Lesser Slave

Integrated Watershed Management Plan

Lesser Slave Watershed Council

ACKNOWLEDGEMENTS

The Lesser Slave Watershed Council thanks all members of the IWMP Steering Committee and the Technical Advisory Committee for their contribution to the development of the Lesser Slave Integrated Watershed Management Plan. In addition, special acknowledgement is given to the contribution made by Ducks Unlimited Canada Boreal Conservation Partnerships & Services Branch for its assistance with the biodiversity tool and spatial data mapping.

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LESSER SLAVE
INTEGRATED WATERSHED MANAGEMENT PLAN

The Lesser Slave Integrated Watershed Management Plan has been endorsed by the Municipal Councils of Big Lakes County, Town of Slave Lake, Town of High Prairie, and MD of Lesser Slave River.

The Lesser Slave Watershed Council looks forward to collaborating with all stakeholders to implement actions outlined in the Plan that strive to meet watershed management goals and objectives.

Big Lakes County supports the Lesser Slave Integrated Watershed Management Plan and will use the Plan as a guide and planning tool for improving and protecting the state of the Lesser Slave Lake watershed for future generations. – Reeve Richard Simard

The Town of Slave Lake endorses the Lesser Slave Lake Watershed Management Plan.

Townof High Prairie endorses the Lesser Slave Lake Watershed Management Plan and looks forward to working with the LSWC to implement the Plan. – Brian Martinson, CAO

MD of Lesser Slave River accepts the final Lesser Slave IWMP as a referece document that supports the development of best management practices and policies for the municipality. – Councillor Brad Pearson

Alberta Environment and Parks congratulates the LSWC on the completion of the Lesser Slave Integrated Watershed Management Plan. AEP will continue to work with the LSWC to advance actions and recommendations as part of the implementation of the Plan.

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ACRONYMS

AAF	Alberta Agriculture and Forestry
ABMI	Alberta Biodiversity Monitoring Institute
ABWRET	Alberta Wetland Rapid Evaluation Tool
ACA	Alberta Conservation Association
AEP	Alberta Environment and Parks
AIS	Aquatic Invasive Species
ALMS	Alberta Lake Management Society
ALUS	Alternative Land Use Services
AOP	Annual Operating Plan
AWWID	Alberta Water Well Information Database
BMA	Bear Management Area
BMP	Beneficial (Best) Management Practice
BOD	Biochemical oxygen Demand
CAP	Canadian Agricultural Partnership
CCME	Canadian Council of Ministers of the Environment
CEQG	Canadian Environmental Quality Guidelines
CFE	Competitive Fishing Event
DFO	Department of Fisheries and Oceans
DUC	Ducks Unlimited Canada
ECA	Equivalent Clear-Cut Analysis
ESRD	(Alberta) Environment and Sustainable Resource Development
FIN	Fall Index Netting
FMA	Forest Management Agreement
GOA	Government of Alberta
GOWN	Groundwater Observation Well Network
IFN	Instream Flow Needs
IRP	Industry Recommended Practice
IWMP	Integrated Watershed Management Plan
LSWC	Lesser Slave Watershed Council
MSGC	Métis Settlements General Council
NAWMP	North American Waterfowl Management Plan
NCC	Nature Conservancy Canada
OHV	Off-Highway Vehicle
SAGD	Steam Assisted Gravity Drainage
TDL	Temporary Diversion Licence
TEK	Traditional Ecological Knowledge
WPAC	Watershed Planning and Advisory Council

1.0 INTRODUCTION

The Lesser Slave watershed is located about 250 km northwest of Edmonton, Alberta. Lesser Slave Lake is the third largest lake in the province and is the central feature in the watershed, encompassing an area of about 1,160 km^2 (Mitchell and Prepas 1990). The watershed supports strong agricultural, forestry, and oil and gas industries, and is a tourist destination for people who are drawn to the lake for the abundant recreation and sport-fishing opportunities.

In 2007, the Lesser Slave Watershed Council (LSWC) was established as one of 11 Watershed Planning and Advisory Councils (WPACs) in Alberta. The WPACs were established by the Government of Alberta under the *Water for Life Strategy.* The objectives of the *Strategy* are safe, secure drinking water, reliable, quality water supplies for a sustainable economy, and healthy aquatic ecosystems. The LSWC undertakes state-of-the-watershed reporting, community education and outreach initiatives, and watershed management planning in support of Water for Life goals.

Since 2015, the LSWC has worked collaboratively with the community to establish goals and objectives that support recommendations for resource management in the Lesser Slave watershed. This Integrated Watershed Management Plan (IWMP or Plan) provides guidance for the management of water quantity, water quality, riparian areas and wetlands, and biodiversity, and recommends actions to achieve desired outcomes. While the economy is not a separate theme in the plan, it was given due consideration in the development of the recommendations. The IWMP builds on previous resource management in the watershed, and is aligned with recent provincial and municipal initiatives that support watershed planning in the basin. This IWMP may also inform future planning initiatives, including the Upper Athabasca Regional Plan.

In 2015, the LSWC initiated the Lesser Slave Integrated Watershed Management Plan (IWMP) process. This is a comprehensive plan that addresses local concerns for management of land and water resources. The IWMP is intended to guide future resource management decisions in the watershed for long-term social, environmental and economic sustainability.

1.1 Previous Planning Initiatives

Resource planning has been prevalent in the watershed since the mid-1980s. Historic planning efforts were generally undertaken to address specific concerns in the watershed that included the conversion of public forested land to agriculture and municipal use (Alberta Forestry, Lands and Wildlife 1985), drainage planning to alleviate flooding of agricultural land (AENV 1985) and low-lying areas around the Lesser Slave Lake (AEP 1993), and bird habitat conservation (Fraser 2000). The Buffalo Bay/Horse Lakes Water Management Program (Alberta Environment 1992) aimed to reduce sediment loads in the East Prairie and West Prairie rivers to natural levels (e.g., prior to channelization), reduce the extent of bed and bank erosion on the East Prairie and West Prairie rivers, reduce damage caused by flooding, and protect the unique habitat features of the bay area. Many of these sediment, erosion, flooding, and habitat concerns remain relevant in the western part of the watershed. Appendix A provides a summary of historic planning initiatives undertaken by provincial and municipal governments, community members, and other stakeholders in the basin.

In 2009, the LSWC completed the Lesser Slave State of the Watershed Report (Jamison 2009) to support watershed planning in the basin. In the same year, Alberta Environment and the LSWC completed the

Lesser Slave Water Management Plan - Phase I (LSWC 2009) to address low flow concerns in the Lesser Slave River. During the development of the 2009 Water Management Plan, additional concerns were raised regarding the long-term management of watershed resources, including water quality, riparian areas, and biodiversity, but these concerns were beyond the scope of that plan.

2.0 PURPOSE, INTENT AND AUTHORITY

The Lesser Slave Integrated Watershed Management Plan (IWMP or Plan) is a guidance document and planning tool for resource managers. It sets out common goals and objectives for the long-term management of land and water resources in the basin. The LSWC, in consultation with the community and stakeholders, developed Terms of Reference to guide the development of the Plan (LSWC 2015). The provincial Framework for Water Management Planning (Alberta Environment 1999) and the Guide to Watershed Planning in Alberta (Alberta Government 2015) were also consulted. The IWMP aligns with preceding and current provincial planning initiatives (Appendix A) and municipal goals, objectives, plans and policies (Appendix B).

The Lesser Slave IWMP does not replace the existing approved Lesser Slave Water Management Plan - Phase I (LSWC 2009) but rather supplements it with aspects not previously considered, and with new information that has become available since 2009. While Water Management Plans provide a framework for Alberta Environment and Parks to make water management decisions under Alberta's *Water Act* and *Environmental Protection and Enhancement Act* (EPEA), the current IWMP does not have legislated authority. However, the Government of Alberta considers IWMPs as valuable planning documents that inform other policy and regional planning initiatives. Where appropriate, recommendations will be made that support the development and approval of Phase II of the Lesser Slave River Water Management Plan.

The Lesser Slave IWMP:

- Takes a strong, comprehensive watershed approach.
- Encourages municipal influence by providing recommendations related to municipal development planning, including land use bylaws, for future lakeshore (subdivision) development that is consistent with goals and objectives of the plan.
- Considers wildlife and fisheries management.
- Provides specific recommendations that are accompanied by greater implementation detail, as opposed to general recommendations that are not easily implemented.

3.0 PLANNING AREA

The Lesser Slave Lake watershed spans an area of about 20,100 km^2 in northern Alberta. The watershed is comprised of five sub-watersheds: South Heart River (including the West Prairie and East Prairie rivers), Driftpile River, Swan River, Lesser Slave Lake North, and Lesser Slave River (Figure 1).

3.1 Climate, Vegetation and Soils

The watershed is situated in the Foothills and Boreal Natural Regions of Alberta. The Upper Foothills Natural Region, represented by the Swan Hills, is characterized by cool wet summers and moist winters that generate relatively large runoff volumes. The forest is dominated by coniferous trees including lodgepole pine with black spruce understory. Brunisolic and Gray Luvisolic soils are typically found in this region, with bedrock dominated by sandstone and mudstone (NRC 2006). The Lower Foothills, represented by the Marten Hills and Pelican Mountains northeast of Lesser Slave Lake, is slightly drier and has a longer growing season and greater forest diversity compared to the Upper Foothills Natural Region. Pure or mixed stands of aspen, balsam poplar, white birch, lodgepole pine, black and white spruce, balsam fir, and tamarack are found here. Soils are Gray Luvisol (NRC 2006), which is commonly deficient in nitrogen, phosphorus and sulphur, but abundant in aluminum and manganese (Pettapiece et al. 2010).

The Boreal Natural Region is comprised of the Central Mixedwood subregion found throughout the northern part of the watershed, parts of the southern area nearest the lake, and the central part of the West Prairie River. The Dry Mixedwood subregion is situated in the area west of the Lesser Slave Lake around High Prairie and Winagami Lake. This subregion is characterized by a mix of aspen-dominated deciduous stands and aspen-white spruce forests, white spruce, and jack pine stands. The Dry Mixedwood subregion is the warmest and has Gray Luvisol and rich, Dark Gray Chernozem soils (NRC 2006). Large parts of this area were cleared for agriculture.

3.2 Watershed Hydrology

Water levels in Lesser Slave Lake are sustained by a number of tributaries that flow in from the west, south and to a lesser extent the north, as well as by groundwater that interacts with surface water to sustain baseflows (Figure 1, Table 1). The South Heart River flows into the lake from the northwest and includes inflows from the West Prairie and East Prairie rivers that join from the south. Extensive channelization in the West Prairie and East Prairie rivers has resulted in ongoing issues of streambank erosion. Driftpile River, Swan River and Assineau River flow directly to the lake from the southern part of the watershed. The Swan River is a higher velocity river in its upper reaches compared to rivers that flow in from the west. It transports a significant amount of sediment to Lesser Slave Lake. The Swan River delta advanced about 400 m from 1982 to 2003 while the old delta retreated about 200 m (AMEC 2005).

Lesser Slave Lake is drained by the Lesser Slave River which flows east from the lake on the eastern shore, and continues eastward to eventually join the Athabasca River. The Lesser Slave River contributes about 6% of the Athabasca River's annual volume (MacLock et al. 1997). Sawridge Creek, Otauwau River and Salteaux River are main tributaries that flow into the Lesser Slave River from the south. Treated effluent from the Town of Slave Lake, as well as effluent from the Slave Lake Pulp Mill, are discharged indirectly (through Sawridge Creek) and directly to the Lesser Slave River (Fiera Biological Consulting Ltd. 2013).

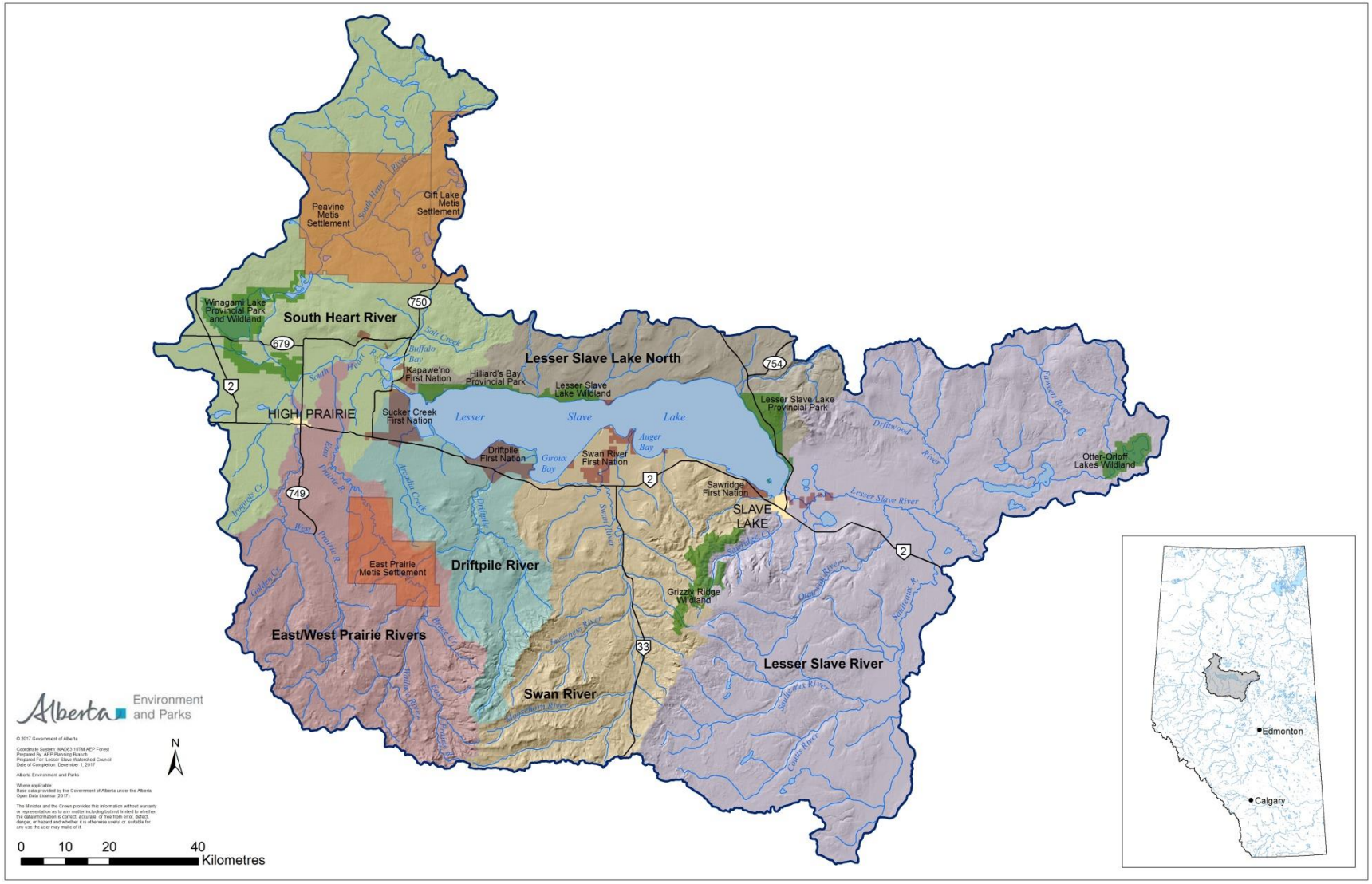


Figure 1. Lesser Slave Lake watershed and its major sub-basins. A large, high-resolution map is available at www.lswc.ca .

Table 1. Characterization of sub-basins in the Lesser Slave Lake watershed. Dashes indicate that information was unavailable.

Sub-Basin (Station)	Area[a]	Average Total Discharge[a]	Sediment Transport[b]	Linear Features	Parks and Protected Areas[a]	Land Cover Types[c]					
						Forested	Agriculture	Wetland	Herbaceous	Developed	Other
(Station)	km^2	dam^3 (m^3/s)	tonnes	Crossings/ km of Stream[a]	%	%					
South Heart River (07BF010)	3,324	51,650 (2.21)	139,000 (seasonal load)[d]	1.49	3.02	48	19	23	3	1	6
West Prairie River (07BF002)	3,563	142,458 (4.52)	284,000 (annual load)[e]			70	12	3	8	1	6
East Prairie River (07BF001)		230,490 (10.80)	847,000 (seasonal load)			61	11	8	11	1	8
Driftpile River (07BH003)	1,429	166,300 (8.42)	337,000 (seasonal load)	1.15	0.00	80	1	3	7	1	8
Swan River (07BJ001)	2,818	407,540 (13.1)	538,000 (annual load)	1.24	2.55	73	3	5	10	2	8
Lesser Slave Lake North	1,324	-	-	1.20	10.2	-	-	-	-	-	-
Lesser Slave River	6,507	1,267,100 (38.3)	-	1.33	1.76	-	-	-	-	-	-
Lesser Slave Watershed	20,100	-	-	-	-	>50	9	17	-	<2	-

[a]Jamison 2009; [b]AMEC 2005; [c]Hutchinson Environmental Sciences Ltd. 2015

[d]Seasonal load – Calculated using monitoring data collected from a truncated monitoring season, generally March or April through October

[e]Annual load – Calculated using monitoring data collected from the entire season, January through December

3.3 Cumulative Effects

The Lesser Slave watershed is rich in natural resources and supports a variety of industries that contribute to the local, regional and provincial economy, including forestry, oil and gas, mining, agriculture, development, and tourism and recreation. The human footprint associated with industry continues to expand as people are drawn to the region. In 2014, the total human footprint[1] covered about 21% of the Lesser Slave watershed. Cut blocks associated with the forest industry accounted for the largest percentage of the human footprint (54%), agriculture accounted for 29% of the footprint, and oil and gas activity (e.g., well sites, pipelines and seismic lines) accounted for about 10% of the footprint (Figure 2).

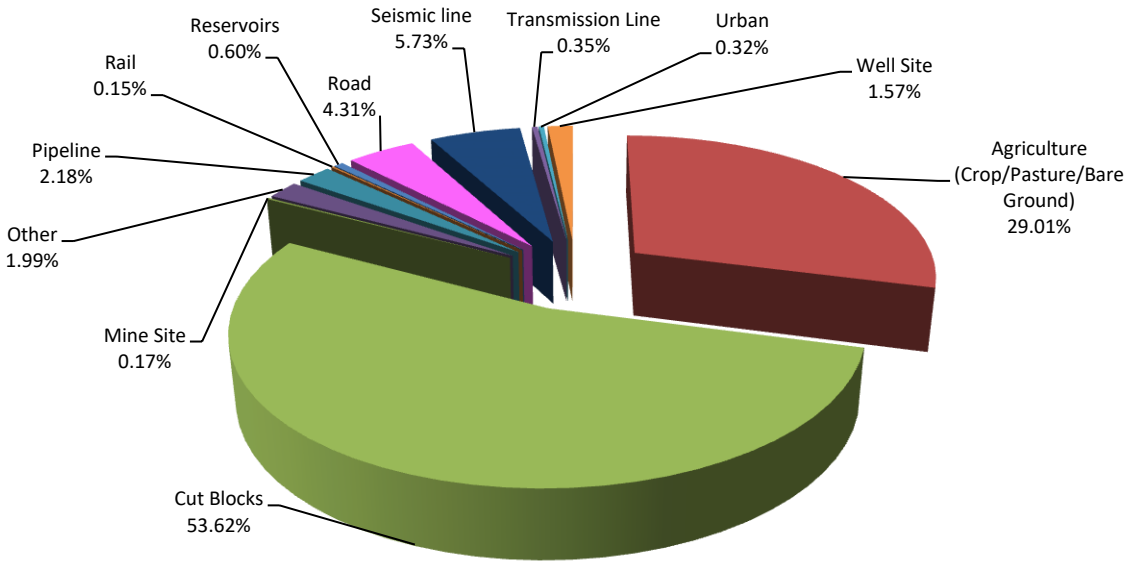


Figure 2. Summary of land use activities that contribute to the total human footprint in the Lesser Slave watershed (ABMI 2015).

[1] Human footprint is defined as the temporary or permanent transformation of native ecosystems to support residential, recreational or industrial land uses (ABMI 2015). The human footprint includes the geographic extent of areas under human use that have either lost their natural cover for extended periods of time (alienating human footprint; e.g., cities, roads, agricultural land, surface mines) or whose natural cover is periodically reset to earlier successional conditions by industrial activities (successional human footprint; e.g., cut blocks and seismic lines). ABMI tracks the status and trends in human footprint across Alberta. This version of the ABMI 3x7 km HF inventory does not account for succession (or reclamation) of human footprint, but treats all types of human footprint on the landscape equally. The current dataset does not present age of disturbance or the current habitat/vegetation cover within features such as harvested areas (former cut blocks) or seismic lines.

Measuring the human footprint is an important indicator of the health of the Lesser Slave watershed. Figure 3 shows the spatial distribution of human footprint in the Lesser Slave watershed for the period 1999 to 2014 (ABMI 2015; AEP 2016a). The cumulative impact of land use activities in each sub-basin affects water quantity, water quality, riparian areas and wetlands, and biodiversity by altering the natural system that functions to maintain equilibrium or balance in the watershed. Altering land cover, by changing vegetation characteristics, replacing vegetation with hard surfaces, or creating bare ground, impacts local and regional hydrology, and is reflected in higher or lower streamflow compared to natural. Subsequently, water quality may be impacted as surface disturbance and changes in streamflow mobilize soils and sediment, nutrients, and other soil minerals into waterbodies. Further impacts on watershed hydrology are experienced when riparian areas and wetlands are altered or lost. The culmination of impacts is found downstream, in rivers and lakes, including Lesser Slave Lake. Aquatic biodiversity (fish) and upland biodiversity is impacted as habitat condition degrades through fragmentation or loss.

Resource management must consider the cumulative impact of land use in the watershed to sustain natural resources in the future. Provincial and municipal governments, industry, non-government organizations, landowners and residents have a shared responsibility to manage watershed resources and should consider the cumulative effects of land use activities on water, soil, air and biodiversity. Water is fundamental to all human activity and to sustaining communities, fish and other aquatic life, and wildlife in the watershed. The integrated management of resources is vital to continued prosperity in the watershed, as well as to the regional and provincial economy.

Zoe Blacha, Hilliard's Bay

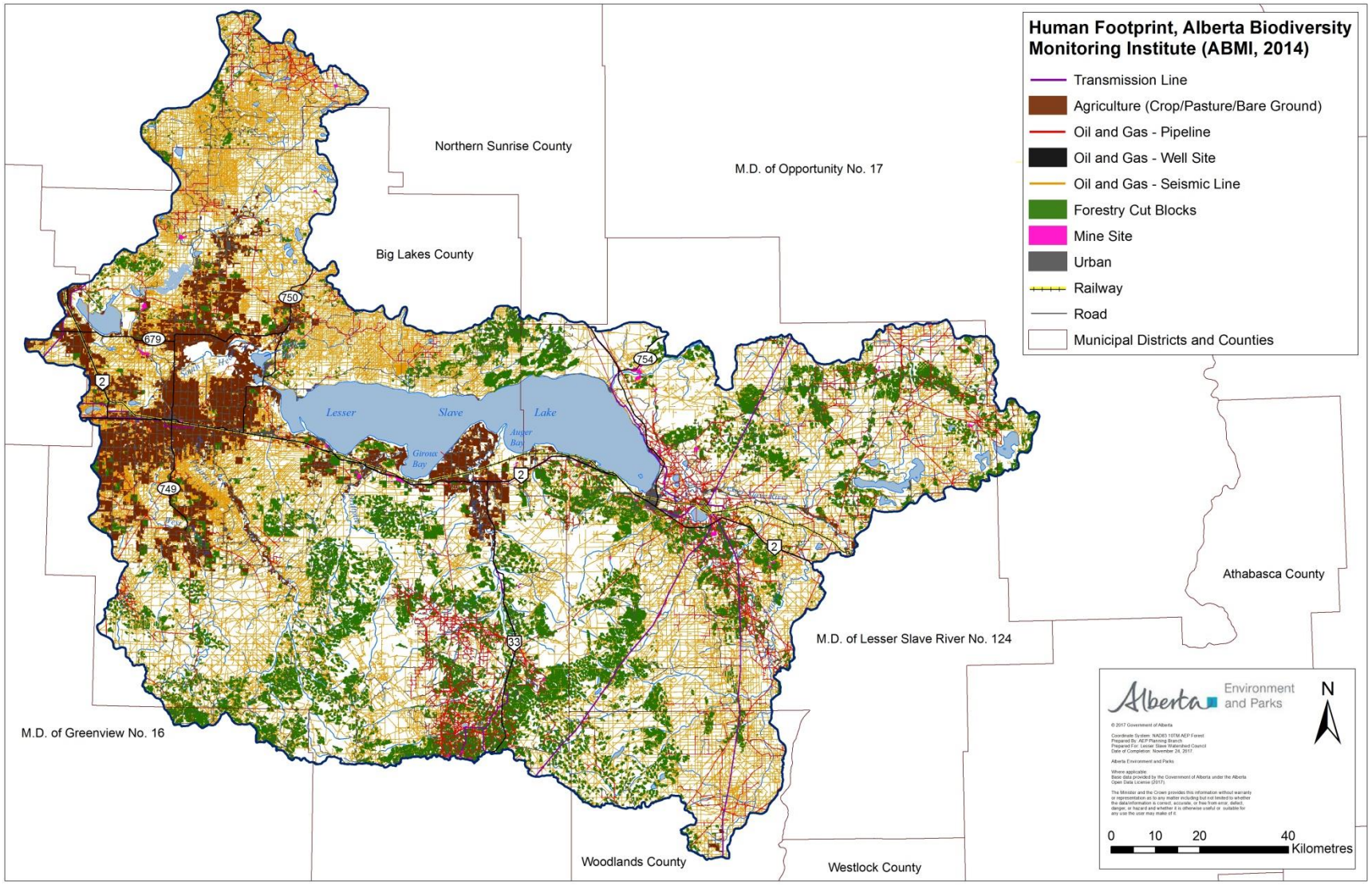


Figure 3. Human footprint in the Lesser Slave watershed (ABMI 2014; AEP 2017). A high-resolution map is available at www.lswc.ca .

