	Landowner Stewardship: Develop a landowner program to encourage shoreline protection and education as stewards. Partnerships could be formed with Cows and Fish and Alberta Conservation Association. This can target current landowners and developers to provide information and appropriate solutions to common concerns such as: • *Public Lands Act* and who owns what part of the shoreline (provincial, the Crown or the landowner); • Encouraging the use of shared docks and day use areas, instead of individual ones, and encouraging temporary/seasonal boat lifts and docks; • Eliminating the use of fertilizers and herbicides along the lakeshore properties.	Community Action	**	**	**
5.8	Littoral and Riparian Vegetation Education: Provide educational tools and materials to watershed property owners and lake visitors about the importance of riparian and littoral vegetation.	Community Action	**	**	**
5.9	Natural Vegetation: Encourage restoration and/or preservation of natural vegetation cover on shores instead of artificial armoring and modification of shorelines.	Policy	**	**	**

*Policy, Technical, or Community Action

**Will be established by the Implementation Committee

9. THE LAKE

Key findings identified in the Summary of the Science are outlined below, which informed the recommendations outlined the tables on the subsequent pages.

9.1.1 Key Findings

- Lac La Biche is highly "eutrophic", meaning it contains high nutrient concentrations that can result in large quantities of blue-green algae (cyanobacteria).
- Resident knowledge and a historical water quality study have confirmed that algal blooms have intensified over the past 200 years.
- The water column of the lake stratifies and mixes repeatedly throughout the summer. As a result, nutrients from the lake bottom are recycled to the surface where algae feed.
- Actions reduce to external loading into Lac La Biche should be proposed. Development of a nutrient reduction model may be an effective approach to determine what combination of activities will result in the most effective remediation. It is important to note that there will be a lag time between implementation of nutrient control measures and water quality improvements, which are gradual and long-term.
- Accurate and up-to-date water quality data for Lac La Biche lake and its tributaries is essential for updating the phosphorus budget and the development of an effective lake and watershed-scale water quality model.
- Lac La Biche has no reported sightings of aquatic invasive species as of 2019.
- The lake supports both indigenous and recreational fisheries for burbot, walleye, northern pike, yellow perch, and lake whitefish.
- The lake has had commercial fishing historically, which had led to overharvesting, but was closed in the province in 2014.
- There have been walleye stocking programs implemented since the 1980s, the most recent being from 2006 to 2011 (tied to a walleye restoration program; see McGregor 2014).

Lac La Biche is highly "eutrophic", meaning it contains high nutrient concentrations that can result in large quantities of algae.

9.1.2 Source Water Protection (SWP) Planning

Source water protection planning, which is a risk-management process designed to maintain or improve the conditions of drinking water and protect drinking water sources, is interconnected with watershed management planning. The quality and quantity of drinking water is influenced by activities that occur in the watershed. The challenges of growing populations, aging infrastructure, climate change, and limited water supplies have increased the need for a more integrated, collaborative approach to minimize the costs of water treatment, reduce public health risks, and protect sources of drinking water. The preparation of a SWP Plan was not within the scope of the preparation of this watershed management plan, but the LLBWMP recognizes the importance of SWP planning and consideration of preparing a SWP Plan in the future.

Source water protection planning is a risk-management process designed to maintain or improve the conditions of drinking water and protect drinking water sources

OBJECTIVE 6: THE LAKE

Improve knowledge about phosphorus and blue-green algae dynamics affecting the lake to reduce phosphorus loading, the intensity of algal blooms and support local fish populations.

The Objective aligns with these Goals:

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
6.1	**Lac La Biche Lake Water Quality Monitoring:** Continue monitoring Lac La Biche to contribute to long term data collection. Update trend analysis using recent data.	Technical	**	**	**
6.2	**Lac La Biche Lake Water Quality Monitoring:** Incorporate other water quality measures (such as heavy metals, suspended sediment, salinity, etc.) into the Lac La Biche lake monitoring program and collaborate with AHS and AEP to share and evaluate the data.	Technical	**	**	**
6.3	**Lac La Biche Lake Water Quality Monitoring:** Consider including invertebrate measurements in the Lac La Biche water quality monitoring program.	Technical	**	**	**
6.4	**Red Deer Brook Water Quality Monitoring:** Maintain the annual surface water quality monitoring program for Red Deer Brook to monitor improvements from the upgraded wastewater treatment plant.	Technical	**	**	**
6.5	**Tributary Water Quality Monitoring:** Expand the scope of the tributary (including Owl River) flow-based water quality monitoring evaluation and reporting program.	Technical	**	**	**
6.6	**Nutrient Budget:** Prepare a nutrient budget including internal and external loading estimates, based on up-to-date information and tools including tributary flow-based water quality and Lac La Biche lake water quality.	Technical	**	**	**
6.7	**Nutrient Reduction:** Develop a nutrient reduction model to determine what combination of activities will result in the most effective remediation with a relatively low level of risk.	Technical	**	**	**
6.8	**Algal Blooms:** Monitor the intensity and frequency of algal blooms.	Technical	**	**	**
6.9	**Algal Blooms:** Undertake research to identify the interactions of the complex factors that contribute to algal blooms in Lac La Biche.	Technical	**	**	**
6.10	**Public Beach Area:** Support the continuation of monitoring of public beach areas to support public health advisories pertaining to risks associated with blue-green algae.	Technical	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
6.11	**Invasive Species:** With provincial partners, develop a response strategy and monitoring program to manage the occurrence of aquatic and riparian invasive species.	Technical	**	**	**
6.12	**Invasive Species:** Provide information to lake users and residents on how to recognize aquatic invasive species to improve early detection and eradication.	Community Action	**	**	**
6.13	**Fisheries and Cormorants:** Undertake monitoring of the fisheries, as well as cormorants and their co-nesting species.	Technical	**	**	**
6.14	**Cormorant Research:** Continue research on cormorant management.	Technical	**	**	**
6.15	**Source Water Protection Planning:** When reviewing the Lac La Biche County Drinking Water Safety Plan, utilize the Alberta Water Council's Guide to Source Water Protection Planning as a tool and guide during the review process.	Policy	**	**	**
6.16	**Source Water Protection Planning:** Research and explore the feasibility of a Source Water Protection (SWP) Plan. Considerations for the Plan may include: • Identification of protection zones; • Surface water protection; • Groundwater protection.	Policy / Technical	**	**	**

*Policy, Technical, or Community Action

**Will be established by the Implementation Committee

10. WORKING TOGETHER

Successful implementation of the LLBWMP will require coordinated efforts to take action on the recommendations and keep the plan as a "living" document that is consistently referred to throughout its lifetime.