4.0 INFORMATION ASSEMBLED

The Lesser Slave Watershed Council worked closely with the IWMP Steering Committee, Technical Advisory Committee, and Municipal Working Group to compile relevant plans, policies and technical reports for the Lesser Slave watershed. The Lesser Slave State of the Watershed Report (Jamison 2009) and Technical Update for the Lesser Slave Watershed (Hutchinson Environmental Sciences Ltd. 2015) were considered. In some instances, raw data was collected and analyzed to support recommendations. Provincial spatial data sets that were relevant to the Plan were also accessed and a series of maps developed to support recommendations. Refer to Section 11.0 for a complete list of literature cited in the development of this Plan.

5.0 SUMMARY OF ISSUES

The summary of issues reflects the concerns expressed by the community during engagement (refer to Section 9.0), as well as best available science (see Section 4.0).

5.1 Water Quantity

Impacts of climate change on streamflows

- Historic data and climate models predict a general trend of decreased precipitation and increased evaporation in the future (although weather patterns will likely vary annually) (AEP pers. comm.; Alberta Watersmart 2017). The impact of this change is likely to result in:
    - Lower streamflows in the Lesser Slave River and potentially poorer water quality (e.g., low dissolved oxygen concentrations) for downstream users[2]
    - Low streamflows in tributaries to Lesser Slave Lake and low lake water levels that may cause source water supply concerns for communities, and prevent boat access to the lake by marina operators and other users of the lake.

Impacts of human alterations on hydrology

- Substantial changes to river morphology has occurred (e.g., at East Prairie, South Heart and Lesser Slave rivers). Channelization was undertaken for flood mitigation purposes and effectively increased local drainage.
- An estimated 22% of riparian areas and wetlands have been impacted (e.g., encroached upon or altered) by human activity (Appendix F), thereby reducing water storage potential in the watershed. Loss of riparian areas and wetlands, and channelization of rivers, has a cumulative impact on watershed hydrology, which is currently not well understood.
- High water levels that result in flooding, and ice ridges that may increase streambank and shoreline erosion.

[2] The effects of water withdrawals on the Lesser Slave River low streamflows are small in comparison to the decreased precipitation associated with natural variability and climate change. In addition, evaporation from the lake is the largest cause of water loss from the lake and consequently low flows downstream in the Lesser Slave River. Thus, withdrawals have little effect on the overall magnitude, duration, and frequency of flow in the Lesser Slave River. In March 2016, the weir at the outlet of Lesser Slave Lake was modified with a gate that can manage low flows and pass a maximum of 6 m^3/s downstream.

- The lack of general knowledge regarding groundwater resources in the watershed.
- A concern that water use by all sectors[3] is inefficient.
- Low water levels and grounded ice that may impact fish spawning and migration into the Buffalo Bay area.

5.2 Water Quality

Nutrient loading on lake water quality

- Nutrient loading has a negative effect on water quality and drives algal growth in Lesser Slave Lake. Nutrients in the lake originate from internal sources (bottom sediments), and from external inputs (Noton 1998; Hutchinson et al. 2015). Nutrient sources include: diffuse surface runoff from agricultural land (cropland and pastures), disturbed land due to forestry or oil and gas activity, municipal effluent discharge, leakage from household septic systems, stormwater from developed areas (e.g., construction sites, and residential, commercial, and industrial areas); and atmospheric deposition.
- Ability to maintain and improve the quality of Lesser Slave Lake in the long-term due to substantial internal nutrient loading.

Sediment transport and deposition

- Sediment is generated by three main mechanisms in the watershed (Choles 2004; AMEC 2005):
    - "Natural" processes that include downcutting of the channels resulting from post-glaciation lowering of Lesser Slave Lake, soil erosion from undisturbed areas, and littoral drift
    - Response of the river channels to man-made flood control, erosion control and river training works (i.e., bank protection, channelization and dyking projects)
    - Land-use changes and altered runoff characteristics in the watershed (e.g., stream crossings associated with resource access roads, recreational activity (e.g., off-highway vehicle (OHV) use in or near water), agricultural practices (e.g., cropping and water management), logging and oil and gas extraction in the upper watershed, and urban development
- Sediment accumulation in Lesser Slave Lake affects access to water from the lakeshore, reduces flows in the Lesser Slave River, and buries important fish spawning grounds.
- Channelization of natural rivers reduces channel length, accelerates streamflow to increase scour and sedimentation, and reduces flooding thereby limiting the natural deposition of sediment in the floodplain.

Recreation activity

- Winter ice fishing activity impacts on Lesser Slave Lake (e.g., sewage, garbage and abandoned shacks). Recent education efforts and peer pressure are effectively reducing these impacts.
- OHV use is an emerging issue. OHVs are bigger, more powerful, and trail networks are increasing (TransCanada Trail) in the watershed. Problem areas include Sawridge Creek (south of Slave Lake), and localized areas where people are driving into the lake.

[3] Sectors include oil and gas (water flood projects, fracking), agriculture (crop and livestock production), and households.

Mobility and accumulation of contaminants

- Cumulative effects of point source pollution to surface water including pulp mill effluent, municipal effluent discharge, other industrial discharges (e.g., frack fluid, condensate, and salt water), and municipal stormwater runoff regulated under licence conditions[4].
- Potential for release of hazardous materials into the watershed from rail cars using the South Shore Rail Line or transportation on Highway 2, pipeline breaks, and mobilization of seepage from historic landfills (South Shore landfill). Cargo on the rail line includes petrochemicals, sodium chloride and sulphuric acid. There are areas where the rail line bisects parts of the lake from the shore. Two trains pass through Slave Lake each day, transporting a total of 56,000 cars full of dangerous goods annually (CBC News, Edmonton). Six derailments were reported in the vicinity of Slave Lake within a period of about four months in 2014 (CBC News, Edmonton, Sep 2014). CN Rail has made substantial progress toward upgrading the South Shore rail line.
- Limited public understanding regarding the presence and mobility of heavy metals (e.g., mercury and PCBs) in the watershed. These contaminants may originate from the Swan Hills Treatment Centre, and from historic oil and gas storage facilities in the 1970s and 1980s.

Impacts to shorelines and riparian functions (also refer to 5.4 and 5.5)

- Shoreline modifications that impact the littoral zone, the natural deposition of sediments, and water quality.
- The use of power boats and other watercraft on Lesser Slave Lake and surrounding waterbodies that may impact the littoral zone and shorelines when near-shore speed limits or setbacks are not respected. Boats and watercraft may also contribute to hydrocarbon spills.
- Alteration of riparian areas (e.g., vegetation removal, conversion, bank and shore structural modifications, and small drainage) throughout the watershed has potential to increase erosion and sediment transport, and alter streamflow.

5.3 Biodiversity

Fish

- The declining status of some fish populations in Lesser Slave Lake[5], declines in density of adult Arctic Grayling in the South Heart, Swan and Lesser Slave River sub-watersheds[6], and the potential for further decline from the cumulative impacts of:
    - Growing sport fishery
    - Habitat loss or degradation resulting from invasive species, the removal or degradation of spawning and rearing areas (i.e., shoreline and littoral zone vegetation), and poor water quality
    - Threat of disease
    - Natural limitations that include beaver, low gradient streams, seasonal limitations
- Concern regarding fish and wildlife consumption due to presence of contaminants in tissue in localized areas

[4] Regulated by Alberta Environment and Parks, and Alberta Energy Regulator.
[5] For Lesser Slave Lake, Brown and Wakeling (2015) described the Walleye population as vulnerable and the Northern Pike population as collapsed.
[6] Brown and Wakeling (2015) described the decline in Arctic Grayling densities in tributaries to Lesser Slave Lake and in the Lesser Slave River. In the South Heart sub-watershed, adult Arctic Grayling densities declined from Moderate to Very Low, from High to Low in the Swan River sub-watershed, and from Moderate to Very Low in the Lesser Slave River sub-watershed).

Habitat

- Cumulative habitat degradation, loss and fragmentation from land use, including forestry activity (e.g., cut blocks and linear disturbances), oil and gas activity (e.g., facilities, well sites, linear disturbances, and pipeline rights-of-way), agricultural land clearing, and operation of a hazardous waste treatment facility in the upper watershed that can negatively impact fish, wildlife and native plant communities.
- The lack of technical and scientific information, and the limited understanding of how to apply Traditional Ecological Knowledge (TEK), to adequately assess biodiversity in the watershed.

Aquatic Invasive Species

- Emerging issue of aquatic invasive species impacting Lesser Slave Lake. The lake attracts many recreational boaters and fishermen from across Alberta and elsewhere through Competitive Fishing Events (CFEs). Vessels contaminated with zebra or quagga mussels may enter at unregulated access points around the lake or at the inspection station during off-hours.
- Atmospheric deposition may be a concern from forest fires (e.g., smoke deposition).
- The threat and occurrence of terrestrial and aquatic invasive species.

5.4 Riparian Areas and Wetlands

- Declining health trends in riparian areas associated with tributaries to Lesser Slave Lake due in part to cumulative impacts of land use (e.g., cattle access, agricultural cropping, forest harvesting, oil and gas activity and OHV activity) that encroach on these areas, and to streambank erosion (Appendix F).
- Declining health trends in riparian areas associated with lake shorelines due to land clearing for development, and removal of riparian vegetation by property owners.
- The lack of understanding regarding the importance of riparian function to overall water balance (e.g., flood and drought mitigation) and water quality.
- The degradation and loss of wetlands due to agriculture, oil and gas, and forestry activity, as well as in areas where urban development is expanding (Appendix F).
- The lack of knowledge regarding wetlands in the watershed.
- Concern regarding the lack of protection for Buffalo Bay and the Horse Lakes wetland complex that are valuable wetlands hydrologically connected to Lesser Slave Lake. These wetlands function to maintain water quantity and quality in Lesser Slave Lake.

5.5 Lake Management

General

- The lack of a lake management policy in Alberta to guide and improve lake management, and to identify a shared vision for sustainable lake management, including goals, objectives, and monitoring and research priorities.
- The lack of coordination, and responsibility among all jurisdictions involved in lake management.

Lake Access

- The need for increased beach access for residents and tourists.
- A desire to increase the number of marinas on Lesser Slave Lake to provide services to recreational users.
- The need to increase management at existing access points on the lake.

5.6 Crown Land

- Crown land covers about 80% of the watershed (Figure 4). Growth potential for municipalities is confined to a relatively small area, mainly in close proximity to lakes and waterways.

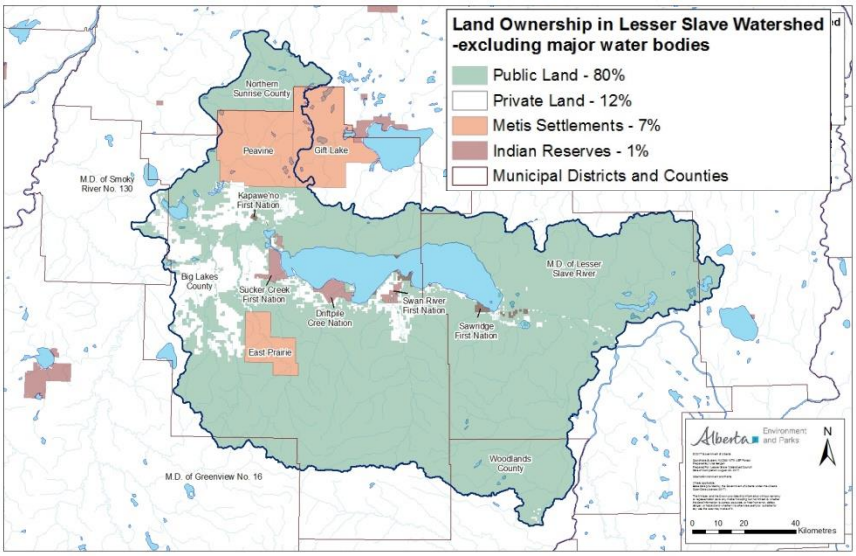


Figure 4. Land ownership in the Lesser Slave watershed.

6.0 GOALS AND OBJECTIVES

Goals and objectives provide clear direction of purpose for the Lesser Slave Integrated Watershed Management Plan (IWMP). Goals are broad statements that identify what the plan will achieve (the outcomes of the plan). Objectives are actions that guide the planning process and offer the mechanism to achieve the goals. Objectives are measureable and may be used to indicate milestones throughout the planning process.

Goals and objectives were developed for four main themes identified by the IWMP Steering Committee in the IWMP Terms of Reference: water quality, water quantity, riparian areas and wetlands, and biodiversity (Table 2) (LSWC 2015).

A fifth theme, “Social and Economic Values”, was also identified by the IWMP Steering Committee as an essential aspect to consider during the development of the IWMP. This theme was not included in Table 2; rather, it was addressed by reviewing recommendations using a social and economic filter – Does the recommendation support communities? How does the recommendation impact economic conditions in the watershed? Recommendations in the IWMP are intended to sustain the Lesser Slave watershed for the health of communities and the sustainable economic growth in the region through sound resource management.

Table 2. Themes, goals and objectives that lead the development of the Lesser Slave Integrated Watershed Management Plan.

Theme	Goal (Outcome)	Objective
Water Quantity	1. Surface water and groundwater are managed to support communities, aquatic ecosystems, recreation, wildlife and economic opportunities.	1. Update the water balance model for Lesser Slave Lake.
		2. Recommend actions needed to sustain water levels in Lesser Slave Lake and streamflows in the Lesser Slave River.
		3. Recommend water conservation strategies that promote efficient use of water.
		4. Identify actions needed to better understand groundwater resources in the watershed, including its role in overall Lesser Slave Lake water balance.
Water Quality	2. Water quality is maintained or improved to support communities, aquatic ecosystems, recreation, wildlife and economic opportunities for future generations.	1. Compile existing water quality data for Lesser Slave Lake, Lesser Slave River, and its major tributaries.
		2. Recommend a long-term water monitoring strategy for the watershed.
		3. Recommend strategies to guide sustainable development adjacent to Lesser Slave Lake.
		4. Identify industry beneficial management practices and other actions to improve and maintain water quality in Lesser Slave Lake and its major tributaries.
		5. Promote a stewardship ethic among watershed residents and users.
Riparian Areas and Wetlands	3. Healthy riparian areas stabilize banks and shorelines, improve water quality, reduce sedimentation, provide habitat and promote biodiversity.	1. Recommend strategies to protect, conserve, and enhance riparian areas in the watershed.
		2. Identify priority areas and actions for riparian restoration.
	4. The hydrologic function of wetlands is maintained to improve water storage capacity for: flood and drought mitigation, water supplies, and improved water quality and habitat connectivity.	1. Recommend wetland conservation strategies that are in line with, or that may improve on, Alberta's Wetland Policy, and other land use planning efforts (e.g., biodiversity monitoring objectives, indicators and thresholds.
		2. Promote wetland and riparian conservation through education, stewardship and use of BMPs (i.e., avoidance and minimization).
Biodiversity	5. Sustainable land use practices take place in the watershed that maintain and support biodiversity.	1. Recommend best management practices for land use that will conserve and enhance biodiversity in the watershed.

7.0 INDICATORS, TARGETS AND THRESHOLDS

Indicators, targets and thresholds are used to measure success in achieving watershed goals and objectives, or desired watershed outcomes. Indicators were identified for major watershed themes (Table 2). The indicators expand on those identified in the State of the Watershed Report (Jamison 2009). Criteria used to establish the indicators included: relevance to the watershed, importance to residents and stakeholders, and measurability. In some instances, indicators relate to more than one theme highlighting the necessity for an integrated approach to watershed management. For example, percent land cover is an indicator for biodiversity as well as for water quality.

Table 3. Summary of watershed condition indicators for the Lesser Slave watershed.

Theme	Indicator	Measure	Significance
Water Quantity	Water supply	Annual streamflow measurements	Streamflows should reflect a normal range of condition and support channel processes (erosion/building), aquatic life, the riparian environment and communities.
		Lake water levels	Maintaining appropriate water levels supports: - Water supplies for local communities - Recreation (boat access, beaches) - Aquatic Life - Downstream needs for aquatic life and waste assimilation.
	Water allocation and use	Water licences and registrations; water use reports	Water supplies support aquatic life, communities and economic activity.
	Groundwater	Water levels	Groundwater is an important water supply.
			Groundwater contributes to the overall water balance in watersheds.
Water Quality	Lake trophic status	Nutrients, chlorophyll *a*, sediment, secchi disk depth, metals, pathogens and other toxins (e.g., PCBs, dioxins, furans, arsenic). Concentration and/or loading rates	Deviation from normal conditions (established through long-term trend analysis) suggests a change in water quality (e.g., a degradation or improvement). Surface water quality should support designated or desired end uses.
	Spatial and temporal trends		
Riparian Areas and Wetlands	Riparian function (lotic systems)	Riparian Health Inventory	Functioning riparian areas and wetlands contribute to water supply, water quality, river channel and shoreline stability, and biodiversity.
	Wetland cover (lentic systems)	Percentage wetland area	
		Impact thresholds (i.e., footprint on each wetland type)	
Biodiversity	Fish, Wildlife and Vegetation, including Species at Risk	Species composition	Aquatic and upland systems that support a diverse group of native fish, wildlife, and plant species is more resilient to ecological adversity or changes in environmental condition.
		Population (a variety of seasonal and resident species)	
		Invasive, disturbance and rare plants	
		Land cover (footprint, linear disturbance, critical habitat)	
Community	Population	Number of people in the watershed	Watersheds should be livable places that sustain people through time.

Theme	Indicator	Measure	Significance
	Stewardship	Local participation in Environmental Farm Plans, Growing Forward Program, Living by Water Program, and Rain Barrel Programs	Stewardship programs help residents, landowners and leaseholders maintain and improve watershed conditions.

Targets and thresholds identify what is desired or what is to be achieved and can be numerical or written statements. Targets are used to determine how valued components in the watershed rate or compare to acceptable or desired ratings and/or conditions. Targets and thresholds were established for each of the major themes in the watershed management plan. These are summarized in Section 10.0. Interim targets, thresholds and objectives were established when comprehensive or local data was unavailable. These interim targets and thresholds should be updated when new information or science is available to support the revision.

8.0 ROLES AND RESPONSIBILITIES

Collaboration between multiple levels of government, various industries (e.g., agriculture, forestry, oil and gas), non-government organizations, landowners, leaseholders, and residents in the basin is essential to cumulative effects management in the watershed. Successful implementation of this plan will be achieved when agencies, organizations and others recognize and accept their individual or shared responsibility for addressing the collective goals and objectives established. For the Lesser Slave IWMP, general roles and responsibilities for key stakeholders are described below. A comprehensive list of applicable legislation, policies and guidelines is provided in Appendix B.

8.1 Federal Government

The *Canada Water Act* enables cooperation between the federal and provincial governments to regulate, apportion, and monitor water resources, and to implement joint programs. The federal government has authority for water quality and publishes water quality guidelines for the environment, drinking water and recreation.

The Canadian Wildlife Service (Environment Canada) oversees birds under the *Migratory Bird Act.* Fisheries and Oceans Canada (DFO) manages and protects fish habitat from harm pursuant to the federal *Fisheries Act* (Section 35(2)). Some of this responsibility is shared with Environment Canada that administers the pollution prevention provisions of the *Fisheries Act*. DFO also has responsibilities pursuant to the federal *Species at Risk Act* and works with Alberta Environment and Parks staff to identify and recover endangered or threatened populations of aquatic species in Alberta (ESRD 2014a). Other federal roles include pollution control, the management of navigation (*Navigation Protection Act*) administered by Transport Canada), and water on federal lands.

8.2 First Nations

The Driftpile First Nation, Swan River First Nation, Sawridge First Nation, Sucker Creek First Nation, and Kapawe'no First Nation have reserve lands and part of their traditional territories located in the Lesser Slave watershed. Other First Nations with reserve lands outside the watershed boundaries also have traditional territories that are in part located in the watershed. First Nations in the Lesser Slave

watershed have traditional values, traditional rights, constitutional rights and the key principles embodied in their treaties, which guide their way of life and jurisdiction in the watershed.

8.3 Provincial Government

The Alberta government's role in the watershed is significant because of the natural water bodies, the sizeable public land-base, and the large diversity of native plant and animal life in the watershed. Crown (public) lands occupy about 75% of the watershed. These lands accommodate a number of different surface and sub-surface land uses that benefit residents and Albertans.

Alberta Environment and Parks (AEP) - AEP has a legislated mandate to manage air quality, water resources, waste management, cumulative effects, provincial Crown (public) lands, the bed and shore of naturally occurring waterbodies, and fish and wildlife resources in the watershed. AEP is responsible for legislation and policies influencing watershed management, including Alberta's *Water Act*, the *Environmental Protection and Enhancement Act* (*EPEA*) and Alberta's Wetland Policy. Water Conservation Objectives (i.e., objectives set within a range of natural variability to meet needs of a variety of desired end uses) are established by AEP under the *Water Act* in Water Management Plans. *EPEA* covers a wide range of activities including environmental assessments, reclamation, conservation easements, wastewater, storm drainage, and substance releases. AEP is responsible for regulating disturbance thresholds through the development of regional and sub-regional plans, and for reporting on the state of the environment. Additional responsibilities include management of parks and recreation areas. AEP, pursuant to the *Fisheries* (Alberta) *Act*, oversees the management of fish populations, advocates for the conservation of fish and fisheries, and is solely responsible for regulating and managing the use of Alberta's fisheries. AEP is responsible for fish population and use assessments, allocation of fish resources, setting regulations in consultation with the public and First Nations, and providing information to the public to promote stewardship (ESRD 2014a).

Alberta Agriculture and Forestry (AAF) - AAF is a *Water for Life* partner and shares responsibility for achieving its goals. AAF is responsible for the *Agricultural Operations Practices Act* (*AOPA*), legislation that sets manure management standards in Alberta. AAF delivers programs to assist producers in developing and implementing plans to minimize impacts on the environment through Environmental Farm Plans. The current Canadian Agricultural Partnership (CAP) offers numerous programs and incentives for the agriculture industry. AAF strives to develop the agriculture and food industry, sustain the industry's natural resource base and encourage the development of rural communities. AAF oversees grazing leases and timber dispositions on Crown lands. AAF is responsible for forest management planning under the authority of the *Forests Act.* AAF is responsible for enforcing the implementation of Annual Operating Plans (AOPs), Forest Harvest Plans (FHPs), Forest Management Plans (FMPs), and General Development Plans (GDP), and reviewing stewardship reports that are required every five years that describe the monitoring programs and how well the objectives of the FMPs are met.