The LLBWMP provides an opportunity to:

- Build common ground among the local communities, organizations, stakeholders, and the Government of Alberta;
- Coordinate actions and policies to move forward together; and
- Develop an implementation plan with defined responsibilities.

To successfully achieve the desired objectives identified within the LLBWMP, municipalities, local authorities, government agencies, non-governmental and community organizations, communities, residents, industry, other stakeholders, and all partnering interest groups must take steps to implement their respective recommendations and actions to the best of their ability. The success of the LLBWMP is dependent on integration of the proposed objectives into policy and regulatory documents which guide land use and land management activities within the watershed.

Further, the continued involvement of dedicated volunteer organizations and a commitment from local landowners within the watershed to work together and, where appropriate, take voluntary action to improve the ecological function of conservation features within the watershed will significantly impact the successful implementation of the LLBWMP. This plan embraces the idea that "we are stronger together" and acknowledges that everyone has a role to play in implementation.

In this section, one of the most important recommendations is to establish an Implementation Committee to oversee the implementation of the LLBWMP. Addressing the resources and effective organizational structures, monitoring progress, updating the plan, providing annual updates, and developing detailed guidelines will be an ongoing role of Lac La Biche County and the Implementation Committee.

The objectives and recommendations on the following page have been proposed to improve the successful implementation of the LLBWMP.

Successful implementation of the LLBWMP will require **coordinated efforts to take action on the recommendations.**

OBJECTIVE 7: WORKING TOGETHER

Improve regional collaboration, partnerships and organizational effectiveness to promote collaboration action for a healthy watershed, healthy lake and healthy community.

The Objective aligns with these Goals:

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
7.1	**Implementation Committee:** Establish an external committee of Lac La Biche County to oversee administration of the LLBWMP including implementation, monitoring progress, annual updates, updating the plan, etc. The Committee should have representation from County Council and Administration, Healthy Waters Lac La Biche, local and regional non-governmental organizations, Indigenous communities, industry operators, and other organizations that were represented on the Steering Committee that prepared this LLBWMP.	.Policy / Community Action	**	**	**
7.2	**Establish Roles, Time Frames, Success Indicators/Measures for WMP Recommendations:** Establish the Roles, Time Frames, and Success Indicators/Measures, and Priorities using the template in Appendix A (to be completed by the Implementation Committee). As part of this process and as the recommendations in the WMP are implemented: • Identify areas where Success Indicators/Measures have already been identified and where they do not exist; • Develop and clarify specific Success Indicators/Measures where they have not been identified.	Policy/ Community Action	**	**	**
7.3	**Regional Plans and Strategies:** Encourage the consideration of the Lac La Biche watershed and incorporation of the recommendations in this LLBWMP when regional plans and sub-regional plans are prepared and/or revised.	Policy	**	**	**
7.4	**Regional Plans and Strategies:** Work towards alignment with the Athabasca Integrated Watershed Management Plan (IWMP).	Policy	**	**	**
7.5	**Municipal Development Plans**: Incorporate the environmental protection policies of the LLBWMP.	Policy	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
7.6	**First Nations and Métis Settlements:** Continue discussion and relationship building with the First Nations and Métis Settlements to develop a deeper understanding of traditional ecological knowledge systems within the watershed.	Policy / Community Action	**	**	**
7.7	**Source Water Protection Planning:** When establishing the priorities of the LLBWMP recommendations and actions and implementing the recommendations, utilize the Alberta Water Council's *Guide to Source Water Protection Planning* as a guide, where appropriate.	Policy / Technical	**	**	**
7.8	**Industry Operators and Stakeholders:** Share the LLBWP with industry operators and stakeholders (forestry, gravel, oil and gas, etc.)	Community Action	**	**	**
7.9	**Industry Operators and Stakeholders:** Engage with industry operators at time of application (renewal, new construction, etc.) and that industry operators consider the LLBWMP at time of application in the design/planning of renewal and new developments.	Community Action	**	**	**
7.10	**Mapping:** Prepare mapping to assist with the implementation of recommendations in the LLBWMP: • Sub-watersheds of the Lac La Biche watershed; • Inventory of wetlands within the Lac La Biche watershed; • Dispositions and protective notations on Crown Land; • Serviced/un-serviced areas (water, wastewater); • Location of aggregate development; • Location of peat operations; • Environmentally Significant Areas (ESAs); • Wildlife Biodiversity Zones; • Environmentally sensitive areas.	Technical	**	**	**
7.11	**Research Opportunities and Priorities:** Establish a multi-disciplinary working group/sub-committee to: • Identify research opportunities and priorities; • Discuss issues and information that can be shared.	Technical	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
7.12	**LLBWP Updates:** At minimum, revisit the LLBWMP every ten years to accommodate the changing condition of the lake, success of current recommendations, new scientific knowledge, new legislation, and new stakeholder and organizational assets and interests.	Policy	**	**	**
7.13	**LLBWMP Annual Updates:** • Provide an update on the implementation progress and the actions completed (See template in Appendix A); • Review and update priorities (See template in Appendix A); • Provide the public with the update (see Communications and Engagement Plan recommendation below).	Policy	**	**	**
7.14	**Assess Organizational Assets:** Investigate organizational options to increase effectiveness, staff resources, financing, risk management, and accountability in undertaking watershed and lake management tasks, including coordination of scientific inquiry, action by municipalities, and community action.	Policy	**	**	**
7.15	**Incentives to Promote Voluntary Action:** Develop non-monetary and monetary incentive programs to promote voluntary action for individuals, municipalities, and organizations	Community Action	**	**	**
7.16	**Communication and Engagement Plan:** Establish a communications and engagement plan for disseminating and reporting LLBWMP progress to and amongst stakeholders and the public. Important considerations include but are not limited to: • Current status of implementation of recommendations; • Actions local residents can take to implement the LLBWMP; • Providing clarity that actions to improve water quality can be gradual and long-term; • Monitoring, restoration, and protection programs and activities undertaken in the watershed by the County, Government of Alberta, stakeholders, Indigenous communities, Healthy Waters, Cows and Fish, Alternative Land Use Services (ALUS), Alberta Lake Management Society (ALMS), and other relevant organizations.	Community Action	**	**	**