Alberta Energy (AE) - AE manages the development of Alberta's non-renewable resources (e.g., coal, minerals, natural gas, petrochemicals, conventional oil, oil sands) and renewable energy (i.e., wind, bioenergy, solar, hydro, geothermal). The ministry grants industry the right to explore for and develop energy and mineral resources, and promotes energy efficiency and conservation.

Alberta Infrastructure – Alberta Infrastructure is the owner of the Swan Hills Treatment Centre which is managed privately. Alberta Infrastructure also owns the historic Alberta Osmose Wood Preservers site, located near the Hamlet of Faust.

Alberta Health and Alberta Health Services – Alberta Health sets guidelines for recreational water quality and issues advisories if guidelines are exceeded. Alberta Health Services routinely monitors water quality (i.e., weekly) during the summer at public beaches through its Recreational Water Quality Monitoring Program.

8.4 Alberta Energy Regulator

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

8.5 Natural Resources Conservation Board

The Natural Resources Conservation Board (NRCB) is an independent, quasi-judicial, and regulatory agency of the GOA. It is responsible for reviewing natural resource projects under the *Natural Resources Conservation Board Act* administered by AEP, and regulating Alberta's confined feeding industry under *AOPA* administered by AAF. The NRCB reviews proposed natural resource projects to determine whether the projects are in the public interest, and have considered associated environmental, social and economic impact. Reviews are mandatory for metallic and industrial minerals, forestry, water management, and recreation projects for which an environmental impact assessment is required under the *Environmental Protection and Enhancement Act*. Under *AOPA*, the Board must determine whether to grant a request for a review of a permitting or compliance decision.

8.6 Municipal Government

The watershed is represented by the rural municipalities of Big Lakes County, MD of Lesser Slave Lake, and to a lesser extent Northern Sunrise County, Woodlands County, and the MDs of Smoky River, Greenview, and Opportunity. Urban centres include the Town of Slave Lake, Town of High Prairie, and the communities of Kinuso, Faust, Driftpile, Joussard, Enilda, Grouard, Canyon Creek, Widewater, and Marten River. Municipal lands in the white zone account for about 18% of the watershed area. Under Part 17 of the *Municipal Government Act* (*MGA*), municipalities have responsibilities in planning, regulating, subdividing, and developing land in Alberta. They have authority to create planning and regulatory documents that prescribe how the land will be developed, including statutory plans that describe planning policies and types of land uses permitted. Appendix B summarizes select municipal plans and policies related to water and land management.

Agricultural Service Boards (ASBs) form part of the rural municipalities and are responsible for administering and developing programs to compliment provincial legislation, including the *Agricultural*

Service Board Act, the *Weed Control Act*, the *Agricultural Pests Act*, and the *Soil Conservation Act*. Many municipalities support programs, services and education initiatives that promote stewardship of watershed resources.

8.7 Métis Settlements

Peavine Métis Settlement, East Prairie Métis Settlement, and part of the Gift Lake Métis Settlement are located in the watershed. These settlements are all in the Region#5 of the Métis Nation of Alberta. The Métis Settlements General Council (MSGC), established by the *Métis Settlements Act,* addresses matters that affect the collective interests of Métis Settlements throughout the Province of Alberta.

8.8 Industry

Agriculture

Agricultural lands cover about 9% of the watershed, and accounts for 29% of the human footprint (ABMI 2014). On deeded lands, agriculture is managed for best production generally achieved by applying good management of resources. Standards for agricultural production are outlined in the *Agricultural Operations Practices Act* (*AOPA),* in municipal Acts, and in industry guidelines (e.g., Alberta Beef Producers, Canadian Cattle Commission, Alberta Canola Producers Commission and Alberta Wheat Commission). The Grazing Lease Stewardship Code of Practice identifies the roles and responsibilities that public land grazing leaseholders have in land management.

Oil and Gas

Oil and gas activity is regulated by the Alberta Energy Regulator. Oil and gas companies have a responsibility to develop resources in a way that minimizes impacts on watershed resources. The Canadian Association of Petroleum Producers (CAPP) encourages responsible development in the upstream oil and gas industry. CAPP aims to enable environmentally and socially responsible performance, and encourages the use of best management practices to reduce impacts on air, land, water, and people.

Forestry

There are seven Forest Management Areas (FMAs) in the watershed that are managed by five forestry companies. The province also manages FMAs in the watershed. The forest industry must develop and implement forest management plans (FMPs) and adhere to the Slave Lake Timber Harvest Planning and Operating Ground Rules (Feb 2015) or other applicable Ground Rules. Pulp and paper production forms part of the forest industry in the Lesser Slave watershed.

Tourism

The tourism industry is represented by private marinas and campgrounds, guiding and outfitting operations, and other recreational user associations (e.g., OHV).

Waste Management

The Swan Hills Treatment Centre (SHTC) is located 12 km northeast of the Town of Swan Hills and has processed hazardous waste since operations began in September 1987.The facility is owned by the Government of Alberta and operated by SUEZ Environmental under an agreement with Alberta Infrastructure.

8.9 Watershed Stewardship Groups, Non-Profit Organizations and Academia

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

8.10 Residents

Residents provide important input into the planning process to ensure that the plan reflects community goals and objectives for natural resource management and the environment. Residents also have a stewardship role.

9.0 ENGAGEMENT PROCESS

The LSWC engaged with the community to seek input into the Lesser Slave IWMP at key stages in the planning processes. Workshops were held early in the process to establish a common vision for the watershed, and to identify issues and concerns regarding the management of land and water resources (Abells and Henry, 2012; 2013). In addition, the LSWC invited representatives of 12 stakeholder groups to a Terms of Reference workshop. Participants were asked to identify the value of healthy aquatic ecosystems, water quality, and water quantity from their perspectives (Aquality Environmental Consulting Ltd. 2013). These discussions formed the basis of the IWMP Terms of Reference (LSWC 2015). A communication and engagement strategy was prepared (CPP Environmental 2015). This strategy included a risk assessment for preliminary issues identified in the watershed, and a list of initial collaborating stakeholders.

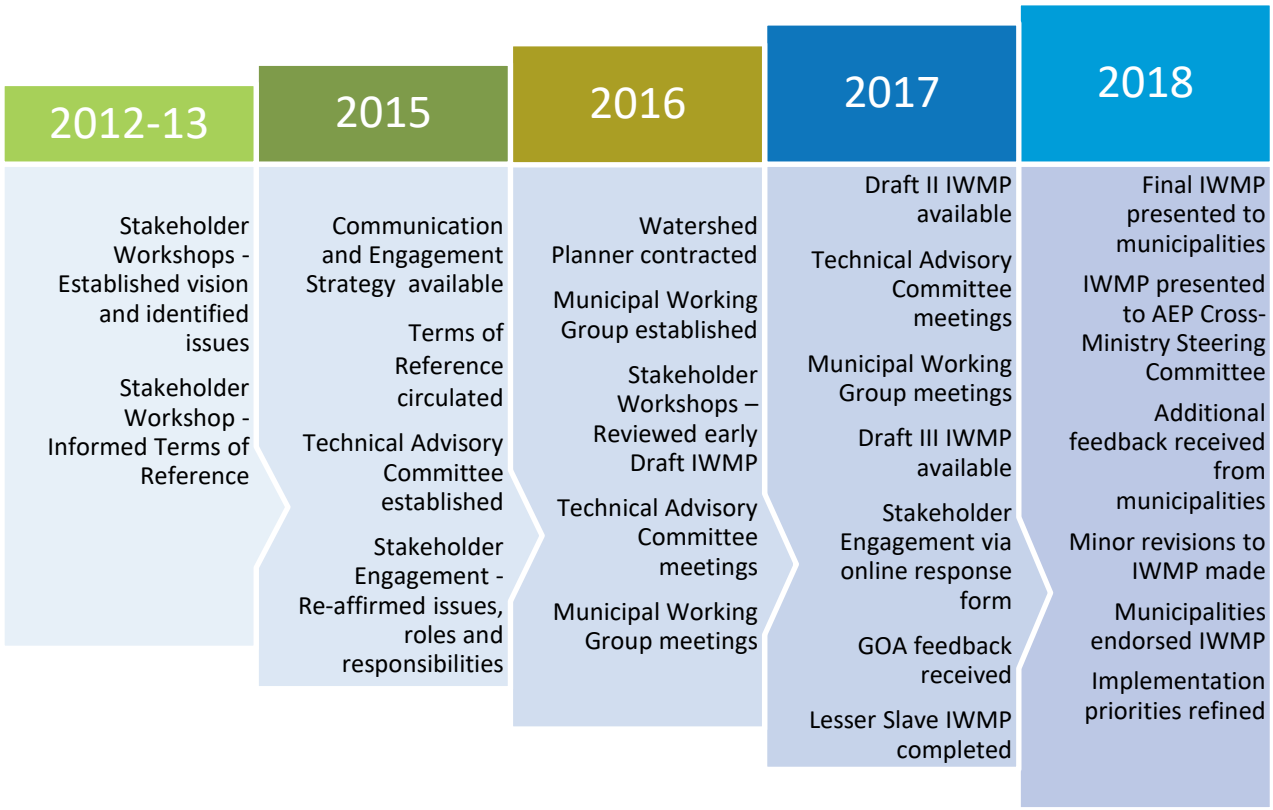
In October-November, 2015, two workshops were held to 1) seek stakeholder advice and input on solutions to problems and issues, and identify who should implement them, and 2) seek stakeholder input on how their agency or organization is already addressing issues in the watershed. An online response form was used to collect feedback (Alan Dolan & Associates 2015). In late fall 2015, a Technical Advisory Committee was established, composed of subject matter experts, to review aspects of the IWMP and provide advice throughout the planning process.

A concerted effort to draft the Lesser Slave IWMP began in May 2016. A Municipal Working Group (MWG) was formed to directly engage with municipalities during the development and subsequent implementation of the IWMP. The first early draft of the plan was available in October 2016. Two workshops were held to present and seek feedback on this early draft, including the topics of indicators, targets and thresholds, and recommendations. An online response form was also used to collect feedback (Alan Dolan & Associates 2017a).

In May 2017, the third working draft of the Lesser Slave IWMP was published for comments and feedback was sought using an online response form (Alan Dolan & Associates 2017b). Additional meetings were held with the Lesser Slave IWMP Steering Committee and Municipal Working Group. The

TAC met via conference call five times throughout the planning process, and provided written feedback on the final draft. A summary of the engagement process is provided in Table 4, with greater detail provided in Appendix C.

Table 4. Summary of engagement undertaken in support of the Lesser Slave IWMP.



Ongoing discussions with indigenous communities throughout the planning process.

9.1 Indigenous Communities

Since 2015, the LSWC has been meeting with indigenous communities in the watershed. The LSWC is at a very early stage of building a relationship with these communities. Conversations have covered a variety of subjects including watershed planning, but these conversations in no way represent any sort of formal consultation process. The LSWC hopes to continue these meetings and share information that will be beneficial to both the LSWC and indigenous communities.

LSWC wants to clearly communicate to First Nations that these conversations can take place without First Nations abrogating any rights they have; nor diminishing the obligation of governments to duly consult with First Nations. Neither the LSWC Board of Directors, nor LSWC staff considers any discussions entered into with First Nations to fall within any mandated duty to consult.

10.0 RECOMMENDATIONS AND IMPLEMENTATION

10.1 General Plan Administration

The Lesser Slave Integrated Watershed Management Plan is an iterative plan that should be reviewed annually in the development of work plans, and in progress reports highlighting Plan achievements to stakeholders. The Lesser Slave Watershed Council should assist in tracking Plan implementation progress in collaboration with its partners.

A more comprehensive review of the Plan should occur every five years. At that time, the implementation status of the recommendations should be thoroughly reviewed; recommendations that have been achieved should be removed from the Plan, new legislation, policies or plans should be documented, and new issues should be highlighted and addressed. The Lesser Slave Watershed Council should lead the review and update of the plan.

10.2 Water Quantity

10.2.1 Goals and Objectives (from Section 6.0)

GUIDING PRINCIPLE

Water and wetlands are integral parts of the Lesser Slave watershed and are managed as a precious resource for future generations.

Goal: Surface water and groundwater are managed to support vibrant communities, healthy aquatic ecosystems, recreation, fish and wildlife, and economic opportunities.

Objectives 1. Update the water balance model for Lesser Slave Lake.

Objective 2. Recommend actions needed to sustain water levels in Lesser Slave Lake and streamflows in the Lesser Slave River.

Objective 3. Recommend water conservation strategies that promote efficient use of water.

Objective 4. Identify actions needed to better understand groundwater resources in the watershed, including its role in overall Lesser Slave Lake water balance.

10.2.2 Targets and Thresholds

Surface water quantity is important to the regional economy and community well-being. Maintaining water levels in Lesser Slave Lake, and streamflows in tributaries to the lake and in the Lesser Slave River, sustains domestic water supplies, the sport-fishing industry through productive fish habitat, tourism activities at beaches and provincial parks, the recreation industry (e.g., marinas), and assimilation of domestic and industrial waste.

Lesser Slave Lake Water Level Target (AENV 1993)

Water levels in Lesser Slave Lake should be maintained at:

- Minimum: 575.5 m
- Maximum: 577.6 m

Lesser Slave River Minimum Instream Flow

Maintaining minimum flows in the Lesser Slave River is important for water supplies, riparian recruitment[7] and function, water quality (assimilation of domestic and industrial wastes), aquatic and terrestrial life (habitat), and recreation. The Lesser Slave Water Management Plan Phase I (LSWC 2009) established an interim minimum flow objective, to be applied until appropriate science-based studies were completed. Additional studies were recommended in the Water Management Plan to better understand the long-term consequences of future water management decisions, including the minimum flow objective, on the Lesser Slave River. The minimum flow objective is particularly important during winter when dissolved oxygen concentrations may reach critical, low concentrations (Alberta Environment 2000).

Maintaining minimum flows in Lesser Slave River is a challenge. A continual supply of sediment exists at the outlet of Lesser Slave Lake that is transported into the Lesser Slave River by littoral drift (Choles 2004). When water levels in the lake are low, as in 1999, 2006 and 2015, the river channel upstream of the weir can become blocked with sediment. Although four main water users undertook dredging activities to remove accumulated sediment and restore river flows in the past, these water users are not responsible for maintaining minimum flows in Lesser Slave River in the future. Impacted water users may choose to submit an application to Alberta Environment and Parks under the *Water Act* requesting approval for dredging activity in the future, but this is not a legislated requirement.

Minimum Instream Flow Target: River flow in the Lesser Slave River should be maintained at a minimum of 6 m^3/s to maintain water quality (e.g., dissolved oxygen) for aquatic life. This minimum flow target should be reviewed and updated according to the recommendations in the Water Management Plan, Phase I.

The minimum instream flow target in the Lesser Slave River may not be achieved if lake water levels are naturally low in dry years, if sediment deposition has blocked flow at the outlet of Lesser Slave Lake upstream of the weir, or in winter if the river freezes to the bottom.

The weir was upgraded in 2015 with a gate that can pass a maximum of 6 m^3/s should water levels fall below the weir crest; this eliminates the need for syphoning water over the weir in future.

10.2.3 Water Quantity Recommendations

A solid understanding of watershed hydrology (including surface water and groundwater interactions), combined with comprehensive water requirements and use information, and water quality data, are needed to accurately determine lake water balance, instream flow needs, nutrient budgets, and to understand land use impacts in the watershed. A detailed hydraulic and hydrologic model, which considers water quality and climate change adaptations, is necessary for sustained land use and development in the watershed.

[7] Riparian recruitment: The hydrological regime necessary to establish and maintain riparian forests through the propagation of seedlings in the riparian zone.

Watershed Hydrology and Management

10.2.3 a Complete a comprehensive review of the historical hydrology at Lesser Slave Lake to better understand the influence of anthropogenic changes and climate change on water quantity (e.g., water level, streamflow) and water quality in the watershed.

10.2.3 b A comprehensive hydrologic model for the Lesser Slave watershed should be developed to recognize and better understand:

1. Importance of headwater streams in maintaining lake water levels and streamflow in the Lesser Slave River
2. Impact of water allocation and use on streamflow in tributaries to Lesser Slave Lake and in the Lesser Slave River, and to water levels in Lesser Slave Lake
3. Potential effects of climate change on hydrology and subsequent effects on the general limnology of the lake. Increased precipitation early in the season along with prolonged warming effects could change nutrient loading characteristics, lake volumes, and residence times (Hutchinson et al. 2015)
4. Changes in water yield through time resulting from land disturbance, including an assessment of the 15% increase in water yield threshold (ESRD 2015a) for forest disturbance
5. Importance of wetlands and aquifers to water storage
6. Impact that future water management decisions may have on the rivers and lakes in the watershed.

10.2.3 c To better inform the water balance model for the Lesser Slave watershed:

1. Establish natural and current streamflow hydrographs for main tributaries to Lesser Slave Lake and the Lesser Slave River (i.e., Salteaux and Sawridge rivers). Extend the historic timeline further than 100 years where possible.
2. Update the water allocation database for the watershed to determine how water use is changing in the basin by sector.[8]

10.2.3 d Assess the volume of water required for human uses, including existing consumptive and non-consumptive water uses, river flow, and groundwater stores and use in the watershed to develop a Water Conservation Objective for the Lesser Slave River (see Recommendation 10.2.3 g) and a water conservation strategy for the watershed.

10.2.3 e Assess surface water and groundwater licence allocations, use and priorities to address the cumulative impact of water diversions in dry years. Explore the application of conditions on existing, new and/or temporary surface water diversion licences when the lake water level is less than 575.5 m or when streamflow is less than Q80[9] for headwater streams (Order 1 to 4). Consider the following scenarios:

1. Apply a lake water level threshold of 575.5 m before approving temporary diversion licence applications. Use the water balance model to identify variable minimum lake water levels (e.g., monthly minimum) to better reflect natural variations.

[8] For the period 1993-2008, four major license holders withdrew an average of 10,824,539 m^3/year. Annual water withdrawal by the four main licence holders was expected to average 12,100,000 m^3/s by 2020 (Jamison 2009)

[9] The exceedance percentile Q_{80} refers to a flow value at which 80% of recorded flows for the indicated time interval (usually one week) are equal to or greater than that value.

2. Limit withdrawals on existing licences from Lesser Slave Lake when water levels fall below 575.5 m.
3. Continue to apply a streamflow threshold of Q80 for headwater streams (Order 1-4) before approving temporary diversion licence applications (A. Asnaashari, AEP, pers. comm.). Evaluate flow conditions at key stations (Water Survey of Canada four character sub-basins) to assist with the analysis (Table 5). When streamflow falls below Q80, withdrawal from the upstream smaller creeks with stream order 1-4 are suspended. If flow at the key station continues to decrease below Q95 then stream orders 5 and 6 will be closed for diversion until sustainable flows are observed. Water can be diverted from stream orders 7 and 8 with limitations to a cumulative diversion of 5%.

Table 5. Key stations used to determine threshold flows (Q80) for temporary diversion licences.

Sub-basin	Key Station	Station Name	Weblink			
			Water Survey of Canada		Alberta River Basins Website	
			Historic	Real-time	Percentile	Current Flow
07BF	07BF905	South Heart River near Big Prairie Settlement	07BF905	07BF905	07BF905	07BF905
07BJ	07BJ003	Swan River near Kinuso	07BJ003	07BJ003	07BJ003	07BJ003
07BK	07BK001	Lesser Slave River at Slave Lake	07BK001	07BK001	07BK001	07BK001

4. Temporarily suspend withdrawals on existing temporary diversion licences when the threshold of Q80 for headwater streams (Order 1-4) is exceeded.

10.2.3 f Adopt strategies to improve water conservation, efficiency and productivity (AWC 2017).

Lesser Slave River Sub-Basin

Natural streamflow and sedimentation processes in the Lesser Slave River are influenced by a weir that was constructed at the outlet of Lesser Slave Lake, and by channelization measures that effectively cut-off eight meander bends in the river, downstream of the weir. Sediment accumulation at the outlet of the Lesser Slave Lake can promote ice accumulation upstream of the weir in winter, thereby reducing streamflow over the weir or through the weir's open gate.

The Lesser Slave WMP Phase I intended to set a Water Conservation Objective for the Lesser Slave River. An interdepartmental committee was formed to develop a defensible, science-based Instream Flow Needs (IFN) recommendation for the long-term protection of the aquatic ecosystem. The committee evaluated IFN determination methods and concluded that the Alberta Instream Flow Needs Guideline (also known as the Alberta Desktop Model) (Locke and Paul 2011) was not applicable to the regulated Lesser Slave River, and that site-specific information was required for all components of the aquatic system (Golder Associates 2004). A detailed work plan to support the IFN determination was developed, and the LSWC was tasked with implementing the field program. Continued funding support from Alberta Environment was identified for the timely completion of the work. Although significant progress was made on the work plan (Appendix D), there are outstanding tasks, including the final IFN determination (Golder Associates 2004).

10.2.3 g Complete the studies recommended in LSWC 2009 that are needed to establish science-based Water Conservation Objectives for the Lesser Slave River, including:

1. The completion of the detailed IFN Study that considers aquatic life, riparian areas, water supply, waste assimilation, and recreational needs. The IFN study should evaluate and verify the current interim 6 m^3/s minimum instream flow objective. This minimum flow was originally determined by an assessment of river flow and water quality during the low flow conditions experienced in 1999 and 2000 (AENV 2000). Further, the study should indicate the consequences of future water management decisions on water quantity and quality in the Lesser Slave River.
2. The development of a running, fully calibrated water quality model to aid in the evaluation of streamflow and its correlation to water quality (GOA 2010, Letter to LSWC).

10.2.3 h The science-based Water Conservation Objective should be determined by the Director under the *Water Act* (Section 15(1)) through a Water Management Plan process as outlined in the Framework for Water Management Planning (AEP 2001). The Water Conservation Objective could be a range of weekly flows represented in an annual hydrograph, rather than a single minimum flow value.

10.2.3 i Future management of water levels in Lesser Slave Lake should consider:

1. Periodic, controlled higher water levels to encourage deposition of sediments on-shore, and to sustain healthy riparian areas.
2. Adequate water levels to maintain productive littoral zones.
3. A range of acceptable water levels to minimize shoreline erosion.
4. Access strategies for harbours and marinas.

Flood Mitigation

10.2.3 j Flood hazard mapping supports emergency planning, and development planning. Priorities for flood hazard mapping in the watershed should be identified and a request for mapping communicated to the province.

10.2.3 k Investigate strategies to reduce flooding in the watershed where it is a known issue. Strategies could include:

1. Restoration and maintenance of river channel morphology to increase river length and area to accommodate natural flooding processes,
2. Management of log jams to minimize damage to existing berms and dykes, and damming of water (also refer to Recommendations 10.3.3 e-g), and/or
3. Land swaps of private land, which is routinely flooded, with Crown Land located in the upland that has less impact on watershed hydrology, water quality and aquatic life.

Forest Hydrology

Detailed Forest Management Plans are required as part of Forest Management Agreements that are negotiated by the Government of Alberta and forest companies. There are seven FMAs in the watershed. Some of the FMA holders are in the process of updating their Forest Management Plans.

FMPs address sustainable forest management, including water balance in the watershed in light of forest disturbance; thresholds are set for the permitted increase in water yield that may result from harvest activity.

Where a Detailed Forest Management Plan does not exist, an increase in water yield threshold of <15% is used to manage forest disturbance. Forest water balance research shows the dominant role that evapotranspiration and annual changes in soil moisture storage have in regional hydrology (Brabender 2005). It is unlikely that the general threshold value of 15% for increases in water yield applies to all watersheds due to differing forest disturbance and hydrologic effects. Management models (e.g., ECA-Alberta and WRENSS-USEPA) have been used for equivalent clear-cutting analysis and impacts on watershed hydrology. Hydrologic analysis (ECA-Alberta) should be improved to understand how regional variation in climate and hydrology in forested regions is related to acceptable harvest levels from a water resources perspective. Effort should be made to establish appropriate disturbance thresholds across the forested regions of the province (Brabender 2005).

10.2.3 l Better understand the impact of forest harvesting on watershed hydrology and disturbance effects on evapotranspiration, overall lake water balance and future water supplies.

10.2.3 m Establish appropriate, region-specific disturbance thresholds (e.g., increase in water yield) for FMAs in the Lesser Slave watershed. Explore the ECA-Alberta model as the preferred tool for the forest sector (industry and government).

Groundwater

The Groundwater Observation Well Network (GOWN) is a network of groundwater monitoring wells located in aquifers across Alberta. Most wells are fitted with data loggers and sensors that continually record groundwater levels, and water quality at many wells is periodically assessed. While there are over 250 active observation wells in Alberta, none are located in the Lesser Slave watershed. The nearest well in this network is located at LaCrete, in the Peace River watershed.

10.2.3 n Groundwater observation wells should be established in the Lesser Slave watershed as part of the Alberta Government's Groundwater Observation Well Network (GOWN).

10.2.3 o Some industries are required to provide well-log reports to the province as part of their approval to operate. Effort should be made to compile existing industrial well drilling reports and groundwater monitoring records contained in the Alberta Water Well Information Database (AWWID), for future reference. The database contains information about individual water well drilling reports, chemical analysis reports up to the end of 1986, springs, flowing shot holes, test holes, and pump tests conducted on the wells (http://aep.alberta.ca/water/reports-data/alberta-water-well-information-database/default.aspx).

10.2.3 p Groundwater data should be used to better understand the contribution of groundwater to the overall Lesser Slave Lake water balance, and to report on the status of groundwater levels and condition in a future state-of-the-watershed report.

10.2.4 Implementation Table for Water Quantity

The table below (and following implementation tables in Sections 10.3.4, 10.4.4, 10.5.4 and 10.6.4) provides guidance on the implementation of recommendations. It highlights who has jurisdiction or interest in the recommendation (e.g., regulatory, economic, research, or stewardship interest) and priorities. High priorities are generally recommendations that: have watershed-wide benefits; address current knowledge gaps; and align with current work and priorities.

Although there are many high priority recommendations, it is not expected that all actions will be undertaken in the short-term. In some cases, implementation of high-priority items may depend on the prior implementation of a related recommendation, thus a high priority becomes a medium-term implementation action. Partners should use the tables to further refine priorities according to individual jurisdictional priorities and resource availability. It is expected that detailed and staged work plans will be developed using these tables as a guide (refer to Appendix I).

Recommendation	Responsible Jurisdiction	Action	Priority[a]
10.2.3 a Review historic hydrology at the lake	AEP	Complete a comprehensive review of historic hydrology for Lesser Slave Lake, including streamflow in tributaries and lake water levels.	H (H)
10.2.3 b Develop a hydrologic/hydraulic model	LSWC	Establish a partnership (sub-committee) to develop an approach to adapting or developing a watershed-scale model. The model should combine climate, land use, water quality, hydrology, and river system models, for the watershed.	H (H)
	AEP, AAF	Allocate personnel to work with LSWC to develop or oversee the development of the model.	H (H)
	U of A, Forest Industry, U of C, U of L, others	Partner with LSWC and AEP to develop and apply the integrated watershed model.	H (H)
10.2.3 c Develop a more robust water balance model	AEP	Update the 1977 bathymetric data for the Lesser Slave Lake. Note that this was partly completed in 2013 (AMEC 2014).	H (H)
		Better understand groundwater contribution to the water balance.	
		Apply the Athabasca Region Integrated Model (ARIM) to update the water balance model in the watershed (Alberta WaterSMART 2017).	
10.2.3 d-e Assess water allocation, use and priorities	AEP	Update water licence and allocation database	H (H)
		Assess water use and allocations and identify conditions for use in dry years.	M (H)
10.2.3 f Water conservation	All	Refer to AWC 2017 for water conservation, efficiency and productivity strategies.	H (H)
10.2.3 g Technical and scientific basis to	AEP	Phase I – Establish the technical and science basis to inform a WCO recommendation - Review the work plan (methods and data requirements) outlined in the Lesser Slave	H (H)

Recommendation	Responsible Jurisdiction	Action	Priority[a]
inform a WCO (IFN Study)		WMP Phase I (Appendix D). - Commit resources to the completion of the IFN Study for the Lesser Slave watershed. - Develop a water quality model to integrate with the hydrologic/hydraulic model and to use in the evaluation of IFNs.	
	LSWC	Collaborate with AEP to establish working team and IFN work plan.	H (H)
10.2.3 h and i Engage with communities to establish WCO	AEP	Phase II – Community Engagement - Engage the public (i.e., local governments, indigenous groups, industry, public) to determine stakeholder values, test options and evaluate trade-offs to inform the final WCO recommendation. - Use the hydrologic/hydraulic model (recommendation 10.2.3 b and c), and Lesser Slave IFN Study results (10.2.3 g), to assess lake level management strategies that will result in the greatest benefit for all users.	M (H)
		Recommend a WCO for the Lesser Slave River.	M (H)
	LSWC	Assist AEP with community engagement during the Lesser Slave Water Management Plan Phase II planning process.	M (H)
10.2.3 j Prioritize flood hazard mapping	LSWC, AEP	LSWC should assess the needs and priorities for flood hazard mapping in the watershed. A written request should be made to the province to complete the necessary mapping.	H (H)
10.2.3 k Flood mitigation strategies	AEP, Municipalities	Use the updated floodplain mapping to assess flood hazard areas and to identify mitigation strategies to address flood issues.	M (H)
10.2.3 l Better understand the role of forest harvesting in watershed hydrology	AAF, AEP, Forest Industry, U of A	Explore forest harvest scenarios, in combination with other land use disturbances to establish disturbance thresholds for FMAs and other land use in the watershed.	M (H)
10.2.3 m Establish appropriate disturbance thresholds for FMAs		Establish appropriate, region-specific disturbance thresholds for FMAs in the Lesser Slave watershed. Evaluate annual water yield in comparison to pre-disturbance scenarios to determine if water yield thresholds are being met.	
10.2.3 n Establish groundwater observation well (GOWN)	AEP	Regional technologists responsible for maintaining and sampling wells, and archiving data into groundwater databases should establish at least one groundwater observation well in the Lesser Slave watershed.	M (H)
10.2.3 o Compile existing groundwater well information	LSWC	Consult the Alberta Water Well Information Database, and work with industry to compile groundwater well information.	M (M)
	Industry	Work with the LSWC to compile groundwater well information.	M (M)
10.2.3 p Use the groundwater data to update the water balance model	AEP	Update the water balance model using the most recent data collected from the GOWN sites (Recommendation 10.2.3 i), and other data compiled	M (H)
	LSWC	Report on groundwater quality and quantity in a future state of the watershed report.	M (M)

[a]H=High Priority; M = Medium Priority; L = Low Priority; (H)=High Community Value; (M)=Medium Community Value; (L)=Low Community Value

10.3 Water Quality

Measurements of water quality in the Lesser Slave watershed are generally limited. The most recent water quality assessments for Lesser Slave Lake were completed in the early 1990s (Noton 1998) and early 2000s (Wolanski 2006). These studies indicate the difference in water quality in the lake between the shallower west basin (mean depth: 9.1 m) and deeper east basin (mean depth: 13.4 m). Higher algae (phytoplankton) concentrations and turbidity in the west basin were noted in the 1940s (Miller 1941, unpublished), and periodically through subsequent decades (Weisberger 1977; Noton 1998). The west basin is considered eutrophic (i.e., high nutrient and chlorophyll *a* concentrations [high productivity], and low Secchi disk depth visibility). The east basin is characterized as a mesotrophic system (i.e., moderate productivity) (Noton 1998).[10] Poorer water quality in the west basin was attributed, in part, to high turbidity and suspended solids loads carried to the lake by some of the major tributaries (Hutchinson et al. 2015).

GUIDING PRINCIPLES

Water Quality: *Good quality water is necessary for communities that rely on the Lesser Slave Lake for their water supply. Water quality is also important to the local sport fishing and tourism industry and should be maintained to support the fishery, contact recreation at swimming beaches, and other water sport activities (e.g., paddle boarding, wind-surfing, tubing and water skiing).*

Erosion and Sediment: *The process of erosion and transport of sediment to and within Lesser Slave Lake is recognized as a natural process that is accelerated by human alteration and disturbance. Effort should be made to reduce/mitigate future transport of suspended sediment in tributaries to the lake, and to minimize shoreline erosion and sediment re-suspension due to human activity.*

Similar to Lesser Slave Lake, monitoring in the tributaries to the lake has been inconsistent in the past, varying in sampling frequency and analysis (Appendix E). Water quality varied among the tributaries. Total suspended solids and phosphorus concentrations were generally highest during peak streamflows in spring and summer, particularly in the East Prairie River (Hutchinson et al. 2015). The Driftpile and Swan rivers tended to have lower concentrations of total and dissolved phosphorus compared to the other tributaries. Differences in water quality were attributed to channel morphology, river gradients, and land-use differences among the catchments (Hutchinson et al. 2015).

Phosphorus loading to Lesser Slave Lake remains a concern. Excessive nutrients in water can cause eutrophic conditions with increased algae and weed growth. In some circumstances, increased plant abundance can change the chemistry of the water, and affect oxygen concentrations (through photosynthesis / respiration, and decay of organic matter), aesthetics and physical movement of water. Certain strains of algae can impart an off-taste to drinking water and in some instances blue-green algae

[10] Values associated with lake productivity indicators are reported by Nurnberg (1996) (Table A). Chlorophyll *a* is an indicator used to measure phytoplankton (algae) suspended in water. The visibility of a Secchi disk measures water transparency in a lake that is partly influenced by the presence of algae (Noton 1998).

Table A. Water quality associated with trophic classes as established by Nurnberg (1996).

Trophic Class	Chlorophyll *a* (mg/m^3)	Total Phosphorus (mg/L)	Secchi Depth (m)
Mesotrophic	3.5-9.0	0.010-0.030	4 - 2
Eutrophic	9.0-25.0	0.030-0.100	2 - 1
Hyper-eutrophic	>25	>0.100	<1

produce toxins that can cause health issues for humans and are toxic to livestock and waterfowl (USEPA 1978; Cole 1994).

10.3.1 Goals and Objectives (from Section 6.0)

Goal: Water quality is maintained or improved to support communities, aquatic ecosystems, recreation, fish and wildlife and economic opportunities for future generations.

Objective 1. Compile existing water quality data for Lesser Slave Lake and its major tributaries.

Objective 2. Recommend a long-term water monitoring strategy for the watershed.

Objective 3. Identify and promote appropriate industry beneficial management practices to improve and maintain water quality in Lesser Slave Lake and its major tributaries.

Objective 4. Promote a stewardship ethic among watershed residents and users.

10.3.2 Targets and Thresholds

Historic water quality conditions for Lesser Slave Lake and the main tributaries to the lake are summarized in Tables 7 and 8. Data collected at Lesser Slave Lake during the open-water season in 1991-93 (Noton 1998), 2000-2002 (Wolanski 2006) and 2010-2011 (Hutchinson et al. 2015) is presented. For major tributaries to the lake, two periods of record are presented that were deemed to be most comprehensive and similar in seasonal variability (i.e., 1992-93 and 2012-13, May to October).

Data collected in future water monitoring programs, should be compared to historic data and other applicable water quality guidelines to identify spatial and temporal trends (e.g., water quality improvements or degradation). The results of the future water monitoring program should be used to establish comprehensive site-specific water quality objectives for Lesser Slave Lake and its tributaries, and for the Lesser Slave River (refer to Recommendation 10.3.3 w).

Table 6. Water quality targets for lakes and rivers in the Lesser Slave watershed.

Waterbody	Target
Lakes	
General	No increase in total phosphorus (or nitrogen) above historic conditions should occur at all lakes in the Lesser Slave watershed. Where nitrogen and/or phosphorus have increased due to human activity, develop lake-specific nutrient objectives and management plans where warranted (ESRD 2014b).
Lesser Slave Lake	Maintain and/or improve water quality in Lesser Slave Lake (Table 7). Site-specific water quality objectives should be established when more comprehensive water quality data is available.
Rivers	
General	Water quality should meet provincial water quality guidelines established to protect fish and other aquatic life, as well as meet needs of human use (e.g., water supplies, aesthetics, recreation, waste assimilation). Maintain and/or improve water quality in tributaries to Lesser Slave Lake (Table 8 and Table 9).

Table 7. Summary of historic water quality data for Lesser Slave Lake.

Period of Record	Basin		Total Phosphorus (mg/L)			Chlorophyll *a* (mg/m^3)			Secchi Depth (m)		
		N	Average	Median	Range	Average	Median	Range	Average	Median	Range
1800-2005[a]	West	32	0.030	0.029	0.022-0.042	-	-	-	-	-	-
1608-2006[a]	East	30	0.035	0.034	0.027-0.044	-	-	-	-	-	-
1991-1993[b]	West	12	0.049	0.040	0.023-0.095	53.80	36.60	1.3-196.9	1.85	1.85	0.7-3.2
	East	13	0.028	0.022	0.016-0.077	27.03	11.20	3.6-114.6	2.58	2.60	1.3-3.8
2000 and 2011[c]	West	5	0.053	0.053	0.028-0.087	41.25	39.10	3.4-107.2	1.70	2.00	0.7-3.1
	East	5	0.040	0.040	0.019-0.070	35.66	21.30	6.3-90.9	2.35	2.10	1.7-3.8

[a]Hutchinson et al. 2015 – Diatom-inferred total phosphorus concentrations; [b]Noton 1998; [c]Wolanski 2006 and Hutchinson Environmental Services Ltd. 2015.

Table 8. Summary of historic water quality data for the main tributaries to Lesser Slave Lake, open-water season (May to October).

Indicator	Statistic	South Heart		West Prairie		East Prairie		Driftpile	Swan	Alberta Surface Water Quality Guidelines (ESRD 2014; CCME 2012)
		1991-92	2012-13	2012-13	2012-13	1991-92	2012-13	1991-92	2012-13	
		N=9	N=12	N=12	N=12	N=11	N=12	N=11	N=11	
Temperature, °C	Median	16.5	12.7	12.8	13.4	16.2	13.9	15.6	14.5	<22
	Minimum	12.0	0.9	3.3	1.3	0.7	1.6	0.8	2.5	
	Maximum	21.5	21.3	21.7	22.6	21.7	23.1	20.0	22.6	
Dissolved Oxygen, mg/L	Median	-	8.36	9.95	9.62	9.00	9.72	8.6	9.6	≥5.0 (acute daily minimum) ≥6.5 (chronic 7-day average) ≥9.5 (spawning)
	Minimum	-	6.05	8.23	7.94	8.00	7.54	8.16	7.80	
	Maximum	-	15.87	13.85	16.04	13.18	15.32	12.89	12.18	
Total Phosphorus, mg/L	Median	0.094	0.143	0.053	0.076	0.040	0.051	0.048	0.060	**Where site-specific nutrient objectives do not exist:** Nitrogen (total) and phosphorus concentrations should be maintained to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen concentration, and recreational quality.
	Minimum	0.050	0.079	0.028	0.028	0.022	0.020	0.026	0.031	
	Maximum	0.190	0.838	1.150	1.120	0.129	0.873	0.173	0.084	
Total Dissolved Phosphorus, mg/L	Median	0.027	0.024	0.018	0.013	0.016	0.012	0.015	0.012	
	Minimum	0.015	0.012	0.006	0.004	0.007	0.005	0.010	0.009	
	Maximum	0.058	0.064	0.033	0.032	0.021	0.025	0.016	0.023	
Total Nitrogen, mg/L	Median	1.197	1.187	0.859	0.565	0.482	0.546	0.431	0.518	
	Minimum	1.052	0.724	0.411	0.249	0.281	0.262	0.275	0.201	
	Maximum	1.955	2.762	3.786	2.972	0.976	7.878	0.832	2.110	
Nitrate+Nitrite Nitrogen, mg/L	Median	0.039	0.032	0.009	0.009	0.003	0.006	0.002	0.012	Nitrite-Nitrogen: Varies with Chloride Nitrate-Nitrogen: 3 (chronic 30-d average); 124 (acute instantaneous maximum)
	Minimum	0.002	0.003	0.003	0.003	0.001	0.003	0.001	0.003	
	Maximum	0.083	0.072	0.086	0.152	0.026	0.148	0.032	0.093	
Total Suspended Solids, mg/L	Median	10	-	-	-	14	-	21	-	**Clear Flow Period**: Max. increase of 25 mg/L from background for short-term exposure (e.g., 24-h period). Max. average increase of 5 mg/L from background for longer term exposures (e.g., inputs lasting between 24 h and 30 d).[c] **High Flow Period**: Max. increase of 25 mg/L from background at any time when background is between 25 and 250 mg/L. Should not increase more than 10% of background when background is ≥ 250 mg/L.[c]
	Minimum	5	-	6	12	2	-	4	-	
	Maximum	132	-	1170	1150	128	-	187	-	
Fecal coliform Bacteria, cfu/100 mL	Median		-						-	≤100 cfu per 100 mL
	Minimum	4	-			2	-	20	-	
	Maximum	264	-			200	-	200	-	

[a]TSS objective is guidance for construction.

Table 9. Summary of historic water quality data for the Lesser Slave River, open-water season (May to October).

Indicator	Statistic	Outlet of Lesser Slave Lake		9.5 km U/S of Confluence		Watershed-Wide Target
		1991-92 (N=11)	2012-13 (N=12)	2012-13 (N=6)	2001-15 (N varies)[a]	
Temperature, °C	Median	14.8	13.7	10.14	11.66	<22
	Minimum	3.97	2.10	7.6	-0.18	
	Maximum	18.99	22.0	21.17	23.11	
Dissolved Oxygen, mg/L	Median	10.0	10.3	10.11	10.42	≥5.0 (acute daily minimum) ≥6.5 (chronic 7-day average)
	Minimum	9.00	7.40	7.80	7.07	
	Maximum	11.93	13.64	11.49	13.55	
Total Phosphorus, mg/L	Median	0.028	0.019	0.036	0.046	**Where site specific nutrient objectives do not exist:** Nitrogen (total) and phosphorus concentrations should be maintained to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen concentration, and recreational quality.[c]
	Minimum	0.015	0.010	0.012	0.012	
	Maximum	0.084	0.058	0.130	0.275	
Total Dissolved Phosphorus, mg/L	Median	0.006	0.005	0.012	0.014	
	Minimum	0.002	0.002	0.006	0.002	
	Maximum	0.008	0.006	0.024	0.088	
Total Nitrogen, mg/L	Median	0.574	0.503	0.895	0.750	
	Minimum	0.432	0.277	0.610	0.490	
	Maximum	0.783	0.918	1.300	1.766	
Nitrate+Nitrite Nitrogen, mg/L	Median	0.003	0.005	0.003	0.012	Nitrite-Nitrogen: Varies with Chloride Nitrate-Nitrogen: 3 (chronic 30-d average); 124 (acute instantaneous maximum)
	Minimum	0.001	0.003	0.002	0.002	
	Maximum	0.012	0.076	0.063	0.074	
Total Suspended Solids, mg/L	Median	24	-	24	18	**Clear Flow Period**: Max. increase of 25 mg/L from background for any short-term exposure (e.g., 24-h period). Max. average increase of 5 mg/L from background for longer term exposures (e.g., inputs lasting between 24 h and 30 d). **High Flow Period**: Max. increase of 25 mg/L from background at any time when background is between 25 and 250 mg/L. Should not increase more than 10% of background when background is ≥ 250 mg/L.
	Minimum	2	-	8	1	
	Maximum	100	-	140	368	
Fecal Coliform Bacteria, cfu/100 mL	Median	6	-	20	19	≤100
	Minimum	2	-	5	5	
	Maximum	48	-	240	260	

[a]N varies between 26 and 43.

10.3.3 Water Quality Recommendations

Maintain and Improve Water Quality

10.3.3 a Maintain and/or improve water quality condition in Lesser Slave Lake by reducing external nutrient and sediment inputs.

10.3.3 b Adopt riparian health targets and apply riparian setbacks to maintain functioning riparian areas in the watershed that contribute to improved water quality, stable streambanks, and reduced erosion (Section 10.4.2).

10.3.3 c Enforce protection of riparian and wetland environments in forest management areas and in oil and gas developments through regular site inspections.

10.3.3 d Review septic and sewage discharges to tributaries, Lesser Slave Lake, and Lesser Slave River.

Channelization

Historic flood mitigation measures that channelized extensive reaches of the East Prairie, West Prairie, South Heart, and Lesser Slave rivers has altered the natural hydrology of the watershed and its assimilative capacity. For example, river length in the Lesser Slave River was effectively reduced by about 8 km when eight meander bends were removed. Channelization accelerates the velocity and increases the energy of water, thereby increasing streambank erosion and scouring. Channelization also limits the access of flood water to the floodplain where sediment removal typically occurs.

10.3.3 e Adopt a policy of “no net loss” in river channel length to discourage further channelization of natural waterways.

10.3.3 f Investigate opportunities to restore river lengths and wetlands to improve water quality and local flooding.

10.3.3 g Log jams, particularly in the channelized reaches of the South Heart River, West Prairie and East Prairie rivers, are an ongoing problem that result in localized flooding and increased erosion. Investigate the frequency and occurrence of log jams and their overall impact on water quality and aquatic ecological integrity. Identify options to manage log jams that are having a negative impact in specific areas.

Land Use

10.3.3 h Apply industry best management practices to reduce point and non-point sources of sediment, nutrients and other contaminants originating from agriculture, forestry, mining, oil and gas, and development activities. BMPs should include minimizing or eliminating the use of herbicides and fertilizers adjacent to watercourses

Agriculture

10.3.3 i Apply the following Beneficial Management Practices:

1. Limit new stream crossings, particularly culverts, and improve existing stream crossings to ensure fish passage (i.e., single-span bridges or open-bottom culverts).
2. Maintain healthy riparian areas that have stable banks supported by deep rooted vegetation.
3. Use soil bio-engineering techniques (e.g., willow cuttings or wattle fences) to stabilize and repair eroded streambanks, where possible. A combination of conventional bank stabilization (e.g., rip rap) and bio-engineering techniques may be considered where appropriate.
4. Establish and maintain riparian management areas and plans for grazing lands.
5. Provide off-stream watering sites to prevent livestock from wading in streams. Off-stream watering has proven to be beneficial for cattle weight-gain, while hoof action can damage streambanks and introduce nutrient and bacterial contamination.
6. When management of stocking rate, timing and duration on grazing lands cannot maintain healthy riparian areas, use temporary or permanent fencing adjacent to waterways or wetlands.
7. Practise soil conservation on cropped lands to reduce soil erosion, conserve soil and protect water quality.
8. Minimize or eliminate the use of herbicides and fertilizers adjacent to watercourses.

10.3.3 j Increase collaboration between municipal Agriculture Service Boards, and other local agricultural organizations to promote the use of beneficial management practices that protect, maintain and improve water quality in agricultural areas.

10.3.3 k Consider an ecological goods and services incentive program that provides payment for maintaining streamside buffers and wetlands through strategic partnerships (e.g., Alternative Land Use Systems (ALUS) or the Green Acreages Program that are available to landowners with less than 40 acres of land and less than $10,000 farm income).

Forestry

10.3.3 l Apply forest industry standards to harvesting practices as outlined in Forest Management Agreements and Operating Ground Rules to:

1. Avoid excessive soil disturbance through careful planning
2. Avoid construction or harvest near ephemeral draws, tributaries and source water areas. Maintain adequate buffers (minimum setbacks for disturbance from watercourses and wetlands) (Appendix E)
3. Conduct proper road construction, maintenance and reclamation. Culverts should be properly sized and installed correctly so as not to affect the natural flow of water or increase soil erosion. Consult the Code of Practice for Watercourse Crossings. (Also refer to Recommendation 10.5.3 f).
4. Minimize the number of roads crossing streams and wetlands, and reduce the use of culverts using clear-span bridges on fish bearing streams where practical.
5. Avoid steep slope road construction or logging activity.

10.3.3 m Adopt strategies in Detailed Forest Management Plans that align with the outcomes of the Lesser Slave IWMP, including those outlined in Table 10.

Table 10. Strategies to be applied by the forest industry for greater watershed protection (adapted from Tolko Industries Limited 2005).