#	RECOMMENDATIONS	TYPE*	ROLES	TIME FRAME	SUCCESS INDICATOR / MEASURE
7.17	**Monitoring Plan:** Develop a monitoring plan for environmental trends including lake and tributary water quality and for plan performance including fulfillment of success measures. Identify resources and funding to conduct the monitoring program.	Technical	**	**	**

*Policy, Technical, or Community Action

**Will be established by the Implementation Committee

11. CONCLUSION

The LLBWMP provides a comprehensive, science-based strategy to coordinate action for the protection and improvement of Lac La Biche, its shore lands, and its watershed. The roadmap provided by the LLBWMP will enable coordinated action of all parties concerned about the health the Lac La Biche and its watershed.

One of the key goals for the preparation of the plan was to develop an implementable plan. To provide a framework and tools for successful implementation, the recommendations in Section 11 - Working Together and the reporting tool in Appendix A - Implementation Priorities Report were prepared. These recommendations and tools aim to help the Implementation Committee, Lac La Biche County, local authorities, government agencies, non-governmental and community organizations, local communities, residents, industry, other stakeholders and all other parties concerned about the watershed successfully implement the LLBWMP and achieve the plan's vision and goals.

Successful implementation of the LLBWMP will support the plan vision to **protect and restore the lake and watershed by leading in knowledge sharing, research, policy, and action.**

12. GLOSSARY

12.1 ACRONYMS AND SHORT FORMS

ABMI	Alberta Biodiversity Monitoring Institute
AEP	Alberta Environment and Parks
ALUF	Alberta Land Use Framework
ALSA	*Alberta Land Stewardship Act*
ASP	Area Structure Plan
AWC	Athabasca Watershed Council
County	Lac La Biche County
ESA	Environmentally Significant Area
IDP	Intermunicipal Development Plan
IRP	Integrated Resource Plan
IWMP	Integrated Watershed Management Plan
LLBWMP	Lac La Biche Watershed Management Plan
LARP	Lower Athabasca Regional Plan
LID	Low Impact Development
LUB	Land Use Bylaw
MDP	Municipal Development Plan
MGA	*Municipal Government Act*
SHIM	Sensitive Habitat Inventory Mapping
WMP	Watershed Management Plan
WPAC	Watershed Planning and Advisory Council

12.2 DEFINITIONS

Adaptive Management

A dynamic system or process of task organization and execution that recognizes the future cannot be predicted perfectly. Planning and organizational strategies are reviewed and modified frequently as better information becomes available. Adaptive management applies scientific principles and methods to improve management activities incrementally as decision-makers learn from experience, collect new scientific findings, and adapt to changing social expectations and demands. (Glossary of Water Terms Used in Alberta)

Algal Bloom

A heavy growth of algae in and on a body of water that is often triggered by environmental conditions such as high nitrate and phosphate concentrations. The decay of algal blooms may reduce dissolved oxygen levels. (Glossary of Water Terms Used in Alberta)

Area Structure Plan (ASP)

A statutory plan identifying many neighbourhoods where residential, commercial, institutional, and recreational areas will be located in a previously undeveloped area. These plans also describe the number of people expected to live in the new area and how development will be staged over time.

Bed and Shore

The bed and shore of a body of water shall be the land covered so long by water as to wrest it from vegetation or as to mark a distinct character on the vegetation where it extends into the water or on the soil itself. (*Surveys Act)*

Best Management Practices (BMPs)

Techniques and procedures that have been proven through research, testing, and use to be the most effective and appropriate for use in Alberta. Effectiveness and appropriateness are determined by a combination of: (1) the efficiency of resource use, (2) the availability and evaluation of practical alternatives, (3) the creation of social, economic, and environmental benefits, and (5) the reduction of social, economic, and environmental negative impacts. (Glossary of Water Terms Used in Alberta)

Bioavailability

The amount of a nutrient that is in a form that is available for uptake and use by biological organisms. (ALMS)

Biodiversity

The variability among living organisms and the ecological complexes of which they are a part. This includes the diversity found within and between species and ecosystems. (Glossary of Water Terms Used in Alberta)

Blue-Green Algae

Blue-green algae (also called cyanobacteria) are a type of bacteria that occur naturally in many lakes, ponds and reservoirs. These bacteria can multiply rapidly during the summer, leading to extensive growth called a bloom. Some bloom-forming types of blue-green algae (cyanobacteria) produce toxins. When these blooms die and decay, these toxins may be released into the water. (Alberta Health Services).

Budget – Phosphorus

The identification and quantification of phosphorus entering and leaving the lake from external and internal sources.

Budget – Nutrient

The identification and quantification of nutrients (e.g., phosphorus, nitrogen, etc.) entering and leaving the lake from external and internal sources.

Chlorophyll

A green, light-absorbing pigment found in plants and other photosynthetic organisms. It is an essential electron donor in photosynthesis. The amount of chlorophyll present in lake water depends on the amount of algae and is therefore used as a common indicator of water quality. (ALMS)

Collaboration

A process through which parties who see different aspects of a problem can explore constructively their differences and search for (and implement) solutions that go beyond their own limited vision of what is possible. Collaboration is a mechanism for leveraging resources; dealing with scarcities; eliminating duplication; capitalizing on individual strengths; building internal capacities; and increasing participation and ownership strengthened by the potential for synergy and greater impact. (Glossary of Water Terms Used in Alberta)

Conservation

1. The planning, management, and implementation of an activity with the objective of protecting the essential physical, chemical, and biological characteristics of the environment against degradation.

2. The process of managing biological resources (e.g., timber, fish) to ensure replacement by re-growth or reproduction of the part harvested before another harvest occurs. A balance between economic growth and environmental and natural resource protection.

(Glossary of Water Terms Used in Alberta)

Cumulative Effects

Cumulative effects are the combined effects of past, present and foreseeable land use, over time, on the environment. (Government of Alberta definition for the purposes of land use planning).

Cyanobacteria

See Blue-green Algae

Development

A change in the use or intensity of use of land or a building or an act done in relation to land or a building that results in or is likely to result in a change in the use or the intensity of use of land or building. (Modified from the *Municipal Government Act*)

Dissolved Oxygen

The amount of oxygen dissolved in water a given temperature and pressure.

Drainage Basin

See watershed.

Ecosystem

A community of interdependent organisms together with the environment they inhabit and with which they interact. (Glossary of Water Terms Used in Alberta)

Ecosystem Functions

Processes that are necessary for the self-maintenance of an ecosystem such as primary production, nutrient cycling, and decomposition. The term is used primarily as a distinction from values. (Glossary of Water Terms Used in Alberta)

Environment

The components of the earth, including air, land, and water, all layers of the atmosphere, organic and inorganic matter, living organisms, and their interacting natural systems. *(Environmental Protection and Enhancement Act).*

Environmental Indicator

A measurement, statistic or value that provides a proximate gauge or evidence of the effects of environmental management programs or of the state or condition of the environment. (Glossary of Water Terms Used in Alberta)

Environmental Outcome

The desired environmental end state defining the specific conditions or functions that one expects for the environment. An outcome is an event, occurrence, or condition that results from an activity or program that has an actual effect on resources, the environment, or Albertans. (Glossary of Water Terms Used in Alberta)

Environmentally Sensitive Area

"Environmentally sensitive area means lands that exhibit one or more of the following:

a. hazard lands and areas that are unsuitable for development in their natural state (i.e., floodplains, steep slopes greater than 15%, unstable slopes, areas with high water tables);
b. areas that perform a vital environmental, ecological, or hydrological function (i.e., aquifers, groundwater recharge areas, or peatlands);
c. areas that contain unique geological or physical features;
d. watercourses and water bodies (including wetlands);
e. riparian areas;
f. forested areas and tree stands;
g. areas that contain significant rare or endangered animal or plant species; or
h. areas that provide wildlife habitat and/or an important link for the natural migration of wildlife."

Environmentally Significant Area (ESA)

ESAs are generally defined as areas that are important to the long-term maintenance of biological diversity, physical landscape features and/or other natural processes, both locally and within a larger spatial context (Jennings & Reganold 1991). ESAs are determined by quarter section based on scoring system that utilizes four criteria. ESAs do not represent government policy and are not necessarily areas that require legal protection, but instead are intended to be an information tool to help inform land use planning and policy at local, regional, and provincial scales.

Erosion

The natural breakdown and movement of soil and rock by water, wind, or ice. The process may be accelerated by human activities. (Glossary of Water Terms Used in Alberta)

Evapotranspiration

The combination of evaporation from the surface of soils and vegetation, plus the transpiration of water through plant leaves and vegetation. (Glossary of Water Terms Used in Alberta)

Eutrophic

Pertaining to a lake or other body of water characterized by large nutrient concentrations such as nitrogen and phosphorus and resulting high productivity. Such waters are often shallow, with algal blooms and periods of oxygen deficiency. (NALMS)

Eutrophication

The process by which bodies of water become enriched with dissolved nutrients, either from natural sources or human activities. Nutrient enrichment may cause an increased growth of algae and other microscopic plants, the decay of which can cause decreased dissolved oxygen levels. (Glossary of Water Terms Used in Alberta)

External Loading

See Loading – External.

Framework

An organized structure of policies, legislation, programs, and tasks created to achieve a specific outcome. There can be frameworks for broad policies and strategic initiatives at various scales (e.g., provincial, regional, sector, media); programs and program delivery; and short-term tasks and projects. (Glossary of Water Terms Used in Alberta)

Geographic Information Services (GIS)

A set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes.

Growth

Growth of a region or municipality is defined as increase in its size, population, or employment.

Governance

The process of decision-making and the process by which these decisions are implemented.

Guideline

A specific performance measure that is not legally binding unless designated in legislation. It is a guide or indication of a future course of action. It describes how something will be accomplished. It may contain numerical performance measures and may deal with multiple uses of water. (Glossary of Water Terms Used in Alberta)

Healthy Aquatic Ecosystem (Healthy Lake)

An aquatic environment that sustains its ecological structure, processes, functions, and resilience within its range of natural variability. (Alberta Water Council)

Hydrological Cycle

Refers to the processes by which water moves in the global environment. Includes condensation, precipitation, runoff, storage and evapotranspiration, and quantitatively measured using distribution and concentration. (ALMS)

Infill Development

Development in existing developed areas, occurring on vacant or underutilized lands, or redevelopment of a developed site to a higher density.