Monitor spatial diversity and forest fragmentation at the landscape level across the FMA area.	
Strategy 1	Develop and implement a twenty year spatial harvest sequence to be followed by all operators on the FMA. Variance from the twenty year spatial harvest sequence will be monitored, tracked and reported annually. If the variance from the twenty-year spatial harvest sequence for the Forest Management Area by compartment, by decade is greater than 20%, the government may require a compartment assessment, a review of the twenty-year spatial harvest sequence or an adjustment to the sustainable harvest level calculation.
Strategy 2	On an ongoing basis, work with other forest users to minimize roads and promote utilization of existing disturbances.
Mitigate the impacts of forestry practices on riparian areas, water bodies, watersheds and hydrological cycles.	
Strategy 3	Identify major watersheds in the FMA area, to improve the understanding of the impacts of forestry practices on hydrological cycles. Through the use of computer simulation models (e.g. Cumulative Watershed Disturbance and Hydrologic Recovery Simulator [ECA-Alberta]) evaluate the potential impacts of forestry practices on water flows.
Minimize the effects of roadway development on watercourses in the FMA area.	
Strategy 4	Install watercourse crossing structures that are appropriate for the watercourse being crossed, the season of use, and in compliance with the provincial and federal legislation.
Strategy 5	Develop a watercourse crossing database for the tracking of crossing installation, removal and re-vegetation efforts within one year of Detailed Forest Management Plan approval.
Strategy 6	Operate cooperatively with other forest industry stakeholders in the FMA area to develop integrated forest harvest plans and coordinate (where possible) the number and timing of entries into operating areas.
Strategy 7	Reduce the amount of new road being developed on the FMA area. Where possible, enter into commercial road use agreements with companies that operate in the area.
Strategy 8	Conduct harvest operations during frozen or dry ground conditions. Watercourse crossing construction techniques such as snow fills, ice bridges or log fills, with removal prior to spring melt will be used to minimize effects of roadway development on watercourses.

ECA means Equivalent Clearcut Analysis

10.3.3 n Pulp mills should continue to seek ways to improve the quality of effluent discharged to the Lesser Slave River and reduce impacts on the aquatic environment.

10.3.3 o Continue to work with AEP to develop a dissolved oxygen model and reduce BOD limits that are discharged to the Lesser Slave River. Ensure that treated effluent does not result in a surface water quality guideline exceedance in the Lesser Slave River.

Oil and Gas Industry

10.3.3 p Apply industry standards and practices to oil and gas development in the watershed according to “Integrated Standards and Guidelines: Enhanced Approval Process (EAP)” (GOA 2012a).

10.3.3 q Road construction and stream crossings can impact water quality by increasing the transport of sediment and other contaminants to surface water. Road construction should be kept to a minimum. Strategies to minimize road construction include:

1. Use existing roads and horizontal drilling techniques to access resources.
2. Collaborate with other industry sectors on road development planning.

Refer to Recommendation 10.5.3 f for road construction strategies used to minimize impacts to wetlands.

Urban Areas

10.3.3 r Apply development setbacks adjacent to watercourses and waterbodies at the time of land subdivision. Refer to Section 10.4 for more detail.

10.3.3 s Stormwater volume, release rate, and quality should be managed in a way to minimize impacts on surface water.

10.3.3 t Identify stormwater management strategies that can be used to protect surface water quality. Consider the following:

1. Inventory stormwater outfalls and place a sign at each site with outfall number/name.
2. Proper storage, handling and application of road salt in winter.
3. Proper storage, handling and application of herbicides and pesticides during the growing season.
4. Use of stormwater ponds and low impact development practices that manage stormwater volumes and release rates, and improve stormwater quality.
5. Conduct a water quality study to examine how stormwater varies among developments.
6. Educate residents about their role in stormwater management.
7. Engage partners to implement the Yellowfish Road Program with local schools.

10.3.3 u Stockpiled snow, when melted, can be a significant source of contaminants (e.g., salt, nutrients and sediment) to surface water. Care should be taken to stockpile snow away from surface water.

10.3.3 v There is a general concern in the watershed regarding the maintenance of quality water in dugouts used for domestic water supplies. The timing and use of herbicides in road-side spraying programs should be communicated to the public either through a public notice of spraying activity, by way of email distribution, or other method that will reach community members.

Tourism and Recreation

10.3.3 w Work with OHV clubs and trappers to construct bridges on main trail systems.

10.3.3 x Develop and provide educational stewardship resources for:

1. OHV Clubs and dealerships regarding the impacts of irresponsible OHV activity on water resources, and promoting stewardship of public lands
2. Campgrounds and resorts regarding riparian management, proper disposal of effluent from RVs, and general stewardship of the shoreline (e.g., garbage disposal)

3. Ice fishermen regarding water quality contamination from human waste, and material left on the ice during the spring melt (e.g., huts, garbage, wood and other debris)

Monitoring and Evaluation

10.3.3 y A comprehensive long-term lake monitoring program should be developed and undertaken at Lesser Slave Lake, and other recreation lakes (i.e., Winagami Lake and Fawcett Lake) in the watershed to:

1. Better understand current conditions
2. Establish site-specific water quality objectives, particularly for nutrients and sediment
3. Understand lake processes (sedimentation, algal blooms)
4. Determine water quality trends at the lake
5. Detect changes in lake water quality through time.

10.3.3 z A comprehensive long-term water monitoring program for tributaries upstream of Lesser Slave Lake should be implemented. The program objectives should be to:

- Collect baseline data for tributaries to Lesser Slave Lake
- Evaluate water quality condition by comparing them to available federal and provincial water quality guidelines and objectives for varying uses (e.g., irrigation, contact recreation, aquatic life), and existing historic data
- Establish site-specific water quality objectives
- Collect long-term suspended solids data that can be used to better understand the sources of suspended solids in the watershed
- Maintain long-term records to examine trends in relationship to land cover and land use activities in the watershed
- Collect data to support water quality model calibrations, and calculation of sediment loads and nutrient budgets. Historic and recent studies regarding sediment transport and nutrient loading to Lesser Slave Lake (AMEC 2005; Hutchinson et al. 2015) are limited by the low frequency of sampling effort and analytical inconsistencies
- Consider continuous monitoring for certain parameters (e.g., temperature, dissolved oxygen, conductivity, turbidity)

The duration of the water monitoring program should span at least 10 years, with a program review conducted at years three and five. The annual sampling frequency should be April through October (open water season). Samples should be collected once in the last week of April, twice per month in May, June and July, and once in August, September and October (10 samples per year).

Sample locations should be selected based on the following criteria:

- Geographic position in the watershed (upstream, midstream, downstream)
- Historic water monitoring sites
- Proximity to current water gauging stations operated by either Water Survey of Canada, or Alberta Environment and Parks

The cost of analysis and availability of funds will dictate the frequency of sampling and suite of parameters that are measured in the monitoring program. Sampling parameters that are of value to furthering the understanding of nutrient and sediment dynamics in the watershed, as well as sampling parameters of interest to the community are outlined in Table 11.

Table 11. Summary of the water quality monitoring program indicators for the Lesser Slave watershed.

Water Monitoring Program	Indicators	Significance
Baseline (Annual Monitoring)	Water Temperature	– Aquatic life indicator (e.g., fish habitat)
	pH	– Aquatic life indicator (e.g., fish habitat); Influences biochemical reactions
	Dissolved Oxygen	– Aquatic life indicator (e.g., fish habitat)
	Conductivity and Total Dissolved Solids	– Important for irrigation as some crops are sensitive to salt – Aesthetic issues, causes taste and odour issues
	Nutrients	– Contributes to local understanding of nutrient load contribution from tributaries to Lesser Slave Lake – Informs nutrient budget for Lesser Slave Lake
	Sediment	– Contributes to local understanding of sedimentation and erosion processes in the watershed. Monitoring should be completed upstream and downstream of channelized reach (South Heart River, West Prairie and East Prairie rivers. – Can impact fish habitat – Can interfere with water treatment processes – Measurement of total suspended solids concentration should be a priority for monitoring in the watershed[11]
	Bacteria	– Human health
Periodic Monitoring	Pesticides/Herbicides	– Human and aquatic health (toxicity)
	PCBs, Dioxins, Furans, Arsenic	– Human and aquatic health (toxicity) (provincial programs)
	Metals	– Human and aquatic health (toxicity)

10.3.3 aa Refer to the water quality summary in Table 8 when evaluating future water quality conditions in the main tributaries to Lesser Slave Lake.

10.3.3 bb Hutchinson et al. (2015) provided a preliminary calibration of the BATHTUB model to better understand nutrient dynamics in the watershed. Robust hydrological data and

[11] Historically, the Water Survey of Canada collected continuous daily sediment concentrations at Driftpile River, Swan River and Lesser Slave River, downstream of Lesser Slave Lake. Most sediment monitoring in the watershed ended in 1983, with some, mostly miscellaneous measurements, collected in the Swan, Driftpile, East Prairie and West Prairie rivers between 1983 and 1997. The most recent water monitoring program in the watershed (2011, 2012) did not include collection of total suspended solids data.

water quality data was needed to simulate current conditions. Effort should be made to refine the model using a more complete/robust data set for a common timeframe for the lake and its watershed, or identify a more appropriate model. Multiple samples over the seasons for at least ten years would be required to confidently evaluate ongoing trends in sediment transport (Hutchinson et al. 2015).

10.3.3 cc Effort should be made to improve understanding regarding the volume and rate of sediment deposition to Lesser Slave Lake. Transects established by Alberta Environment in Buffalo Bay in 1980 may be re-established and periodically surveyed (e.g., every ten years) to determine the amount and rate of sediment deposition in Buffalo Bay (AMEC 2005).

10.3.3 dd Continue to monitor surface water quality to detect unique pollutants (e.g., PCBs, dioxins, furans, arsenic and heavy metals) associated with activity at the Swan Hills Treatment Centre, and historic activity at the Faust Osmose site.

10.3.3 ee Evaluate the required frequency of lake sediment sampling for PCBs, dioxins, furans, and arsenic.

Lake Stewardship

10.3.3 ff Educate the public regarding the need for erosion and sediment controls at Lesser Slave Lake.

10.3.3 gg Develop a Lesser Slave Lake User's Checklist that highlights expectations regarding fishing and boating on the lake. As an example, the checklist could include:

1. Observe a boating speed limit of 10 km/h (6 mph) within 30 metres (100 ft) of the shore[12]
2. Observe posted speed limits and "No Wake" zones and know your boat's wake-free speed
3. Remember that operating your boat on plane creates a smaller wake than when "plowing" through the water at lower speeds
4. Avoid waterfowl nests and other sensitive wildlife habitat
5. Follow safe refueling guidelines to avoid polluting water.

10.3.3 hh Continue to deliver programs and disseminate existing educational resource materials that support the stewardship of Lesser Slave Lake and other important waterbodies in the watershed. Resources include:

- Lesser Slave Lake Stewardship Handbook (LSWC 2016)
- Lake Stewardship Reference Guide (Association of Summer Villages of Alberta 2006)
- Caring for Shoreline Properties: Changing the Way we Look at Owning Lakefront Property in Alberta (Alberta Conservation Association 1999)
- The Shore Primer (Prairies Edition) (Fisheries and Oceans Canada and Cottage Life 2008)
- Living by Water Project (LSWC and Nature Alberta)

[12] Canada's Vessel Operation Restriction Regulations, jointly administered by some provinces and municipalities, set out the restrictions for the operation of small boats on specific bodies of water in Canada, such as speed limits, power limitations, or when and where certain activities, such as waterskiing, are permitted.

10.3.4 Implementation Table for Water Quality

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
10.3.3 a Reduce external nutrient and sediment loads to Lesser Slave Lake	AEP, AER, AAF	Encourage the use of beneficial management practices, and monitor and enforce compliance to existing regulation on Crown land.	H (H)
	Municipalities	Continue to monitor and report on effluent quality and volume discharged to surface water.	H (H)
		Minimize the potential for erosion at stormwater discharge locations.	H (H)
		Develop integrated stormwater management policies that support the implementation of the stormwater management recommendations (Recommendations 10.3.3 r – t).	H (H)
	Industry (agriculture, forest, tourism and recreation)	Apply industry best practices to activities in the watershed to reduce nutrient and sediment loads.	H (H)
	Landowners	Manage shoreline properties to reduce impacts on the lake: Maintain natural shoreline where possible. Prevent septic leakage, and/or nutrient rich runoff water from fertilized lawns from reaching surface water.	H (H)
10.3.3 b Adopt riparian health targets and apply riparian setbacks	AEP	Integrate riparian health targets in operating standards for greater stewardship on public lands.	H (H)
	Municipalities	Incorporate riparian health targets and setbacks into land use bylaws. Apply setbacks to new developments in the watershed at the time of subdivision.	
	Industry	Adhere to Standard Operating Procedures and apply riparian setbacks accordingly.	
	Landowners	Adopt the riparian health targets and implement the riparian setbacks and protection strategies outlined in Section 10.4	H (H)
10.3.3 c Enforce protection of riparian and wetland environments	AEP	Conduct regular site inspections to ensure compliance of Annual Operating Plans and Operating Ground Rules.	H (H)
	AAF		
10.3.3 d Review septic, sewage and stormwater discharges to surface water	AEP	Monitor and report on the quality and quantity of discharge of treated effluent to surface water.	H (H)
	LSWC	Work with AEP to report stormwater conditions in a state of the watershed report.	M (M)
	Municipalities	Work with LSWC and AEP to understand and document the quantity and quality of stormwater discharged to surface water and its impacts on the aquatic environment.	M (M)
10.3.3 e Adopt policy of no net loss in river channel length	AEP	Review applications and determine if a net loss in river channel length will result from the project.	H (H)
		Encourage a gain in net channel length, where practical.	M (M)
10.3.3 f	AEP	Identify opportunities to restore river lengths or wetlands in the watershed to	M (H)

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
Restore river lengths and wetlands	Municipalities	mitigate flooding.	
10.3.3 g Develop strategy to manage log jams	AEP	Investigate options to manage log jams in tributaries to Lesser Slave Lake, particularly South Heart River, and East Prairie and West Prairie rivers.	M (H)
10.3.3 h Apply BMPs to reduce nutrient and sediment movement	Industry (Agriculture, Forestry, Oil and Gas, Development)	Apply industry best management practices as recommended to Agriculture (Recommendations i-k), Forestry (Recommendations l-n), Oil and Gas (Recommendations o-p), Development (Recommendations q-u), and Tourism and Recreation (Recommendations (v-w).	H (H)
10.3.3 i Adopt agricultural BMPs	Farmers and Ranchers	Seek cost-sharing opportunities to implement best management practices that result in on-farm benefits and support watershed goals (e.g., Growing Forward II, and Watershed Restoration and Resiliency Program).	H (H)
		Consult agricultural BMP guides developed by the agricultural industry and Alberta Agriculture	
	AAF	Work with agricultural producers to relate the value of BMP implementation to on-farm benefits.	
10.3.3 j Increase collaboration among agricultural organizations to promote use of BMPs	LSWC	Establish an agricultural community network in the watershed that promotes Environmental Farm Plans, Growing Forward II, and hosts field days and workshops relevant to agricultural producers.	H (H)
10.3.3 k Consider an ecological goods and services incentive program	LSWC	Organize a forum to discuss ecological goods and services. Invite ALUS (Alternative Land Use Services), other similar organizations and staff/landowners from municipalities using ALUS approach to present to local government and landowners.	M (M)
	Municipalities	Attend forum to learn more about ecological goods and services programs.	
	Landowners		
10.3.3 l Apply forestry BMPs	Forest Industry	Seek opportunities to implement best management practices that result in forest benefits and support watershed goals.	H (H)
	AAF	Work with forest industry to relate the value of BMP implementation to forest benefits.	
		Increase the frequency and scale of inspections.	
		Determine and track the number of times a request is made for a variance from the ground rules outlined in the Annual Operating Plan.	
10.3.3 m Adopt detailed FMP strategies that align with the outcomes of the IWMP	Forest Industry	Update Forest Management Plans to include strategies that address watershed concerns, and that will achieve watershed goals.	M (H)
		Adhere to Timber Harvesting Ground Rules	H (H)
	AAF	Promote sharing of information, strategies for consistency and increased	H (H)

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
		collaboration to achieve watershed goals.	
10.3.3 n and o Pulp mills continue to seek ways to improve processing	Industry	Continue to monitor and report on effluent and instream water quality. Share results with the LSWC.	H (H)
	AEP	Develop tools to better understand dissolved oxygen and BOD processes in the Lesser Slave River.	
10.3.3 p Apply oil and gas development BMPs	Oil and Gas Industry	Seek opportunities to implement best management practices that support watershed goals.	H (H)
	AER	Promote sharing of information, strategies for consistency and increased collaboration to achieve watershed goals.	H (H)
		Work with the oil and gas industry to promote BMP implementation to achieving watershed goals.	
10.3.3 q Road construction strategies	Forest Industry; Oil and Gas Industry	Implement best road construction practices to maintain water quality. Many of the road construction strategies that are outlined in Partington et al. 2016 aimed at conserving wetlands will also serve to protect water quality.	H (H)
10.3.3 r Apply development setbacks to watercourses	Municipalities	Develop riparian policies to support development setbacks adjacent to watercourses and waterbodies (Section 10.4).	H (H)
10.3.3 s Stormwater volume and release rates	AEP	Historically, sediment (Total Suspended Solids) was viewed as a proxy for other contaminants in stormwater, thus, no other contaminants were considered as part of stormwater management design and approval practice. Consider updates to the Stormwater Management Guidelines for the Province of Alberta (AEP 1999) to include limits for nutrients and suspended sediments to protect water quality.	H-M (H-M)
	Municipalities	Amend existing policies, guidelines and procedures to manage stormwater volume and release rates to surface water (particularly to smaller tributaries like Sawridge Creek). Outfalls should be planned carefully to mitigate the potential impacts to water quality.	M (M)
		Develop a Master Drainage Plan for the Town of Slave Lake and High Prairie.	M (M)
		Standards and Procedures should be updated to reflect a new approach and terminology used for Integrated Stormwater Management (ISM) that will help to achieve the stormwater volume and release rate recommendation.	M (M)
10.3.3 t Stormwater strategies to protect surface water quality	Municipalities	Update standards and procedures to include design standards, construction specifications and maintenance procedures for Low Impact Development (e.g., the use of absorbent landscaping - minimum soil depth of 300 mm; bioretention), considering other design/construction factors (e.g., safety, FireSmart).	M (M)
10.3.3 u Snow management	Municipalities	Develop a snow management strategy that minimizes impacts of snow removal and storage on surface water, and riparian areas and wetlands.	M (M)

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
10.3.3 v Communicate with communities prior to spraying	Municipalities	Post public advisory notices, signage, or use other methods to advise residents of intended road-side spraying activity near communities.	H (H)
10.3.3 w Manage access on OHV trails	Residents	Use bridge crossings when possible to cross streams and rivers.	H (H)
	AEP/Municipalities	Promote stewardship on OHV trails.	H (H)
	LSWC	LSWC to collaborate with OHV Clubs, dealerships, and AEP to develop resources specific to the Lesser Slave watershed.	H (H)
10.3.3 x Develop and disseminate stewardship resources to tourists and recreational users	LSWC	Continue to disseminate existing stewardship resources to the public. Develop new resources targeted to tourists and other recreational users in the watershed.	H (H)
10.3.3 y Implement a water quality monitoring program at Lesser Slave Lake	AEP, LSWC	Identify a technical team to develop an annual Lesser Slave Lake water quality monitoring program. The program should include, at minimum, water quality analysis of nutrients, chlorophyll *a* and secchi depth. Sampling should be completed monthly from May through September.	H (H)
		Add Lesser Slave Lake to the Long-term Lake Monitoring Program (LTLN).	
		Refer to the historic water quality summary in Table 7 when evaluating and reporting on water quality condition in Lesser Slave Lake.	
		Work with partners to establish site-specific water quality objectives for the Lake.	
10.3.3 z Implement a tributary water quality monitoring program	LSWC	Coordinate partners to secure funding for the program, either through grants or partners contributions.	H (H)
		Coordinate the implementation of the program.	
		Assist with sample collection at select sites in the watershed.	
	AEP	Monitor and report on water quality conditions in the watershed and/or provide financial and technical support the LSWC to implement the comprehensive water monitoring program.	
		Archive data in the provincial water quality database.	
	Municipalities, Industry	Assist with sample collection at select sites in the watershed.	
10.3.3 aa Refer to historic water quality summary when evaluating water quality condition in tributaries	LSWC	Compile, review and report on water quality annually.	H (H)
		Prepare an annual water quality report to disseminate to program partners, industry, non-profit organizations and the public.	H (H)
		Evaluate water quality and identify priority actions needed to improve water quality.	
		Work with partners to establish site-specific water quality objectives for tributaries.	
10.3.3 bb Refine the BATHTUB model	LSWC	Share data from the long-term water monitoring program with partners to refine the BATHTUB model or to use the data to support a more appropriate model.	L (H)

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
using new data, or identify a more appropriate model.	AEP	Use the long-term water quality monitoring data to refine the BATHTUB model, or identify a more appropriate model to simulate conditions in Lesser Slave Lake.	
10.3.3 cc Understand volume and rate of sediment deposition.	AEP	Revisit transects that were historically established at Buffalo Bay, or establish new field methods to measure changes in sediment deposition through time.	M (M)
10.3.3 dd Monitor unique pollutants that pose a risk to public health	AEP	Conduct a risk assessment of the Fauste Osmose Wood Preservers site using the monitoring data that was collected at this historical contaminated site. Develop an exposure control plan for the site.	M (H)
	Alberta Health, AEP, Alberta Infrastructure	Provincial departments should continue to monitor surface water and groundwater quality (and vegetation, fish and wildlife tissue) in the vicinity of the Swan Hills Treatment Centre and historic Fauste Osmose site. Monitoring of the SHTC is done as part of the approval to operate.	H (H)
10.3.3 ee Public education for sediment and erosion control	LSWC	Create a factsheet summarizing the understanding of sediment and erosion processes in the watershed.	H (H)
10.3.3 ff Disseminate lake stewardship resources	LSWC	Continue to disseminate existing resources (e.g., handbooks, Lake User Guides and other materials) to watershed residents, landowners, and users. Augment existing information where needed.	M (M)

[a]H=High Priority; M = Medium Priority; L = Low Priority; (H)=High Community Value; (M)=Medium Community Value; (L)=Low Community Value

10.4 Riparian Areas

10.4.1 Goals and Objectives (from Section 6.0)

Goal: Healthy riparian areas stabilize banks and shorelines, improve water quality, reduce sedimentation, provide habitat, and promote biodiversity.

Objective 1. Recommend strategies to protect, conserve, and enhance healthy riparian areas in the watershed.

GUIDING PRINCIPLES

Riparian areas: *Healthy riparian areas associated with rivers, creeks, wetlands and smaller lakes contribute to better water quality, stable stream banks, flood reduction, and wildlife habitat in the Lesser Slave watershed.*

Objective 2. Identify priority areas and actions for riparian restoration.

Objective 4. Promote wetland and riparian conservation through education, stewardship and use of BMPs (i.e., avoidance and minimization).

10.4.2 Targets and Thresholds

Riparian Condition

Riparian Health Inventory, Riparian Health Assessment, and aerial videography are methods used to evaluate riparian health and function for lakes, wetlands, streams and small rivers, and large rivers. A suite of indicators related to ecological status, plant community structure, and site stability are used to indirectly evaluate the ability of a site to perform ecological functions. Indicators include vegetative cover, presence of disturbance and invasive plants, tree and shrub establishment, regeneration and utilization, and human disturbance (refer to Appendix F for a list of all the parameters and their significance). Targets for riparian condition are summarized in Table 12; these targets also apply to wetlands (lentic riparian systems) that are discussed further in Section 10.5.

Table 12. Targets and thresholds for riparian area condition in the Lesser Slave watershed.

Measure	Riparian Assessment Method	Watershed-Wide	Headwater Reaches or Riparian Areas Associated with Environmentally Significant Areas
Target	Riparian Health Inventory	Riparian areas score ≥80 (healthy).	Riparian areas score ≥90 (healthy).
	Aerial Videography	Greater than or equal to 80% of riparian area is in good condition. No more than 10% of an area is in poor condition.	Greater than or equal to 90% of riparian area is in good condition. No more than 5% of an area is in poor condition.
Threshold	Riparian Health Inventory	Riparian areas score ≥70 (healthy with problems).	Riparian areas score ≥80 (healthy with problems).
	Aerial Videography	Greater than or equal to 60% of riparian area is in good condition. No more than 30% of an area is in fair condition and 10% of an area is in poor condition.	Greater than or equal to 80% of riparian area is in good condition and no more than 10% of an area is in poor condition.

Note: Riparian Health Inventory Scores: Healthy (Score ≥80); Healthy with Problems (Score 60 to 79); Unhealthy (Score <60) (Fitch et al. 2001)

10.4.3 Riparian Area Recommendations

Riparian Area Condition

10.4.3 a Adopt the riparian area condition targets presented in Table 12 for the Lesser Slave watershed. Efforts should focus on decreasing the percentage of the reach in the Poor category (e.g., less than or equal to 10% poor), and increasing the percentage of sites in the good category (e.g., more than or equal to 70%) by implementing best management practices.