Infrastructure

Physical assets to provide services to citizens and to support the functioning of a local or regional economy, including roads, sewer lines, transit, emergency response vehicles, recreational facilities, parks, information technology and more. (Pigeon Lake Watershed Management Plan)

Infrastructure, Local

Infrastructure that has capital investment and maintenance requirements, including roadways, sidewalks, street lights and traffic signals, transit facilities, solid waste and water delivery systems, potable water distribution systems, storm sewers, sanitary sewers, sports fields, playgrounds, arenas, pools, police and emergency stations, civic buildings and parks to support the concept of complete communities. (Pigeon Lake Watershed Management Plan)

Infrastructure, Regional

Infrastructure developed by the federal government, Province, municipality, and/or regional service and provincial commissions to provide services to citizens and businesses, and to support the function of a regional economy (e.g., major interchanges, post-secondary institutions, hospitals, bridges, highways, extension of light rail transit, regional water and/or sewer systems, power systems). (Pigeon Lake Watershed Management Plan)

Infrastructure, Social

Social infrastructure, or soft infrastructure, can refer to services provided by or in municipalities such as hospitals, community and recreational facilities, public spaces, social housing, volunteer networks and community based agencies. (Pigeon Lake Watershed Management Plan)

Intermunicipal Development Plan (IDP)

A statutory plan is jointly prepared by two or more neighbouring municipalities and adopted by municipal bylaw to address land use and other matters as outlined in the *MGA*. Their main purpose is to establish strategic policies, identify issues in areas of mutual interest, and ensure that future growth reflects the mutual and individual interests of the municipalities involved. Typically, the focus is on the boundary area between rural and urban municipalities.

Intensification

The development of a property, site or area at a higher density than currently exists, such as redevelopment (including the reuse of Brownfield sites),

development of vacant and/or underutilized lots, the conversion or expansion of existing buildings, and infill development, which may include Greenfield sites with development densities higher than historical norms.

Internal Loading

See Loading – Internal.

Land Use Bylaw (LUB)

A Bylaw that divides a municipality into land use districts and establishes procedures for processing and deciding upon development applications. It sets out rules that affect how each parcel of land in a municipality may be used and developed.

Land Use Framework

A policy of the Government of Alberta to introduce and implement regional land use plans to ensure the long-term health of Alberta's communities, economy, and the environment.

Legal Bank

The line where the bed and shore of the body of water cease and the line is to be referred to as the bank of the body of water. The legal bank in Alberta is the line separating the Crown-owned bed and shore from the adjoining upland. (*Surveys Act)*

Littoral Zone

The littoral zone is the zone below the bank, and it includes the portion of the lake and its bed that is well lit by the sun and supports aquatic plants. (Alberta Conservation Association)

Loading – External

Phosphorus entering the lake from runoff from the watershed (e.g., measured flow from streams and creeks that enter the lake and unmeasured diffuse runoff), as well as atmospheric deposition, groundwater inputs and sewage.

Loading – Internal

The release of phosphorus from the lakebed sediments.

Low Intensity Development

"Low intensity development means development that is designed to:

- have a low residential density;
- generate relatively -small increases traffic volumes;
- avoid the modification of environmentally sensitive features including wetlands and riparian buffers;
- minimum the clearing of vegetation;
- provide a continuous system of open space along watercourses or forested areas;
- Utilize stormwater best management practices (e.g., low impact development) wherever possible.

Municipal Development Plan (MDP)

A statutory plan that functions as a municipality's overall policy guide for future growth and development. The LLBWMP outlines the direction of future development, the provision of transportation systems and municipal services, the coordination of municipal services and programs, environmental matters, and economic development.

Municipal Government Act (MGA)

The primary provincial legislation that governs municipalities is known as the *Municipal Government Act* (*MGA*, or the *Act*). The *MGA* sets out legislated roles and responsibilities of municipalities and municipal officials.

Municipal Reserve (MR)

Lands designated as "Municipal Reserve" are lands for schools, parks and public recreation purposes provided by the developer as part of the subdivision process.

Non-point Source Pollution

Non-point source pollution is contamination that cannot be identified as originating from one site. This type of pollution comes from a larger area of land and is carried by run-off and groundwater. *(Water for Life)*

Nutrient

An element essential for plant or animal growth. Major plant nutrients include nitrogen, phosphorus, carbon, oxygen, sulphur, and potassium. (Glossary of Water Terms Used in Alberta)

Nutrient Budget

See Budget – Nutrient.

Objective

The result of either planned or unplanned actions. For planning purposes, "objectives" are the desired endpoint and should guide the development and implementation of related programs. Outcomes can be broad and long-term in nature or focused. They are used in both direction setting and performance measurement.

Partnership

A relationship in which individuals or organizations share resources and responsibility to achieve a common objective, as well as any resulting rewards or recognition. It often includes a formal contract, new resources and shared risks and rewards. The structure includes a central body of decision-makers whose roles are defined. The links are formalized. Communication is frequent, the leadership is autonomous, and the focus is on specific issues. Partnerships are a form of collaboration. (Glossary of Water Terms Used in Alberta)

Phosphorus Budget

See Budget – Phosphorus.

Point-Source Pollution

Pollution that originates from one, easily identifiable cause or location, such as a sewage treatment plant or feedlot. *(Water for Life)*

Policy

A governing principle, plan, or consistent course of action developed in order to meet recognized needs and to achieve specific measurable outcomes. Policies are normally broad, conceptual documents that outline approaches and/or considerations to be taken into account by decision makers. Policies do not act as constraints, but provide information;

and/or;

A statement of intent that is not legally binding. It sets direction and expectations for activities. (Glossary of Water Terms Used in Alberta)

Pollutant

A contaminant in a concentration or amount that adversely alters the physical, chemical, or biological properties of the natural environment. (Glossary of Water Terms Used in Alberta)

Recreation Corridor

Inter-connected crown, public or private lands that are generally linear in form and are of regional significance for the purpose of providing recreational opportunities, such as the Great Trail or Alberta's Iron Horse Trail, walking trails and parks and open space. Regional Recreation Corridors may also provide access to municipal recreation opportunities.

Riparian Area

Pertaining to the banks of a river, stream, waterway, or other, typically, flowing body of water as well as to plant and animal communities along such bodies of water. (NALMS)

Riparian lands are transitional areas between upland and aquatic ecosystems. They have variable width and extent above and below ground and perform various functions. These lands are influenced by and exert an influence on associated water bodies, including alluvial aquifers and

floodplains. Riparian lands usually have soil, biological, and other physical characteristics that reflect the influence of water and hydrological processes. (Alberta Water Council)

Runoff

This refers to water that moves over the surface of the ground. Run–off collects sediments and contaminants as it moves from higher elevations to lower elevations. *(Water for Life)*

Shore or Shoreline

The edge of a body of water and includes the land adjacent to a body of water that has been covered so long by water as to wrest it from vegetation or as to mark a distinct character on the vegetation where it extends into the water or on the soil itself.

Smart Growth

Smart Growth is the planning, design, development, and revitalization of communities to promote a sense of place, the preservation of natural and cultural resources, and the equitable distribution of the costs and benefits of development. Smart Growth enhances ecological integrity over the short and long term and improves quality of life by expanding the range of transportation, employment, and housing choices in the region in a fiscally responsible manner.

Source Water Protection (SWP) Planning

Source Water Protection (SWP) Planning is a risk-management process designed to maintain or improve the conditions of water through proactive, collaborative identification, validation, assessment, and management of risk. The quality and quantity of drinking water is influenced by activities that occur in the watershed that supplies the drinking water system. In Alberta, SWP is a voluntary and collaborative process that has been undertaken by several groups. SWP is a component of broader water management in which a suite of approaches is implemented as a cost-effective way to ensure safe and secure water quality and quantity conditions. It is most closely linked to drinking water safety. (Alberta Water Council)

Stakeholder

An individual, organization, or government with a direct interest in a particular process or outcome. (*Water for Life*)

State of the Watershed Report

A document that identifies the current condition of a watershed including the physical, chemical, and biological characteristics of its surface and groundwater and the pressures acting on it. (Glossary of Water Terms Used in Alberta)

Statutory Plan

A plan approved by a municipality under the authority of the *MGA* with the passage of a municipal bylaw. Examples of a statutory plan are: an intermunicipal development plan (IDP), a municipal development plan (MDP), area structure plans (ASP), neighbourhood structure plan (NSP) and area redevelopment plans (ARP).

Stewardship

A principle or approach whereby citizens, industry, communities, and government work together as stewards of the province's natural resources and environment. In general terms, stewardship means managing one's life, property, resources, and environment with regard for the rights or interests of others. This can apply to a person, company, community, government, or group. Stewardship is an ethic and a value that results from public education and partnerships. It is people-focused in the sense that it relies on the desire and ability of people to make good decisions on their own accord that help resource and environmental outcomes. (Glossary of Water Terms Used in Alberta)

Stratification

The layering of water due to differences in density. As water warms during the summer, it remains near the surface while colder water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion). The narrow transition zone between the epilimnion

and cold bottom water (hypolimnion) is called the metalimnion or thermocline. (ALMS)

Summary of the Science

The Summary of the Science is a summary of the current scientific knowledge regarding the environmental concerns associated with Lac La Biche and to highlight where further research or remedial efforts are needed. It provides current updates and benchmarks to many of the environmental indicators relevant to Lac La Biche and its watershed. The Summary of the Science serves as a foundation to the development of the watershed management plan and includes general watershed planning implications to provide a background to the specific recommendations in the plan.

Surface Water

Water bodies such as lakes, ponds, wetlands, rivers, and streams, as well as groundwater with a direct and immediate hydrological connection to surface water (for example, water in a well beside a river). (Glossary of Water Terms Used in Alberta)

Sustainability

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The balancing of opportunities for growth with the need to protect the environment. It reflects a vision of a vibrant economy and a healthy environment. Regarding renewable resources (e.g., water, timber, fish, and wildlife), sustainability involves managing renewable natural resources so that their status, condition, or use is maintained over time. In this context, the use of a renewable resource, or impacts on it from other human activities, should not exceed its capacity to maintain itself through re-growth, reproduction, and management practices. Regarding non-renewable resources (e.g., coal, oil, gas, and minerals), sustainability involves the development of resources in a responsible manner. This means protecting the environment during the construction and operation phases and ultimately reclaiming the land disturbed by development. In this context, non-renewable resource development is a temporary land use. (Glossary of Water Terms Used in Alberta)

Total Dissolved Solids (TDS)

A measure of the concentration of dissolved matter in water. Total Dissolved Solids measurements are often used to estimate a water body's salinity, which may affect the distribution of aquatic organisms. Calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and silica are typical dissolved solids. (Glossary of Water Terms Used in Alberta)

Total Suspended Solids (TSS)

A measurement of the quantity of matter suspended, but not dissolved, in a unit of water. Suspended solids include a wide variety of materials such as silt, decaying plant matter, industrial wastes, and sewage. (Glossary of Water Terms Used in Alberta)

Turbidity

The cloudiness of water. It is determined by the presence of suspended matter such as clay, silt, organic matter, and living organisms. High turbidity may reduce light transmission, and therefore reduce photosynthesis of aquatic plants. (Glossary of Water Terms Used in Alberta)

Upland

An area of dry land surrounding or upstream of a water body.

Utilities, - Franchised

Facilities for gas, electricity, telephone, cable television, water, storm and sanitary sewer.

Water Act

A piece of provincial legislation in Alberta used to protect the quality of water and manage its distribution. The *Water Act* regulates all developments and activities that might affect rivers, lakes, or groundwater. (*Water for Life)*

Water Body

Any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent, or occurs only during a flood. This includes, but is not limited to, wetlands and aquifers. (*Water for Life*)

Water for Life: Alberta's Strategy for Sustainability

The Government of Alberta's water management approach, outlining a comprehensive set of strategies and actions that will ensure Albertans have safe, secure drinking water, healthy aquatic ecosystems, and a reliable quality water supply for a sustainable economy.

Water Management Plan

A document developed under the *Water Act* that provides broad guidance regarding water conservation and management, sets clear and strategic directions regarding how water should be managed, or results in specified actions. Alberta's *Framework for Water Management Planning* outlines the process for water management planning and the components required for water management plans. The process applies to all watercourses and water bodies in Alberta, including streams, rivers, lakes, aquifers, and wetlands. The plans may be considered by a Director when making licence and approval decisions. An Approved Water Management Plan must be considered by a Director when making licence and approval decisions. (Glossary of Water Terms Used in Alberta)

Water Quality

The chemical, microbiological, and physical characteristics of water.