10.4.3 b Establish a riparian health monitoring strategy. Riparian health assessments should be undertaken in representative reaches of each major tributary to Lesser Slave Lake. Riparian health assessments should reoccur every 5 to 7 years and involve staff from the Alberta Riparian Habitat Management Society (Cows and Fish). Use of the riparian health assessment methods (Fitch et al. 2001) that rate specific health indicators, together with landowner involvement, will help to prioritize restoration efforts and improve local understanding of the importance of riparian areas to watershed function.

Riparian assessments should also be completed periodically on public land using aerial videography and/or assessment by Cows and Fish. Priority should be given to rivers that have not been assessed.

Riparian Protection

10.4.3 c Municipalities should develop riparian policies to maintain functioning (healthy) riparian areas in the watershed.[13]

10.4.3 d At the time of subdivision, development setbacks greater than the 6 m minimum established by the *Municipal Government Act* should be applied to waterbodies and watercourses (e.g., lakes, rivers, creeks, streams) to maintain important riparian (including wetlands and shoreline) functions in the watershed. New developments require a development permit from each municipality and riparian setbacks could vary between municipalities.

Guidance for determining appropriate development setback widths is provided in the provincial Stepping Back from the Water document (GOA 2012b) and in the Riparian Setback Matrix Model (Aquality 2012) (Appendix F). Important factors to consider include type of waterbody (ephemeral, intermittent, or permanent), soil type, slope, and depth to groundwater.

[13] Municipal authority to establish riparian buffers or development setbacks is enabled by the *Municipal Government Act*. Section 640 of the *MGA* enables municipalities to set development setbacks for buildings on land subject to flooding or subsidence or that is low lying, marsh or unstable or on land adjacent to or within a specified distance of the bed and shore of any lake, river, stream or other body of water through a land use bylaw. Section 664(1) of the MGA states that, subject to section 663, a subdivision authority may require the owner of a parcel of land that is the subject of a proposed subdivision to provide part of that parcel of land as environmental reserve if it consists of: a) a swamp, gully, ravine, coulee or natural drainage course, b) land that is subject to flooding or is, in the opinion of the subdivision authority, unstable, or c) a strip of land, not less than 6 metres in width, abutting the bed and shore of any lake, river, stream or other body of water for the purpose of preventing pollution, or (ii) providing public access to and beside the bed and shore.

For fish-bearing streams, or where the riparian vegetation is dominated by trees, a minimum 30 m riparian setback should be considered for waterbodies in developing areas. This would maintain important riparian functions such as streambank stability, shading and overhang by trees (GOA 2012b).

Existing subdivisions, buildings and structures, roads, utilities, and pathways may be exempt from development setbacks.

10.4.3 e Setbacks related to agricultural activities, including manure storage, manure application, and seasonal feeding and bedding sites, are established and regulated through the *Agricultural Operations Practices Act* (*AOPA*). Inorganic fertilizer application is indirectly regulated by the *Environmental Protection and Enhancement Act* that prohibits operators from releasing substances to the environment in an amount, concentration or level, or at a rate of release that causes or may cause a significant adverse effect on the environment. Pesticide use, application, and storage or washing of equipment is regulated through The *Environmental Code of Practice for Pesticides* and administered by AEP. Refer to Appendix G for agricultural related setbacks. Adhere to the established agricultural setbacks.

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

10.4.3 g The oil and gas industry is regulated by the Alberta Energy Regulator. The industry must abide by the Integrated Standards and Guidelines: Enhanced Approval Process (GOA 2012a) and should consider industry respected practices (IRPs). The required setbacks for oil and gas activity from water range from 15 m adjacent to ephemeral watercourses up to 100 m adjacent to large watercourses and permanent lakes and wetlands (DACC 2015; GOA 2012a). Refer to Appendix I for oil and gas related setbacks.

Riparian Restoration

Aerial videography was used to assess riparian condition at South Heart River, West Prairie River, Lower Swan River, and Lesser Slave Lake. Generally, poor conditions prevail at South Heart and West Prairie rivers due to encroachment of agricultural cropping practices and industrial activity (i.e., saw-mill at West Prairie River) in the riparian area (Johns and Hallet 2009). Most reaches that rated in poor condition lacked an adequate riparian buffer next to the river, had little or no woody vegetation present, and had unstable streambanks. The presence of deeply rooted, woody riparian vegetation contributes to stable streambanks, thereby reducing erosion and sediment transport downstream. River reaches that were channelized in the past were also rated in poor condition. Channelization increases streamflow velocities and the erosive force of water. It also limits water access to the floodplain and recruitment of riparian vegetation.

Generally, poor conditions prevail at the lower Swan River due to encroachment of agricultural cropping practices, and moderate-to-heavy livestock grazing on lands adjacent to the river (Hallett 2006). Similar to the South Heart and West Prairie rivers, most reaches that rated poor condition lacked an adequate riparian buffer next to the river, had little to no woody vegetation present, and had unstable streambanks. In addition to agricultural activity, pipelines, roads and well-sites

associated with oil and gas activity were contributing to poor riparian health ratings. Exposed pipelines were observed. ATV trails and crossings contributed to bare soil and unstable river bank in some areas. Bare soil is more susceptible to erosion and can increase suspended sediment in the river.

At Lesser Slave Lake, poor conditions generally prevail where shorelines have been developed (Osokin and Hallet 2007). In the case where shorelines have been hardened with retaining walls, there are limited opportunities to restore sites to their natural state. Preventative measures should be taken to prevent further loss of natural shoreline.

Table 13 summarizes the results of the riparian condition assessments in the Lesser Slave watershed. Priorities for riparian restoration were determined by ranking the sites according to the desired threshold: ≥60% of area should rate in "Good Condition" and <10% of area should rate in "Poor Condition".

Table 13. Riparian restoration priorities based on aerial riparian condition assessments (Johns and Hallet 2006; Osokin and Hallet 2007; Hallet 2011). Values represent the percentage of the reach assessed (e.g., 57% of the reach was in good condition).

Waterbody or Watercourse	Good Condition		Fair Condition	Poor Condition		Restoration Priority
	Threshold	Actual	Actual	Threshold	Actual	
Lesser Slave Lake	≥60%	57	32	<10%	11	3
South Heart River LB[a]		64	13		23	2
South Heart River RB[b]		60	12		28	
West Prairie River LB		39	26		35	1
West Prairie River RB		48	34		18	
Lower Swan River		71	10		19	4
Upper Swan River	≥80%	96	1		3	5
- Moosehorn River		87	12		1	
- Inverness River		97	1		2	

[a]LB - left bank; [b]RB - right bank

10.4.3 h Implement the following restoration measures at West Prairie River, South Heart River, and Lower Swan River (Restoration Priorities 1, 2 and 4, respectively, in Table 13):

1. Implement a riparian buffer program that provides incentives to agricultural producers who establish a minimum 15 m buffer in cropped fields adjacent to the river. Restore the riparian vegetation community, particularly woody vegetation, to stabilize streambanks and improve water quality in the river. Manure or commercial fertilizers should not be applied to the buffer.

2. On grazing lands, manage timing, density and duration of livestock. Encourage remote livestock watering systems (e.g., solar) as an alternative, and often preferred, water source to the river. Use fencing as a tool to manage timing and duration of grazing activity where needed.

3. At West Prairie River, establish a vegetated buffer and/or manage runoff water from the adjacent saw-mill upstream of the Town of High Prairie for pollution

control. Increase the recovery potential of the riparian area by planting appropriate trees and shrubs.

4. At West Prairie River, limit future channelization in the watershed and identify opportunities to increase river channel length where possible.

5. At Lower Swan River, maintain OHV trails and where possible, establish bridge crossings to reduce impacts to streambanks.

Shorelines

10.4.3 i At Lesser Slave Lake (Restoration Priority 3 in Table 13), and at other lakes in the watershed where appropriate, implement the following restoration measures:

1. Apply administrative tools to manage lakeside development and limit future shoreline erosion in the watershed. The location and nature of development in the context of shoreline functions should be considered. Administrative tools may include:
    - Master planning, shoreline zoning, and plan review, to recognize dynamic shoreline processes and protect ecological functions that shores provide
    - Development setbacks and vegetative buffers (Recommendation 10.4.3 d)
    - Development limits on continuous hard surfaces (e.g., retaining walls) to prevent erosion of neighbouring properties. Natural shorelines dissipate wave energy and minimize erosion
    - Requirements for restoration of littoral zones where needed
    - Lot clearing criteria for new developments (e.g., limit lot clearing to improve views to 30% of property area)
    - Encourage yard management strategies that maintain shoreline functions
    - Identify best practices for marinas

2. Manage human-induced wave action on shorelines by posting maximum speeds in the most vulnerable areas (shallow water adjacent to exposed shoreline) or at a set distance from shore.

3. Manage beaches to support natural processes, such as the transport of material from the beach inland by wind (i.e., deflation), the protection of the natural formation of sand dunes, and vegetation succession in open beach areas. Management may include:
    - Strategically limiting foot and OHV traffic (“Quad parking area” and signage)
    - Preserving beach vegetation in key areas

4. Encourage the use of beneficial management practices for agricultural producers who operate adjacent to the lake:
    - Maintain a riparian or vegetative buffer between crops and the shoreline
    - Provide offstream water to livestock
    - Use permanent or electric fence to manage livestock when stocking density or timing restrictions cannot prevent impacts to the shoreline

5. Improve knowledge regarding normal shoreline processes, how human activities alter shorelines, the rate of shoreline change, and the measures that can be taken to protect the dynamic equilibrium of the shorelines.

Municipalities identified the need to maintain beaches, as opposed to natural shoreline, in strategic locations around the Lesser Slave Lake for community enjoyment, and to increase tourism and recreation opportunities in the area.

10.4.3 j While retaining the majority of the Lesser Slave Lake shoreline in natural vegetation is important for maintaining water quality and fish in the lake, municipalities and AEP should investigate areas along the shoreline that could be designated as "beach area" for community enjoyment and to support tourism and recreation in the watershed.

Education, Awareness and Outreach

10.4.3 k Improve community understanding of riparian functions, management strategies to maintain function (including shoreline functions), and encourage local restoration efforts where needed:

- Host riparian field days for private landowners and residents
- Disseminate riparian stewardship resources

10.4.3 l Encourage lake-side residents to complete riparian health assessments at their shoreline using the field workbook "Riparian Health Assessment for Lakes, Sloughs and Wetlands" (Ambrose et al. 2004).

Brandi Papineau, Shaw's Point Resort

10.4.4 Implementation Table for Riparian Areas

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
10.4.3 a Adopt riparian health targets	AEP, AAF, AER	Adopt the riparian area condition targets for Crown land and include them in industry codes of practice and/or operating guidelines.	H (H)
	Municipalities	Adopt the riparian area condition targets and include them in applicable policy and planning documents.	
	LSWC	Host a workshop with shoreline owners to present riparian health assessment methods and encourage them to complete a self-assessment using incentives.	
	Landowners	Complete riparian health assessments to understand current conditions. Apply BMPs to improve condition if it is below a healthy score (score < 80).	
10.4.3 b Monitor riparian health	LSWC	Develop a strategy to prioritize riparian health assessment work in the watershed.	H (H)
	Municipalities	Collaborate with LSWC to develop a riparian strategy to monitor riparian areas and prioritize future restoration projects.	
	Cows and Fish	Work with LSWC and landowners in the Lesser Slave watershed to implement a riparian monitoring program in priority areas (refer to Table 13).	H (H)
	Landowners	Work with the LSWC and Cows and Fish to better understand riparian area condition. Implement appropriate measures to improve riparian condition where needed.	H (H)
10.4.3 c Create riparian policy	Municipalities	Develop a riparian policy to guide planning and the drafting of riparian strategies to manage future development lands and municipal lands (EIDOS 2015).	H (H)
10.4.3 d Apply appropriate development setbacks	Municipalities[14]	Determine the potential impact of riparian setbacks on landowners adjacent to Lesser Slave Lake, and major rivers and creeks in the watershed. Alternative site design scenarios should be considered when exploring the riparian setback implications (e.g., density, flexible MR, conservation development designs).	H (H)
		Amend land use bylaws to include riparian setback criteria and other riparian protection measures.	
		Specify and apply development setbacks at time of subdivision that would apply to land located adjacent to water (e.g., lakes, rivers, creeks, and ephemeral and intermittent streams).	
		Develop a map tool that clearly shows the riparian setback delineation.	
	Landowners	Identify riparian setbacks on all site plans submitted to the appropriate jurisdiction for permitting. A development permit should only be approved after the delineation of the riparian setback is completed.	H (H)

[14] Recommendations should be incorporated into Municipal Development Plans, Inter-municipal Development Plans, Land Use Bylaws, Area Structure Plans, Outline Plans, Concept Plans, Redevelopment Plans, Servicing Standards, Development Permits, and Development Agreements.

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
10.4.3 e Setbacks related to the agricultural industry	AAF	Promote awareness and understanding of *AOPA.*	H-M (H)
	Agriculture Industry	Adhere to agricultural setbacks established and regulated through *AOPA* (Appendix G).	H (H)
10.4.3 f Forestry related setbacks	AAF	Projects that may impact riparian areas and wetlands should demonstrate why disturbance cannot be avoided through either relocation or redesign and how impacts will be mitigated.	H (H)
		Monitor and enforce forest harvest practices to ensure riparian and wetland setbacks are respected.	
	Forest Industry	Adhere to forestry setbacks established in Alberta's Timber Harvest Planning and Operating Ground Rules.	
10.4.3 g Oil and gas related setbacks	AER	Monitor and enforce oil and gas well-site and pipeline developments to ensure setbacks from watercourses and water bodies are respected.	H (H)
	Oil and Gas Industry	Adhere to oil and gas activity setbacks for watercourses and waterbodies established in the Integrated Standards and Guidelines: Enhanced Approval Process.	H (H)
10.4.3 h Implement restoration measures at South Heart, West Prairie, and Lower Swan rivers	LSWC	Lead the development of a riparian buffer program. Investigate potential for a partnership with ALUS or other ecosystem goods and service programs. Promote Growing Forward II and other programs that support riparian restoration and/or buffer implementation.	H (H)
	AEP	Review applications that involve channelization and assist to identify alternatives. Work with Municipalities to identify strategies to restore channel length where possible.	H (H)
	Municipalities	Work with AEP to identify strategies to limit future channelization. Work with the LSWC to encourage BMP implementation on private land.	M (M)
	Forest Industry	Work to establish a buffer between the saw-mill operation and West Prairie River.	H (H)
	Agriculture Industry	Develop grazing management plans that support healthy riparian areas and good water quality. Manage timing, density and duration of grazing activity, and offstream watering to minimize impacts.	M (H)
		Implement vegetated buffers adjacent to watercourses.	
	AER	At the Lower Swan River, inspect pipelines that cross watercourses to identify exposed pipelines. Implement measures to bury exposed pipelines and stabilize the site.	H (H)
	Oil and Gas Industry		
	Recreational Users	Stay on established OHV trails and use bridges to cross the Swan River whenever possible.	H (H)
10.4.3 i Implement riparian restoration measures at Lesser Slave Lake	LSWC	Use existing stewardship resources to prepare a factsheet to assist municipalities inform the public about normal shoreline processes, how human activities impact shorelines, the rate of shoreline change, and measures that can be taken to protect shorelines.	H (H)
	AEP	Maintain natural shoreline functions on Public Lands, including in provincial parks and	H (H)

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
		recreation areas. Identify areas where managed beaches are most suited for public use (refer to 10.4.3 j)	
	Municipalities[15]	Develop and apply administrative tools to manage lakeside development.	H (H)
		Designate areas adjacent to the lake that should remain as "significant natural shoreline", opposed to managed beach area (refer to 10.4.3 j).	H (H)
		Develop and enforce land use bylaws to manage municipal environmental reserve and maintain healthy shorelines.	H (H)
	Agriculture Industry (livestock)	Develop grazing management plans that support healthy riparian areas and good water quality. Manage timing, density and duration of grazing activity, and offstream watering to minimize impacts.	H (H)
	Cows and Fish, Alberta Lake Management Society (ALMS)	Support the LSWC and local municipalities in their effort to improve understanding of lake processes and stewardship.	H (H)
	Landowners	Apply appropriate shoreline BMPs on private property.	H (H)
		Respect established environmental reserve established by municipalities.	H (H)
10.4.3 j Investigate lake shoreline for suitable beach areas	Municipalities, AEP	Designate "beach area" as a land use in land use bylaws to support local community recreation and economy. Designating areas as beach area (opposed to natural shoreline) would allow parts of the shoreline to be cleaned, and weeds/debris to be removed from swimming areas.	M (H)
10.4.3 k Improve community understanding of riparian areas	Cows and Fish, ALMS	Work with the LSWC and the community to improve understanding of riparian areas, shorelines and their importance to lake quality. Riparian function, management, and restoration opportunities should be a priority.	H (H)
10.4.3 l Shoreline property owners to complete riparian health assessments	LSWC, Cows and Fish	Develop a citizen science approach to riparian health assessment. Host training days for residents and landowners on the use of the field workbook for assessment of lakes, sloughs and wetlands (Ambrose et al. 2004).	H (H)

[a]H=High Priority; M = Medium Priority; L = Low Priority; (H)=High Community Value; (M)=Medium Community Value; (L)=Low Community Value

[15] Guiding Legislation: Tri-Council Regional Growth Plan (EIDOS 2015)

10.5 Wetlands

Wetlands provide flood protection and mitigate the impacts of drought through water storage, filter water to maintain water quality, and provide habitat for an abundance of wildlife in the watershed. Studies have shown a variety of seasonal and permanent wetlands are required to maintain an appropriate water balance in watersheds (van der Kamp and Hayashi 2009). Wetlands play a critical role in moderation of climate change. Undisturbed peatlands, in particular, are important areas where carbon is stored. About one-third of the global soil carbon is stored in undisturbed boreal peatlands (Gorham 1991 *in* AEP 2015). Peatlands in Alberta contain an estimated 48 petagrams[16] (Pg) of carbon (Vitt et al. 2000 *in* AEP 2015), compared to 2.7 Pg contained in the forests and 0.8 Pg in the grasslands (Vitt et al. 2000 and Vitt 2006 *in* AEP 2015).

The Lesser Slave watershed is comprised of a variety of important wetland environments that include bog, fen, swamp, marsh, and open water (Figure 5). In the South Heart River and East Prairie River sub-watersheds on the western end of Lesser Slave Lake, a large wetland complex spans an area of about 7,717 ha in the lowlands around Horse Lakes and Buffalo Bay; this area was noted as the most significant wetland area in the Upper Athabasca Region (Forcorp Solutions Inc. 2012).

10.5.1 Goals and Objectives (from Section 6.0)

Goal: The hydrologic function of wetlands is kept intact to provide flood and drought mitigation, improved water quality, and fish and wildlife habitat.

Objective 3. Recommend wetland conservation strategies that are in line with, or that may improve on, Alberta's Wetland Policy and other land use planning efforts (e.g., biodiversity monitoring objectives, indicators and thresholds).

Objective 4. Promote wetland and riparian conservation through education, stewardship and use of BMPs (i.e., avoidance and mitigation).

10.5.2 Targets and Thresholds

Management Target: All wetlands in the Lesser Slave watershed contribute to watershed health and should be retained; however due to the density of wetlands in the watershed, this may not always be feasible. Effort should be made to maintain wetlands, to avoid impacts to all wetlands through design, and to mitigate impacts where avoidance is not possible. Wetlands in the Lesser Slave watershed should be classified and evaluated, and those wetlands having the highest value should be protected (e.g., Class A and B wetlands).

A preliminary investigation of the biodiversity value of wetlands indicates that open water and rivers, and emergent marshes are important Class A wetlands in the Lesser Slave watershed. Emergent marshes are important to amphibians, birds and mammals and should receive greater management consideration but make up only 1.2% of the wetlands in the watershed (Figure 5). This valuation is consistent with the literature regarding the importance of emergent marshes (littoral zone in lakes) to fish. Refer to Section 10.4.2 for wetland targets and thresholds related to riparian area condition (health).

[16] A petagram is equivalent to a metric gigaton. One petagram is equal to one quadrillion grams, or one trillion kgs.

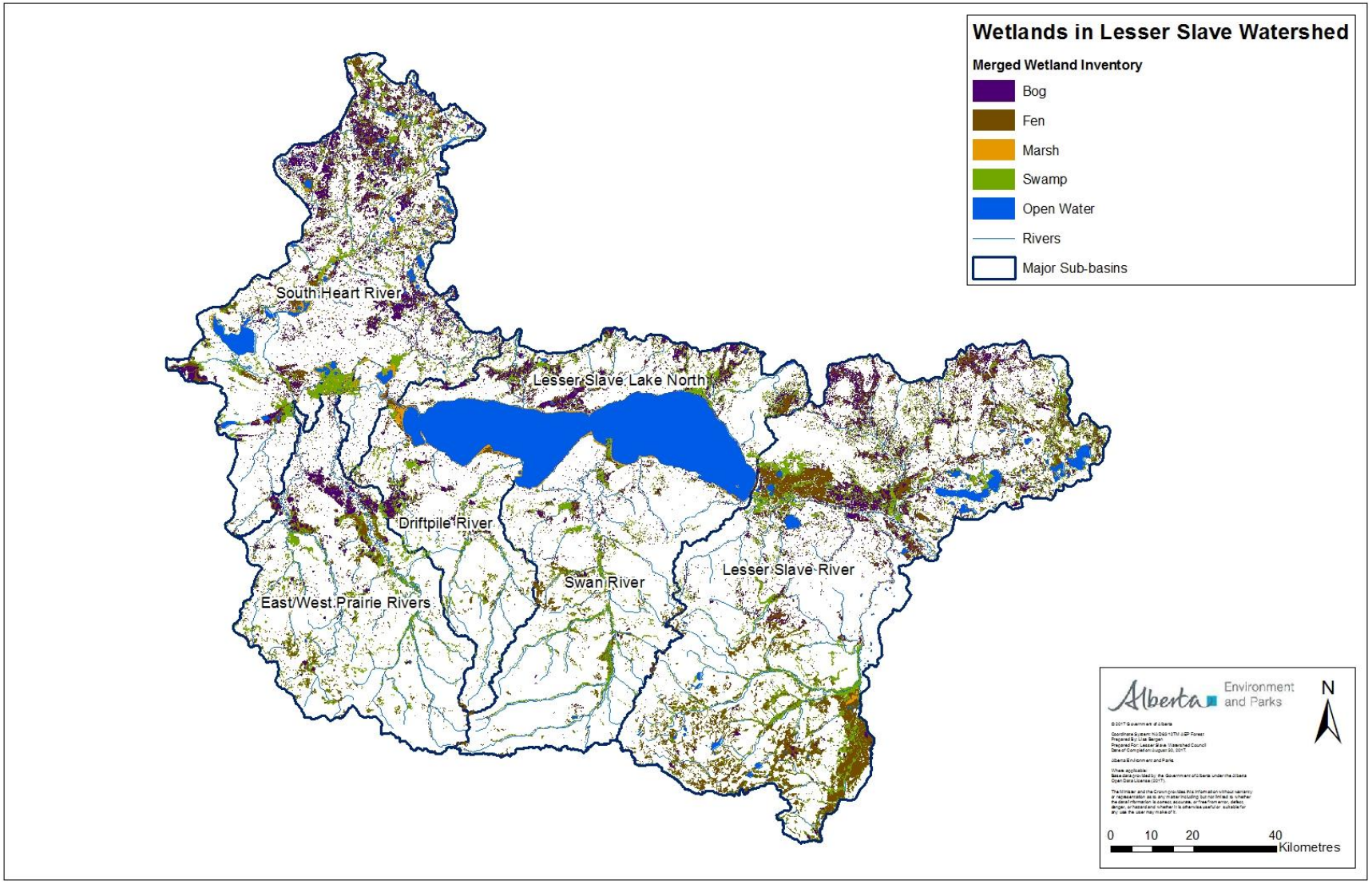


Figure 5. Alberta Merged Wetland Inventory, Lesser Slave watershed (AEP 2017). A larger and higher resolution map can be viewed at www.lswc.ca, along with the enhanced wetland classification map (19 wetland classifications) for the watershed (also refer to Appendix G).