Water Quantity

The volume or amount of water.

Watercourse

The bed and shore of a river, stream, creek, lagoon, swamp, marsh or other natural body of water, or a canal, ditch, reservoir, or other artificial surface feature made by humans, whether it contains or conveys water continuously or intermittently. *(Environmental Protection and Enhancement Act).*

Watershed

The total area of land that catches precipitation and drains into a larger body of water such as a marsh, stream, river, or lake (*Water for Life*). A watershed is often made up of a number of sub-watersheds that contribute to its overall drainage. Watersheds are also called drainage basins.

Watershed Approach

A way of thinking and acting that focuses efforts within a watershed, taking into consideration both ground and surface water flow. This approach recognizes and plans for the interaction of land, water, plants, animals, and people. Focusing efforts at the watershed level gives the local watershed community a comprehensive understanding of local management needs and encourages locally led management decisions. (*Water for Life)*

Watershed Management

The protection and conservation of water and aquatic ecosystems, including their associated riparian areas. Land use activities on the uplands of a watershed can affect ground and surface water quality and quantity; a broader, more comprehensive approach to planning is often required. (Glossary of Water Terms Used in Alberta)

Watershed Management Plan

A comprehensive document that addresses many issues in a watershed including water quantity, water quality, aquatic ecosystems, riparian areas, land use issues, point and non-point-source pollution, and source water protection. It may or may not include a Water Management Plan. It may also examine ways to better integrate land and resource management within a watershed. Watershed management plans require water and land use managers to work together to ensure healthy watersheds. (Glossary of Water Terms Used in Alberta)

Watershed Management Planning

A comprehensive, multi-resource management planning process involving all stakeholders and partners within the watershed, who, together as a group, cooperatively work toward identifying the watershed's resource issues and concerns as well as develop and implement a watershed plan with solutions that are environmentally, socially, and economically sustainable. (Glossary of Water Terms Used in Alberta)

Watershed Planning and Advisory Council

Collaborative, independent, volunteer organizations with representation from all key partners within the watershed. Their mandate is to engage governments, stakeholders, partnerships, and the public in watershed assessment and watershed management planning, while considering the existing land and resource management planning processes and decision-making authorities. (Partnerships)

Watershed Stewardship Group

Community-based groups made up of volunteer citizens, often supported by local businesses and industries, who have taken the initiative to protect their local creek, stream, stretch of river, or lake. These proactive groups develop on-the-ground solutions to ensure the protection of their specific watersheds. (Glossary of Water Terms Used in Alberta)

Wetland

Lands saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, water-loving vegetation, and various kinds of biological activity which are adapted to a wet environment. *(Alberta Wetland Policy)*

13. LITERATURE CITED

AAFC. 2019. Annual Crop Inventory – 2019. Earth Observation Team, Science and Technology Branch, Agriculture and Agri-Food Canada. Available from: http://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9

Alabaster, J. S., Shurben, D. G., and G. Knowles. 1979. The effect of dissolved oxygen and salinity on the toxicity of ammonia to smolts of salmon, Salmo salar L. Journal of Fish Biology, 15:705-712.

Alberta Conservation Association. 1999. Caring for Shoreline Properties: Changing the Way We Look at Owning Lakefront Property in Alberta. 32pp.

Alberta Environment. 2000. Effect of Field Lake Outflow on Water Quality in Red Deer Brook. Water Sciences Branch. Natural Resource Service. Available on the internet at https://open.alberta.ca/dataset/a0289323-c444-4560-a13f-ddfb5850c06a/resource/7b5ada16-ca7d-4b61-b3c3-6b2e0ad2a6d1/download/5842.pdf

Alberta Environment. 2008. Glossary of terms related to water and watershed management in Alberta. 1st Edition. Available at: https://open.alberta.ca/dataset/3a1ea2fa-1a41-41e6-9e39-bab1e87eb6bb/resource/e9e4c432-c625-4a27-9a3b-27bdd85f5848/download/glossarywatermanagement-nov2008.pdf

Alberta Environment and Parks (AEP). 2018. Lac La Biche FIN Summary, 2016. https://open.alberta.ca/dataset/8b23be5d-2c75-4852-88ec-35fa97de33c8/resource/b119ac5f-1bec-417d-a758-3999641dc18c/download/laclabiche-fallindexnettingreport-2016.pdf

Alberta Environment and Parks (AEP). 2019. Lac La Biche FIN Summary, 2018. https://open.alberta.ca/dataset/c4074704-0d19-4ad4-ab4d-84c50d0c6063/resource/1add61ef-df82-4fad-b68c-6f9d18021784/download/laclabiche-fallindexnettingreport-2018.pdf

Alberta Environment and Parks (AEP). 2019. Whirling Disease Decontamination Risk Zone. Whirling Disease Program, Fish and Wildlife Policy Branch. Current as of February 25, 2019. Available on the internet https://open.alberta.ca/dataset/c240b099-18cb-4037-91fa-4038de4012f7/resource/19eb094b-6c55-4856-a2a5-8ad75042319c/download/ep-decontamination-riskzone-full-province-2019-02.pdf

Alberta Environment and Parks (AEP). 2020. ArcGIS REST Services Directory [GENESIS Server Farm 6]. Current Version: 10.71

Alberta Lake Management Society (ALMS). 2004. Lakewatch: The ALMS Volunteer Lake Monitoring Program for Lac La Biche Lakes. 2004 Report.

Alberta Water Council (AWC). 2020. Guide to Source Water Protection Planning: Protecting Sources of Drinking Water in Alberta. 58pp.

Aquality Environmental Consulting Ltd. 2006. Red Deer Brook 2006 “Phase 1” Water Quality Summary Report. Prepared for Lakeland County. 65pp.

Aquality Environmental Consulting Ltd. 2009. Lac La Biche Watershed Management Plan.

Aquality Environmental Consulting Ltd. 2011. Red Deer Brook Water Quality Monitoring Results from Initial two Sampling Events. Prepared for Lac La Biche County. 5 pp.

Aquality Environmental Consulting Ltd. 2013. Red Deer Brook Water Quality Monitoring Lac La Biche County, Alberta. Prepared for Lac la Biche County. 27 pp.

Athabasca Watershed Council. 2018. State of the Athabasca Watershed: Summary Report. Athabasca Watershed Council, Athabasca, AB.40 pp. Available on the internet at https://awc-wpac.ca/wp-content/uploads/2018/12/Athabasca-SoW-Summary-FINAL-DRAFT.pdf

Babin, J., and E. E. Prepas. 1985. Modelling winter oxygen depletion rates in ice-covered temperate zone lakes in Canada. Canadian Journal of Fisheries and Aquatic Sciences, 42:239-249.

Banks, R. B., and F. F. Herrera. 1977. Effect of wind and rain on surface reaeration. Journal of the Environmental Engineering Division, American Society of Civil Engineers. 103:489-504.

Barica, J. and J. A. Mathias. 1979. Oxygen depletion and winterkill in small prairie lakes under extended ice cover. Journal of the Fisheries Research Board of Canada. 36: 980-986.

Casey, R. 2011. Water quality conditions and long-term trends in Alberta lakes. Alberta Environment and Water, Edmonton. 419 pp + Appendix (6p).

Chipeniuk, R.C. 1975. Lakes of the Lac La Biche District.

Fenson, S., T. Johns, and B. Schmidt. 2018. Owl River riparian restoration and enhancement project: Monitoring report II. Data Report produced by Alberta Conservation Association, Sherwood Park, Alberta, Canada. 29 pp + App.

Genivar. 2008. Stormwater Management Master Plan for Lac La Biche County Hamlet of Lac La Biche. December 2008. Available on the internet http://sedesign.ca/wp-content/uploads/2015/04/Hamlet-of-Lac-La-Biche-SWMMP_WHOLE_REPORT.pdf

Greenbank, J. 1945. Limnological conditions in ice-covered lakes, especially as related to winter-kill of fish. Ecological monographs. 15(04): 344-463.

Hutchinson Environmental Sciences Limited. 2017. Foreshore Inventory and Mapping Report. Prepared for Living Lakes Canada. 69 pp.

Hutchinson Environmental Sciences Limited. 2017. Lac la Biche Sensitive Habitat Index Mapping and Shoreline Management Guidelines. Prepared for Living Lakes Canada. 69 pp.

Lac La Biche County. 2010. Lac la Biche County Policy: Riparian Setback Matrix. Policy No. PI-63-003. Available on the internet https://www.laclabichecounty.com/home/showdocument?id=9176

Lac la Biche Technical Committee. 1993. Lac la Biche Causeway Investigation. 256 pp.

Lac la Biche County. 2019. 2019 Water Quality Report Lac la Biche – East Basin, Lac la Biche County, Alberta. October 31, 2019. Available on the internet https://www.laclabichecounty.com/home/showdocument?id=9076

Lac la Biche County. 2019. 2019 Water Quality Report Lac la Biche – West Basin, Lac la Biche County, Alberta. October 31, 2019. Available on the internet https://www.laclabichecounty.com/home/showdocument?id=9078

Lac la Biche County. 2018. 2018 Water Quality Report Lac la Biche – East Basin, Lac la Biche County, Alberta. December 15, 2018. Adapted from EnviroLead Canada. Available on the internet https://www.laclabichecounty.com/home/showdocument?id=8638

Lac la Biche County. 2018. 2018 Water Quality Report Lac la Biche – West Basin, Lac la Biche County, Alberta. December 15, 2018.Adapted from EnviroLead Canada. Available on the internet https://www.laclabichecounty.com/home/showdocument?id=8642

McGregor, A.M. 2014. Lac la Biche Fisheries Restoration Program Summary Report. Government of Alberta, Edmonton, AB. 43 pp.

McGregor, A.M., C.L. Davis, C.J. Walters, and L. Foote. 2015. Fisheries restoration potential for a large lake ecosystem: using ecosystem models to examine dynamic relationships between walleye, cormorant, and perch. Ecology and Society 20(2): 29.

Mitchell P and Prepas EE. 1990. Atlas of Alberta Lakes. University of Alberta Press. 675 pp.

Neufeld, S.D. 2005. Effects of catchment land use on nutrient export, stream water chemistry, and macroinvertebrate assemblages in boreal Alberta. M.Sc. thesis, Department of Biological Sciences, University of Alberta, Edmonton, AB.

North Saskatchewan Watershed Alliance (NSWA). 2015. A Compilation of Stream Nutrient Data for Alberta. Prepared by the NSWA, Edmonton, AB. 35 pp + Appendices. Available on the internet at https://www.nswa.ab.ca/resource/compilation-of-stream-nutrient-data-alberta/

Schindler, D.W. *et al*. 2008. The cultural eutrophication of Lac la Biche, Alberta, Canada: a paleoecological study. NRC Canada. Canadian Journal of Fisheries and Aquatic Sciences 65: 2211-2223. Doi:10.1139/F08-117.

Schindler, D.W. *et al*. 2004. Water quality of Lac la Biche: A preliminary assessment of past and present conditions. Unpublished report submitted to the Lac la Biche Watershed Steering Committee. 27 pp.

Schwalme, K. 1995. A review of winterkill remediation techniques for Alberta. Alberta Environment Centre. Vegreville, AB. 84 pp.

Stantec Consulting Ltd. 2017. Red Deer Brook 2011-2016 Sampling Program. Prepared for Environmental Services for Lac la Biche County. 15 pp.

Wetzel, R.G. 1983. Limnology. 2nd ed. Saunders College Publishing, Toronto. 767 p.

Geographic Information Systems Data (Shapefiles)

Alberta Environment and Parks (watershed boundaries, planning areas shapefiles)

Altalis, https://www.altalis.com/ (Geo-administrative layers, hydrography)

Government of Alberta Open Data, https://open.alberta.ca/opendata (parks and protected areas)

Lac La Biche County (various County shapefile datasets)