Valuation of Wetlands

The Alberta Wetland Policy provides direction on the value of wetlands based on their functional group (Table 14). While the Alberta Wetland Evaluation Tool (ABWRET) provides some guidance, the actual valuation of wetlands still remains a challenge for wetland managers. In the boreal ecosystem, many wetlands are interconnected below ground and the hydrology of these systems is not well understood. Carbon storage potential should also be valued as an important wetland function.

Table 14. Wetland value functional groups basedon the Alberta Wetland Policy (ESRD 2013).

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

Ducks Unlimited Canada (DUC) developed a tool that examines the biodiversity value of specific wetland types (DUC 2014; Appendix J). The Biodiversity Value Calculation Matrix was used to assign values to wetlands in the Lesser Slave watershed based on species at risk (Table 15). The results show that emergent marshes have the highest value for all species; rivers, conifer/tamarack swamp, mixedwood swamp, and meadow marshes are also highly valued habitats. This is a preliminary effort to prioritize wetland values using a general tool that does not consider local distribution and use by wildlife. Future valuation tools will address wetland hydrology (A. Richard, DUC, pers. comm).

Table 15. High value wetland habitats (scored 8-12 for one or more species categories) using the Biodiversity Value Calculation Matrix (DUC 2017). Note that Sprague's Pipet and Grizzly Bear are not included in this analysis.

Wetland/Habitat Type	Biodiversity Value*				
	Amphibians *Northern Leopard Frog Canadian Toad*	**Birds** *Peregrine Falcon Barred Owl Bay Breasted Warbler Cape May Warbler*	**Mammals** *Woodland Caribou Wolverine*	**Waterfowl** *Trumpeter Swan Western Grebe White-winged Scoter*	**All Species**
Rivers	**12**	**10**	0	3	**11**
Aquatic Bed	0	0	0	**12**	6
Mudflat	6	0	0	2	2
Open Water	**12**	**10**	0	**12**	**12**
Emergent Marsh	**12**	**10**	0	**12**	**12**
Meadow Marsh	**12**	**10**	0	4	**9**
Treed Fen	2	2	**8**	4	5
Treed Bog	0	2	**8**	4	5
Mixedwood Swamp	3	**10**	6	4	**10**

Wetland/Habitat Type	Biodiversity Value*				
	Amphibians *Northern Leopard Frog Canadian Toad*	**Birds** *Peregrine Falcon Barred Owl Bay Breasted Warbler Cape May Warbler*	**Mammals** *Woodland Caribou Wolverine*	**Waterfowl** *Trumpeter Swan Western Grebe White-winged Scoter*	**All Species**
Conifer/Tamarack Swamp	0	**10**	**8**	4	**11**
Coniferous Upland	0	**10**	**8**	0	**10**
Mixedwood Upland	0	**10**	6	0	7

*High Value: Score 8-12; Medium Value: Score 4-7; Low Value: Score 0-3.
Note that swamps, bogs, fens, and mixed uplands are generally important to mammals.

10.5.3 Wetland Recommendations

10.5.3 a Develop tools that support the valuation of wetlands in watersheds, considering the Alberta Wetland Policy and criteria established in the Alberta Wetland Rapid Evaluation Tool (ABWRET). Develop a comprehensive inventory of "key" wetlands for the watershed based on various hydrological, ecological, and cultural values.

10.5.3 b To maintain high value wetlands (e.g., Category A and B based on criteria in Table 13), adopt a policy to avoid impacts on wetlands (through project redesign or relocation). If avoidance cannot occur, minimize impacts to the greatest extent possible using mitigation strategies (e.g., BMP implementation during planning and operation). Compensation should apply when wetlands are permanently lost.

10.5.3 c Apply appropriate development setbacks to wetlands in the watershed to maintain hydrologic (flood and drought protection), water quality, and biodiversity functions on the landscape. Refer to Appendix F for industry related setbacks.

10.5.3 d Preliminary results of the Biodiversity Valuation Calculation Matrix indicate that emergent marshes have high value for amphibians, birds, and waterfowl. Emergent marshes (or littoral zones in lakes) are also important spawning and rearing areas for fish (e.g., Walleye) (Section 10.6). Special provisions to maintain emergent marshes, which are generally rare in the watershed, should be developed. Additional wetland priorities should be identified as other valuation tools become available.

10.5.3 e Use the Alberta Merged Wetland Inventory (enhanced classification) map as a tool to avoid impacts to emergent marshes. Emergent marshes are associated with open water (e.g., the littoral zone at Lesser Slave Lake and other lakes) in the watershed (see Figure 5 and the enhanced classification wetland map in Appendix G).

Mitigation

10.5.3 f Resource industries should apply beneficial management practices (BMPs) to mitigate impacts of road construction on wetlands in the watershed. Proper resource road construction and maintenance is detailed in Partington et al. (2016)[17]; this resource

[17] The road construction guide focuses on: 1) reducing the impacts of resource roads on wetlands; and 2) ensuring that resource roads that cross wetlands are able to meet operational performance in a cost-effective way.

should be consulted and used by industry. Some road considerations in the guide include:

1. Size and space culverts to promote hydrologic connectivity and mitigate ponding and ditching next to roads
2. Wide wetland crossing may span small upland areas that can be used to avoid, saturated wetland soils (known as island hopping)
3. Use soil moisture probes to estimate peat depth and determine drainage structure placement
4. Strategically place borrow pits along higher ground
5. Apply minimal disturbance practices by crossing wetlands when soils are frozen
6. Use wide tires on gravel trucks to reduce compaction and improve load bearing capacity
7. Source fill materials from outside wetlands to maintain wetland hydrology
8. Monitor and repair roads (e.g., rutting, perched/sunken culverts, excessive erosion)

10.5.3 g Agricultural producers should minimize impacts on wetlands that may result from livestock access or cropping practices. The following BMPs should be applied to maintain wetlands in agricultural landscapes (AAFRD 2004):

1. Retain temporary wetlands in pastures and cropland to provide early spring breeding habitat for wildlife
2. Maintain or restore permanent cover (e.g., perennial forages for hay) in wet areas to provide habitat
3. Avoid cultivating near the edges of wetlands
4. Maintain, restore or enhance riparian vegetation for flood and drought mitigation, to maintain and improve water quality, and to provide wildlife habitat
5. Delay mowing and haying of grassed waterways and other wet areas until mid-July to reduce nesting losses and fawn mortality. Use a flushing bar when haying
6. Provide alternative water to livestock to deter use of wetlands by livestock, and prevent soil compaction in low-lying areas. Use temporary or permanent fencing

Restoration

10.5.3 h Connectivity between wetlands and natural drainages (e.g., ephemeral and intermittent watercourses) should be maintained and restored where possible.

Education, Awareness and Outreach

10.5.3 i Promote wetland protection and conservation in the watershed:

1. Provide opportunities for people to interact with wetlands
2. Provide wetland resources to landowners, the community, and school groups:
   - Project Web-foot (Ducks Unlimited Canada)
   - Wetlands: Webbed Feet Not Required (Alberta Environment)
   - Wetlands on My Lands: Landowner Guide for Restoring and Maintaining Wetlands in Alberta (Ducks Unlimited Canada)
3. Encourage landowners to maintain wetlands through incentive programs (e.g., ALUS)

10.5.4 Implementation Table for Wetlands

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
10.5.3 a Complete the valuation of wetlands in the watershed	AEP, AAF	The majority of wetlands are located on Crown land and managed under forest lease agreements. AEP, with support from AAF, should take the lead to develop tools that can assist with the valuation of wetlands in the Lesser Slave watershed, particularly areas under development pressure.	H (H)
	DUC	Continue with efforts to develop and refine wetland valuation tools.	
10.5.3 b Adopt a policy to avoid wetlands and minimize impacts through mitigation	AAF	Projects that may impact wetlands should demonstrate why disturbance cannot be avoided through either relocation or redesign and how impacts will be mitigated (EIDOS 2015).	H (H)
	Municipalities		
	Industry		
10.5.3 c Apply minimum setback adjacent to wetlands	AAF	Monitor and enforce forest harvest practices to ensure setbacks are respected.	H (H)
	Municipalities	Apply development setbacks adjacent to priority wetlands.	
	AER	Monitor and enforce oil and gas activity to ensure setbacks are respected.	
10.5.3 d Preserve emergent marshes and identify other wetland priorities as new tools are available	Municipalities	Identify emergent marshes within municipal boundaries. Provide a measure of protection to emergent marshes by adopting policy and developing land use bylaws.	H (H)
	Industry (Agriculture, Forest, Oil and Gas)	Identify emergent marshes within the boundaries of operation and take active measures to maintain them during development and operation.	
10.5.3 e Use the wetland map to avoid impacts to emergent marshes	Industry (Agriculture, Forest, Oil and Gas)	Use the Alberta Merged Wetland Inventory map for planning purposes, to provide a cursory indication of the presence and type of wetlands in operation areas. A high-resolution map is available on the LSWC website at www.lswc.ca	H (H)
10.5.3 f Mitigate impacts of road construction on wetlands	Alberta Transportation	Refer to available guidance to mitigate impacts of road construction on wetlands.	H (H)
	Municipalities		
	Industry (Forest, Oil and Gas)		
10.5.3 g Minimize impacts to wetlands	Agriculture Industry	Apply cropping and grazing BMPs to maintain wetlands on agricultural land.	H (H)
10.5.3 h Maintain wetland connectivity in the watershed	Municipalities, Industry (Forest, Oil and Gas, Agriculture)	Use available resources to identify wetlands early in development planning in order to minimize impacts and maintain wetland connectivity.	H (H)
10.5.3 i Provide education and awareness opportunities	LSWC	Continue to provide opportunities for residents and landowners to learn about wetlands and watersheds.	H (H)
	Ducks Unlimited Canada (DUC), NAWMP, Nature Conservancy of Canada (NCC)	Support LSWC to provide wetland resources to residents, landowners and other community members in the watershed.	H (H)

[a]H=High Priority; M = Medium Priority; L = Low Priority; (H)=High Community Value; (M)=Medium Community Value; (L)=Low Community Value

10.6 Biodiversity

10.6.1 Goals and Objectives (from Section 6.0)

Goal: Sustainable land use practices take place in the watershed that maintain and support biodiversity.

Objective 1. Recommend beneficial management practices for land use that will conserve and enhance biodiversity in the watershed.

GUIDING PRINCIPLE

Biodiversity is an important part of the Lesser Slave watershed. Effort should be made to conserve quality habitat in substantial size to support plants, fish, and wildlife throughout the watershed.

10.6.2 Targets and Thresholds

There are 13 species at risk in the Lesser Slave watershed, four of which are "Threatened" (as per Jamison 2009) (Table 15). While changes in species diversity and abundance may change and/or fluctuate due to natural causes, human alteration and disturbance to habitat can impact local biodiversity. Research and local knowledge should be used to derive targets and thresholds for biodiversity indicators. These targets and thresholds should be adopted in the Lesser Slave watershed in a future update to the plan.

Table 15. Species at risk in the Lesser Slave watershed (Jamison 2009).

Biodiversity Group	Species at Risk	Legal Designation
Mammals	Woodland Caribou (*Rangifer tarandus caribou*)	Threatened
	Wolverine (*Gulo gulo*)	Data Deficient
	Grizzly Bear (*Ursus arctos*)	In process
Birds	Peregrine Falcon (Falco peregrinus)	Threatened
	Barred Owl (Strix varia)	Species of Special Concern
	Bay-breasted Warbler (Dendroica castanea)	In process
	Cape May Warbler (Dendroica castanea)	In process
Amphibians	Northern Leopard Frog (*Rana pipiens*)	Threatened
	Canadian Toad (*Bufo hemiophrys*)	Data deficient
Waterfowl	Trumpeter Swan (*Cygnus buccinators*)	Threatened
	Western Grebe (Aechmophorus occidentalis)	Species of Special Concern
	White-winged Scoter (*Melanitta fusca*)	Species of Special Concern
Fish	Arctic Grayling (*Thymallus arcticus*)	Species of Special Concern

Water Temperature Targets for Fish: Water temperature is an important indicator of fish habitat. Removal of riparian vegetation (e.g., trees and shrubs), or the forest canopy, on streambanks reduces shade and can increase water temperature.

Water temperature should be maintained in Lesser Slave Lake tributaries within the optimum range described in Table 16. Refer also to Table 7, Table 8, and Table 9 (Section 10.2) for additional water quality targets.

Table 16. Summary of water temperatures required for key sport fish species in rivers and lakes in the Lesser Slave Lake watershed. Temperatures in **green** are optimum temperatures for growth. Temperatures in **black** are the tolerance range (sub-optimum growth at the lower and upper extreme temperature). Temperatures higher than the upper tolerance range may result in mortality for all life history components and cessation of spawning. Temperatures lower than the lower tolerance range may result in reduced growth for all components, cessation of spawning and increased mortality for incubating eggs and newly-emerged fry.

Species	Egg Incubation	Egg Incubation Timing	Fry	Juvenile	Adult	Spawning	Spawning Timing	Reference
Arctic Grayling (*Thymallus arcticus*)	**6 - 10°C** **2 - 16°C**	8 – 32 days: early-May to mid-June		**10 - 12°C** **2 - 24.5°C**	**10°C** **1 - 20°C**	**6 – 10°C**	early-May to early-June	1, 2
Burbot (*Lota lota*)	**4 - 7°C** **1 - 7°C**	30 days: February to April		**16 - 18°C** **8 - 23°C**	**16 - 18°C** **1 - 23°C**	**1 - 2°C**	February to March (under ice)	2, 3
Lake Whitefish (*Coregonus clupeaformis*)	**3 - 6°C** **0 - 12°C**	180 days: April to May	**14°C** **12 - 20°C**	**14 - 20°C**	**8 - 14°C** **0 - 22°C**	**3 - 6°C** **0 - 7°C**	late-September to January	3, 4, 6, 11
Northern Pike (*Esox lucius*)	**6 - 15°C** **3 - 17°C**	14 days: mid-April to mid-May	**21 - 26°C** **6 - 26°C**	**26°C** **6 - 33°C**	**19 - 21°C** **0 - 29°C**	**6 - 12°C**	April to early-May	2, 6, 10
Walleye (*Sander vitreus*)	**9 - 15°C** **6 - 19°C**	17 - 21 days: mid-April to mid-June	**22°C** **13 - 28°C**	**22 - 28°C** **15 - 31°C**	**20 - 23°C** **0 - 28°C**	**6 - 12°C**	April to May	2, 3, 6, 7, 8, 9, 12
Yellow Perch (*Perca flavescens*)	**10°C** **7 - 20°C**	8 - 14 days: late-April to late-May	**3 - 28°C**	**19 - 24°C** **6 - 31°C**	**19 - 24°C** **6 - 31°C**	**7 – 12°C**	mid-April to early-May	3, 4, 5
Note: Where temperature data is not available for 'fry' component, use temperature data from 'juvenile'.								

References:

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

10.6.3 Biodiversity Recommendations

Fisheries

Nearshore areas (i.e., littoral habitat) are important spawning and rearing areas for fish. Littoral areas and the adjacent shoreline areas (i.e., riparian zone) are particularly vulnerable to shoreline developments such as terrestrial vegetation removal, land clearing, break-walls, docks, marina developments, riprap, or hardened shorelines.

10.6.3 a Maintain water quality to preserve a diverse fish population and a healthy sport and subsistence fishery in Lesser Slave Lake and its tributaries. Maintain appropriate water temperatures (Table 16) and dissolved oxygen (Tables 8 and 9, Section 10.2) for sport fish.

10.6.3 b For Lesser Slave Lake,

1. Continue to identify critical spawning and rearing areas for Walleye, Lake Whitefish, Northern Pike and Yellow Perch. A map of important spawning and rearing habitat, similar to Figure 6 should be updated as new spawning and rearing sites are identified.
2. Establish lake management zones to direct development (e.g., retaining walls, docks, cottages, homes, marinas or other infrastructure) in the vicinity of spawning and rearing areas. Refer to Figure 6 for known spawning and rearing areas for Walleye and Lake Whitefish.
3. Protect the littoral zone and adjacent riparian areas to maintain these areas as important fish spawning and rearing habitat.

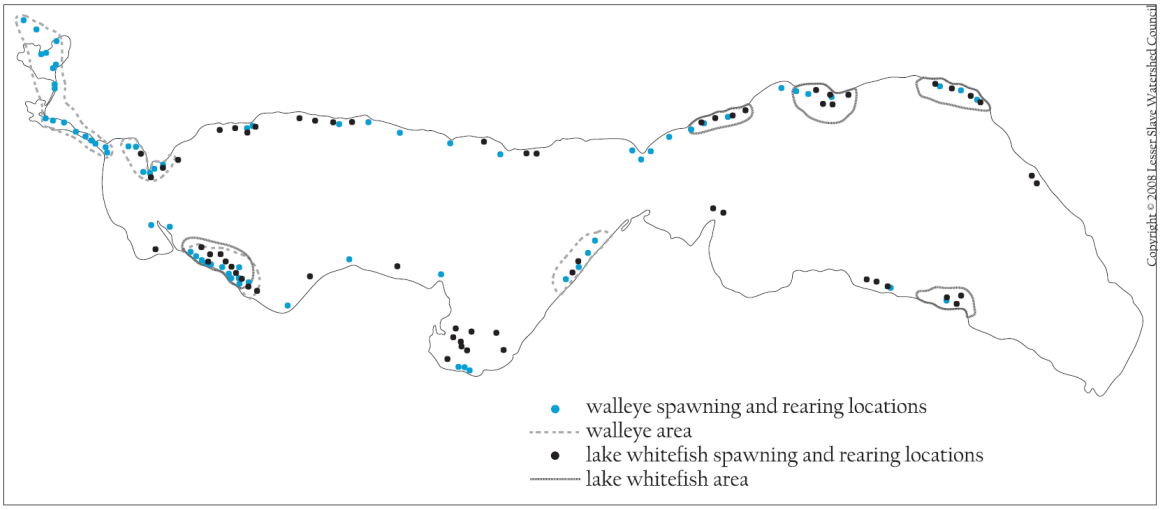


Figure 6. Walleye and Lake Whitefish spawning and rearing locations (LSWC 2008).

Research in the Swan River watershed in 2002 reported that 74% of stream crossings (N=352) likely impede fish movement and 19% of culverts likely contribute moderate or high levels of sediment to second order or greater streams (Tchir *et al.* 2004). Debris blockages, hanging outlets, damaged culverts and undersized culverts were the primary causes of barriers to fish movement. Tchir et al. (2004) calculated that fish populations may not be able to access 20% of the headwater areas of the Swan River. Stream fragmentation, as a result of road construction and culvert barriers, was

identified as a critical limiting habitat feature for Arctic Grayling (Walker 2005). In 2015, the level of fragmentation due to stream crossings in the Swan River watershed was re-assessed (ACA 2016). Of the 176 crossings assessed, 131 culverts (74%) were found to impede fish passage. The culvert barriers resulted in 737 stream-kilometres of fragmented habitat, which prevent migrating fish from accessing 24.8% of the watershed (ACA 2016). The proportion of fragmented habitat was greatest in small-order streams.

10.6.3 c To increase the availability of productive fish habitat through the restoration of stream connectivity and reduce sediment inputs to streams and downstream areas, the following recommendations should be implemented:

- Establish a working group comprised of the crossing owners from the oil and gas, forestry, railroad, municipal and provincial sectors to examine stream crossings at resource, municipal and provincial roads and highways. The process, protocols and implementation should follow the Provincial Directive for Watercourse Crossings Remediation (ESRD 2015a).
- Use the results of watershed-based stream crossing assessment at the Swan River watershed, conducted by the Alberta Conservation Association in 2015 (ACA 2015), to prioritize remediation activity. The ACA followed the Roadway Watercourse Crossing Manual (GoA 2015b) to complete the assessment.
- Prioritize the stream crossing sites so stream crossings that fully impede fish movement with the highest sediment load are given a higher priority for restoration or replacement.
- Create and implement a stream crossing watershed remediation plan including inspection and assessment output, fish passage ratings, sediment/erosion assessment, restoration/replacement priorities, planned remedial work, and timelines (ESRD 2015a).
- The working group should identify other sub-watersheds for future stream crossing assessments in the Lesser Slave watershed that have a high density of culvert crossings potentially impeding fish movement and contributing sediment to rivers.

10.6.3 d The Horse Lakes complex contains high numbers of forage fish, and is an important feeding and rearing area for pre- and post-spawning Walleye (Osokin and Tchir 2006). Water inputs to the Horse Lakes complex should be maintained and no drainage activities or diversion should be permitted, so that Walleye can continue to utilize this important habitat.

10.6.3 e The province of Alberta has designated portions of two waterbodies within the Lesser Slave watershed as Class A[18] fish habitat due to their importance as Walleye spawning habitat:

<u>Walleye (Class A waterbodies, refer to Code of Practice maps for locations)</u>

- Lower South Heart River (including Buffalo Bay and the Grouard Channel)

[18] Class A water body – "Highest sensitivity; habitat areas are sensitive enough to be damaged by any type of activity within the water body; known habitats in water body critical to the continued viability of a population of fish species in the area" (GOA 2013).

- Unnamed tributary of Fawcett Lake

Access to these areas by Walleye should be maintained and no development or activity that impacts spawning habitat should be permitted. Development activities at Class A waterbodies around pipelines, telecommunication lines, watercourse crossings, outfall structures and hydrostatic testing sites are regulated by the applicable provincial Codes of Practice. The Code of Practice for Class A waterbodies prohibits the construction of new outfalls, pipeline crossings, telecommunication lines and road crossings (with the exception of single-span bridges for pedestrian and/or equestrian purposes).

Landings, decking and bared areas not permitted within 100 m of the high water mark at forestry harvesting operations adjacent to a Class A waterbody. Any existing roads may be maintained at present classification standards. Any proposed watercourse crossings within 2 km upstream must be specifically approved in the Annual Operating Plan (AOP). No disturbance or removal of timber within 100 m of the high water mark is permitted. No duff disturbance of intermittent (minimum 10 m vegetated buffer) or ephemeral drainages (minimum 5 m vegetated buffer) within 2 km upstream of Class A waterbody (ESRD 2015b).

10.6.3 f The province of Alberta has designated portions of 18 waterbodies in the Lesser Slave watershed as Class B[19] fish habitat due to their importance as Walleye spawning habitat or as critical spawning and rearing habitat for Arctic Grayling:

<u>Walleye (Class B waterbodies, refer to Code of Practice maps for locations)</u>

- Howard Creek
- South Heart River
- Unnamed tributary of Fawcett Lake

<u>Arctic Grayling (Class B waterbodies, refer to Code of Practice maps for locations)</u>

- Adams Creek
- Allan River
- Inverness River
- Moosehorn River
- Otauwau River
- Sawridge Creek
- Swan River
- Unnamed tributary of Marten Creek
- Unnamed tributary of Otauwau River
- Unnamed tributary of Sawridge Creek
- Unnamed tributaries (5) of Swan River

Development activities at Class B waterbodies around pipelines, telecommunication lines, watercourse crossings, outfall structures and hydrostatic testing sites should adhere to the guidelines provided by the applicable provincial Codes of Practice (*Water Act*).

[19] Class B waterbody – "High sensitivity; habitat areas are sensitive enough to be potentially damaged by any type of activity within the waterbody; habitat areas important to continued viability of a population of fish species in the area" (GOA 2013).

Landings, decking and bared areas are not permitted within 60 m of the high-water mark at forestry harvesting operations adjacent to a Class B waterbody. Any existing roads may be maintained at present classification standards. Any proposed watercourse crossings within 500 m upstream must be specifically approved in the AOP. No disturbance or removal of timber within the appropriate riparian area specified by stream type unless specifically approved in the AOP. No duff disturbance of intermittent (minimum 10 m vegetated buffer) or ephemeral drainages (minimum 5 m vegetated buffer) within 500 m upstream of Class B waterbody. Where removal of timber within 60 m is approved, no machinery is permitted within 30 m of the high-water mark (ESRD 2015b).

10.6.3 g Fall index netting (FIN) is used by Alberta Environment and Parks to monitor Walleye and Northern Pike populations, and may be used to assess the sustainability of other popular fisheries (e.g., Lake Whitefish and Yellow Perch) in the future. The annual fall index netting summary for Lesser Slave Lake should be reported on the AEP's website (http://aep.alberta.ca/fish-wildlife/fisheries-management/fall-index-netting/fall-index-netting-summaries/).

Aquatic Invasive Species

The Lesser Slave watershed, and in particular Lesser Slave Lake, is susceptible to aquatic invasive species (AIS) such as zebra mussel, quagga mussel, flowering rush, Prussian Carp, and Eurasian milfoil, among other threats. In August 2016, whirling disease (a parasite that affects salmonids including trout and Mountain Whitefish) was detected in Alberta at Banff National Park and has since been confirmed throughout the Red Deer, Bow River, and Oldman River watersheds. In the Lesser Slave watershed, fish susceptible to whirling disease include Rainbow Trout and Brook Trout stocked in lakes, and populations of Mountain Whitefish occurring mainly in the Lesser Slave River. Lake Whitefish and Arctic Grayling do not appear to display clinical signs of the disease but may be vectors (carriers) of the disease (MacConnell *et al.* 2002).

10.6.3 h Strategies should be implemented to mitigate the potential for aquatic invasive species (AIS):

1. Post signs at all access points around the lake to increase awareness regarding the threat of AIS. The signs should identify the AIS of concern, their impacts, and techniques that anglers, boaters and other recreational users can implement to reduce the spread of AIS (e.g., cleaning, draining and drying all aquatic equipment including watercraft, waders, nets, and fishing gear).

   Signage should emphasize that all standing water is to be drained prior to leaving a waterbody, including draining the ballast, bilge and live wells. Signage should remind boaters that it is illegal to transport a boat with the drain plug in, and that contravention of this regulation is subject to a fine of up to $100,000 and/or a year in prison.

2. Include notes on AIS in advertisements for fishing tournaments.

3. Make a boat-wash station available at all major access points, particularly during fishing tournaments and the peak summer season. Consideration should be given

to having personnel at major access points during the peak season to assist with education and proper cleaning techniques for boats.

Wildlife

10.6.3 i Create a unified access management plan for the Lesser Slave watershed to maintain quality habitat for fish and wildlife. Include a review of unrestricted access points to Lesser Slave Lake.

Grizzly Bear - The draft Alberta Grizzly Bear Recovery Plan recommends a number of strategies to address declining bear populations in Alberta (ESRD 2016). In the Lesser Slave watershed, Grizzly Bear are managed in Bear Management Area 7 – Swan Hills. While no empirical estimate of the number of Grizzly Bars is available for this BMA, Boulanger et al. (2009) calculated a habitat-based population estimate of 23.2 (CI 5.9-70.9). There are records of Grizzly Bears occurring in the Martin Hills in the Support Zone of the northeast portion of this BMA (Figure 7), but it is unclear how this habitat contributes to the viability of the subpopulation. Poaching is the primary cause (5 of 7) of known human-caused mortality in BMA 7. Open road density is highest in this BMA with 57.1% and 44.4% of the Core and Secondary Zones respectively, exceeding recommended thresholds. There is some evidence of a reduction in the expected level of genetic fitness potentially due to in-breeding depression (Proctor et al. 2012). The bears in this BMA are at risk of becoming further isolated from BMA 2 because of anthropogenic changes, including increased traffic volume and road density associated with oil and gas activity (AEP 2016).

10.6.3 j As per the draft Grizzly Bear Recovery Plan (AEP 2016), the following recovery priorities should be addressed:

1. Estimate population size.
2. Implement access management recommendations, particularly adhering to the road density thresholds of 0.6 km/km^2 in Core Zones and 0.75 km/km^2 in Secondary Zones for roads open to public motorized access.
3. Assess the degree of genetic isolation from other BMAs.
4. Develop strategies to restore demographic connectivity to BMA 2 – Grande Cache, that may include remediation and restoration of access roads.

Woodland Caribou

10.6.3 k Increase effort to maintain quality habitat in sufficient size to support Woodland Caribou, according to the strategies outlined in the Woodland Caribou Recovery Strategy (Environment Canada 2012) and Alberta's Caribou Range Plan (draft November 2017).

Waterfowl

10.6.3 l Establish a landowner stewardship program to enhance conservation of shoreline habitat.

Education, Awareness and Outreach

10.6.3 m Increase public awareness, through the use of automobile stickers, licence plate decals, online videos, signage, newspaper ads, and the Report a Poacher program. Encourage residents to phone the 24-hour hotline (1-800-642-3800) to report suspicious activities.

Host events in the watershed to increase public awareness regarding wildlife.

Colin Ross, Driftpile River

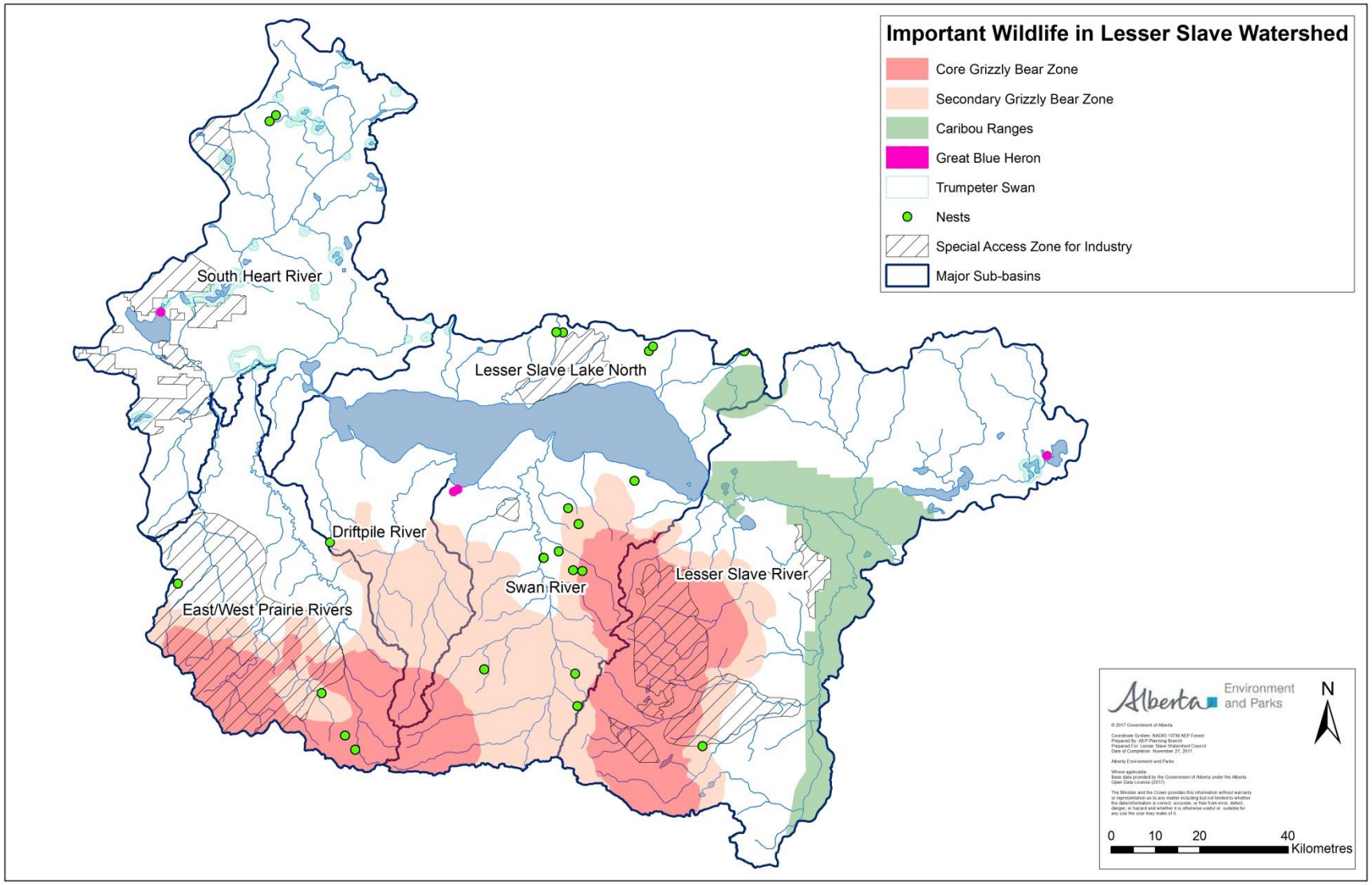


Figure 7. Important wildlife areas in the Lesser Slave watershed, including Grizzly Bear habitat and Woodland Caribou range. A larger, high resolution map is available at www.lswc.ca.

10.6.4 Implementation Table for Biodiversity

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
10.6.3 a Maintain water quality to support fish	AEP	Implement water monitoring program (Section 10.2) and compare to fish habitat requirements. Disseminate results to stakeholders annually.	H (H)
	LSWC		
	Municipalities	Manage stormwater and effluent quantity and quality discharged to surface water.	
	Industry (Agriculture, forestry, oil and gas)	Apply BMPs and minimal disturbance practices to protect fish habitat.	
	Landowners	Adhere to catch limits. Prevent hazardous/deleterious substances from reaching surface water. Encourage participation in the "Report a Poacher" program.	
10.6.3 b Lesser Slave Lake fishery	AEP[20]; DFO	Assess spawning and rearing activity at Lesser Slave Lake, and update map showing important spawning and rearing habitat.	M (H)
		Protect the littoral zone and adjacent riparian areas to maintain these areas as important fish spawning and rearing habitat.	H (H)
	Municipalities[21]	Establish lake management zones to deter development in the vicinity of spawning and rearing areas. Include zoning in Municipal Development Plans and Land Use Bylaws. Municipal tools such as Environmental Reserve and land use bylaws may be used to maintain natural shoreline in these important areas.	H (H)
		Update land use bylaws to reflect zoning and riparian setbacks to maintain natural shoreline in these important areas.	
	Landowners	Protect littoral zone and adjacent riparian areas by applying BMPs found in the reference Caring for Shoreline Properties (ACA 1999). *Landowners can maintain natural shoreline (trees and native vegetation), use swimming rafts rather than clear large areas of littoral vegetation for recreation.*	H (H)
10.6.3 c Restore stream connectivity and reduce sediment inputs to streams and downstream areas	AEP[22]; ACA	Increase auditing and enforce proper culvert placement for stream crossings.	H (H)
		Assess stream crossing sites, prioritize sites for restoration (highest priority to sites impeding fish passage or contributing to high sediment loads), and create and implement a remediation plan. Identify other sub-watersheds for future stream crossing assessment based on high density of culvert crossings.	
		Engage the Alberta Conservation Association, or other consulting service provider, to conduct inspections, data acquisition, planning, and crossing remediation.	
	LSWC	Support AEP to establish a working group to address habitat fragmentation and	

[20] Guiding Policy: *Public Lands Act*
[21] Guiding Policy: *Municipal Government Act*
[22] Guiding Policy: Roadway Watercourse Crossings Remediation Directive (ESRD, Compliance, 2015, No. 1).

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
		sedimentation from improper culvert placement at stream crossings.	
	Municipalities	For White Zone areas, municipalities are encouraged to assess IWMP stream flow and fish passage requirements during bridge/culvert inspections to achieve desired Plan outcomes.	
	Industry (Forestry, oil and gas, rail)	Participate in a working group to address habitat fragmentation and sedimentation from improper culvert placement at stream crossings.	
10.6.3 d Protect the Horse Lakes wetland complex	AEP	Review applications that propose habitat alteration or water withdrawal from the Horse Lakes wetland complex.	H (H)
10.6.3 e Manage access and development at Class A waterbodies	AEP	Enforce restricted activities for Class A waterbodies.	H (H)
		Ensure proper signage noting the sensitive Walleye spawning area at Fawcett Lake.	
	Industry	Adhere to the restrictions for industrial access and development at the lower South Heart River and unnamed tributary of Fawcett Lake.	
	LSWC	Investigate OHV use, and other recreational activity, unnamed tributary of Fawcett Lake and area to determine the potential for impact on Walleye spawning habitat.	
		Based on investigation of recreational activity, increase awareness regarding fish habitat and communicate stewardship actions to maintain habitat.	
10.6.3 f Manage access and development at Class B waterbodies	AEP	Enforce restricted activity periods and developments for Class B waterbodies.	H (H)
		Post fish habitat sensitivities on signs at unnamed tributary of Fawcett Lake.	
	Industry	Adhere to the restrictions for industrial access and development at the lower South Heart River and unnamed tributary of Fawcett Lake.	
	LSWC	Investigate OHV use, and other recreational activity, at creeks and rivers designated 'Class B' (see recommendation 10.6.3 f) to determine the potential for impact on Walleye and Arctic Grayling spawning habitat.	
		Based on findings, increase awareness regarding fish habitat and communicate stewardship actions to maintain habitat.	
10.6.3 g Report Fall Index Netting summary	AEP	Include Lesser Slave Lake data in the summary of Fall Index Netting on AEPs website.	M (H)
10.6.3 h Implement strategies to mitigate potential for aquatic invasive species	AEP	Establish a boat inspection station and boat-wash station at all major access points, particularly during fishing tournaments and the peak summer season.	H (H)
	Municipalities	Provide training to municipal summer staff working at near the municipal boat launch to assist with education and proper cleaning techniques for boats.	
		Work with the LSWC to circulate a notice to rate-payers regarding aquatic invasive species, risks and stewardship.	

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
	LSWC	Work with municipalities to ensure that proper signage is posted at all access points around the lake, including unmanaged access points. Signs and information should be placed at campgrounds and marinas around the lake.	
		Prepare a standard message to include with fishing tournament advertisements, including on websites.	
10.6.3 i Create a unified access management plan	AEP	Integrate access management strategies for Crown Land. Collaborate with municipalities and LSWC to review access on public and private land and develop and access management plan.	M (H)
	LSWC	Lead collaboration to establish an access management plan for Lesser Slave Lake. Work with AEP and municipalities to review current access at the lake and develop an access management plan for the lake on public and private land.	
	Municipalities	Work with AEP and LSWC to review current access at the lake and develop an access management plan for the lake on public and private land.	
10.6.3 j Maintain critical habitat for Grizzly Bear	AEP	Implement recommendation in Recovery Plans. Complete a periodic review to determine if goals and objectives are being met.	H (H)
	Industry	Adhere to the recommendations in the Recovery Plan. Adhere to Codes of Practice, and wildlife timing restrictions and setbacks.	
10.6.3 k Maintain critical habitat for Woodland Caribou	AEP	Implement recommendation in Recovery Plans. Complete a periodic review to determine if goals and objectives are being met.	H (H)
	Industry	Adhere to the recommendations in the Recovery Plan. Adhere to Codes of Practice, and wildlife timing restrictions and setbacks.	
10.6.3 l Landowner stewardship program to conserve shoreline habitat	LSWC	Lead collaboration among landowners to conserve shoreline habitat. Use mapping to identify	M (H)
		Consolidate data from multiple agencies to develop a shoreline map showing critical habitat for fish and waterfowl. Use the bathymetry study to show littoral vegetation, as well as the Alberta Merged Wetland Inventory that shows emergent marsh.	
	First Nations	Collaborate to enhance and promote shoreline habitat conservation.	
	Municipalities		
	Landowners		
10.6.3 m Report a Poacher program	LSWC, ACA	Disseminate information to the public to raise awareness and increase the use of the Report a Poacher program.	H (H)

[a]H=High Priority; M = Medium Priority; L = Low Priority; (H)=High Community Value; (M)=Medium Community Value; (L)=Low Community Value

11.0 LITERATURE CITED

Abells, S. and M. Henry. 2012. A Vision for the Lesser Slave Watershed 2012 – 2013 IWMP Project: Step Two: Online Survey Results. Lesser Slave Watershed Council, High Prairie, AB. 24 pp.

Abells, S. and M. Henry. 2013. A Vision for the Lesser Slave Watershed 2012 – 2013 IWMP Project. Final Report. Prepared for the Lesser Slave Watershed Council, High Prairie, AB. 53 pp.

Alan Dolan & Associates. 2015. Integrated Watershed Management Plan: First Nations, Métis, and Stakeholder Engagement. Prepared for the Lesser Slave Watershed Council, High Prairie.

Alan Dolan & Associates. 2017a. Community Engagement for the Integrated Watershed Management Plan, October – December 2016. Prepared for the Lesser Slave Watershed Council, High Prairie, AB.

Alan Dolan & Associates. 2017b. Community Engagement for Draft III Integrated Watershed Management Plan, May – June 2017. Prepared for the Lesser Slave Watershed Council, High Prairie, AB.

Alberta Conservation Association. 1999. Caring for Shoreline Properties: Changing the Way We Look at Owning Lakefront Property in Alberta. Alberta Conservation Association, Edmonton, AB. 29 pp.

Alberta Conservation Association. 2016. Swan River Arctic Grayling: A Stock and Watershed Connectivity Survey 2015/16 Project Summary Report. Alberta Conservation Association, Edmonton, AB. 6 pp.

Alberta Biodiversity Monitoring Institute (ABMI). 2015. 3x7 km Human Footprint Inventory (Version 1) Data Request Overview. 5 pp.

Alberta Agriculture, Food and Rural Development. 2004. Beneficial Management Practices: Environmental Manual for Crop Producers in Alberta. Edmonton, Alberta. 165 pp.

Alberta Environment. n.d. Framework for Water Management Planning. Edmonton, Alberta. 37 pp.

Alberta Environment. 2000. Low Flow Conditions in the Lesser Slave River. 1999-2000. Water Sciences Branch, Water Management Division, Natural Resource Services, Edmonton, Alberta.

Alberta Environment. 2003. Water for Life: Alberta's Strategy for Sustainability. Alberta Environment, Edmonton, Alberta. 31 pp.

Alberta Environment. 1985. Iroquois Creek Basin Study.

Alberta Environment. 1992. Buffalo Bay/Horse Lakes, East/West Prairie Rivers,
Water Management Program, Final Report. Public Advisory Committee, Interagency Management Committee and Interagency Technical Committee. 23 pp. + Appendix.

Alberta Environmental Protection (AEP). 1993. Lesser Slave Lake Regulation Status Report. Prepared by Planning Division, Alberta Environmental Protection. Edmonton, AB. 24 pp.

Alberta Environmental Protection (AEP). 1996. Walleye: Alberta's fish, A series of informative brochures about Alberta's fish species. Government of Alberta. 6 pp.

Alberta Environment and Parks. 2015. Reclamation Criteria for Wellsites and Associated Facilities for Peatlands, October, 2015, Edmonton, Alberta. 142 pp.

Alberta Environment and Parks. 2016b. Alberta Grizzly Bear (Ursus Arctos) Recovery Plan. Alberta Environment and Parks, Alberta Species at Risk Recovery Plan No. 38, Edmonton, AB. 85 pp.

Alberta Environment and Sustainable Resource Development (ESRD). 2013. Alberta Wetland Policy. Alberta Environment and Sustainable Resource Development, Edmonton, AB. 25 pp.

Alberta Environment and Sustainable Resource Development (ESRD). 2014a. Fish Conservation and Management Strategy for Alberta. Alberta Environment and Sustainable Resource Development, Edmonton, AB. 56 pp.

Alberta Environment & Sustainable Resource Development (ESRD). 2014b. Environmental Quality Guidelines for Alberta Surface Waters. Water Policy Branch, Policy Division. Edmonton, AB. 48 pp.

Alberta Environment and Sustainable Resource Development (ESRD). 2015a. Roadway Watercourse Crossings Remediation Directive (ESRD, Compliance, 2015, No. 1). Fish and Wildlife Compliance. 7 pp.

Alberta Environment and Sustainable Resource Development (ESRD). 2015b. Slave Lake Regional Timber Harvest Planning and Operating Ground Rules. Endorsed by West Fraser Mills Ltd., Tolko Industries Ltd., and Vanderwell Contractors (1971) Ltd. 70 pp. + 5 appendices.

Alberta Forestry, Lands and Wildlife. 1985. Frost Hills Local Integrated Resource Plan.

Alberta WaterSMART. 2017. Quantifying the effects of climate change and land use on streamflow and lake levels in the Lesser Slave Watershed. Prepared for the Lesser Slave Watershed Council, High Prairie, AB.

Ambrose, N., G. Ehlert and K. Spicer-Rawe. 2004. Riparian Health Assessment for Lakes, Sloughs and Wetlands – Field Workbook. Modified from Fitch, L., B. Adams, and G. Hale. 2001. Riparian Health Assessment for Streams and Small Rivers – Field Workbook. Lethbridge, AB. Cows and Fish program. 90 pp.

AMEC Earth and Environmental. 2005. Lesser Slave Lake Sedimentation Study. Prepared for Alberta Environment, Edmonton, AB. Publication No. T/815. 41 pp. + Appendices.

AMEC Environment and Infrastructure. 2014. Lesser Slave Lake Select Bathymetry Survey and Report. Prepared for Lesser Slave Watershed Council, High Prairie, AB. 15 pp + Appendices.

Aquality Environmental Consulting Ltd. 2012. The Riparian Setback Matrix Model, Sturgeon County, Alberta. Prepared for Sturgeon County. Edmonton, Alberta. 29 pp.

Aquality Environmental. 2013. Integrated Watershed Management Plan – Summary of Stakeholder Workshop. Aquality Environmental Consulting Ltd., Edmonton, Alberta. 19 pp.

Association of Summer Villages of Alberta. 2006. Lake Stewardship Reference Guide. Edmonton, AB. IBSN 0-9739418-0-4.

Athabasca University. Online. The Bibliography of the Athabasca River Basin. http://www.barbau.ca/search/apachesolr_search/Lesser%20Slave%20Lake . Accessed March 21, 2016.

Boulanger. J. et al. 2009. Estimation of grizzly bear population size for the Swan Hills management unit using DNA sampling and habitat-relative occupancy models. Report prepared for Alberta Sustainable Resource Development. 15-16 pp.

Brabender. 2005. Hydrologic Effects of Forest Harvesting for Tolko Industries Ltd. High Prairie OSB Division and Buchanan Lumber. In, Tolko Industries Ltd. Detailed Forest Management Plan: Appendix G. Prepared for Silvacom Ltd., Edmonton, AB. 11 pp.

Carlander, K.D. 1997. Handbook of freshwater fishery biology: Volume 3. Life history data on Ichthyopercid and Percid fishes of the United States and Canada. Iowa State University Press, Ames, Iowa. 397 pp.

Choles, J. 2004. Sediment Sources and Movement in Lesser Slave Lake. Alberta Environment, Edmonton, AB. 19 pp. + Appendix.

Clapp, D.F., T. Bhagwat and D.H. Wahl. 1997. The effect of thermal stress on walleye fry and fingerling mortality. North American Journal of Fisheries Management 17(2): 429-437.

Cole, G.A. 1994. Testbook of limnology, 4th Edition. Waveland Press, Inc. 412 pp.

CPP Environmental. 2015. Lesser Slave Integrated Watershed Management Plan: Risk Assessment Results. Prepared for Lesser Slave Watershed Council, High Prairie, AB. 7 pp.

Drilling and Completion Committee (DACC). 2015. IRP 20: Wellsite Design Spacing Recommendations An Industry Recommended Practice (IRP) for the Canadian Oil and Gas Industry, Volume 20 – 2015.

Ducks Unlimited Canada (DUC). 2014. Ranking Vertebrate Biodiversity in Boreal Wetland Habitats of Alberta using the Enhanced Wetland Classification System – Version 2.1. Ducks Unlimited Canada, Edmonton, AB. 154 pp.

Ducks Unlimited Canada (DUC). 2017. Biodiversity Value Calculation Matrix: Model Output for the Lesser Slave watershed. Prepared for the Lesser Slave Watershed Council. Excel Spreadsheet.

EIDOS Consultants Incorporated. 2015. Tri-Council Regional Growth Plan for Sawridge First Nation, M.D. of Lesser Slave River and Town of Slave Lake. Policies and Agreements. Municipal District of Lesser Slave River, Slave Lake, AB.

Environment Canada. 2012. Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, ON. 138 pp.

Fiera (Fiera Biological Consulting Ltd.). 2012. Athabasca State of the Watershed Report: Phase 2. Report prepared for the Athabasca Watershed Council. Fiera Biological Consulting Report #1142. Pp. 100.

Fiera Biological Consulting Ltd. 2013. State of the Watershed Report Phase III: Water Quantity and Basic Water Quality in the Athabasca Watershed. Report prepared for the Athabasca Watershed Council. Fiera Biological Consulting Report #1234.

Fisheries and Oceans Canada and Cottage Life. 2008. The Shore Primer. Queen's Printer for Canada. Calgary, AB. 27 pp.

Fitch, L., B.W. Adams and G. Hale. 2001. Riparian Health Assessment for Streams and Small Rivers – Field Workbook. Lethbridge, AB: Cows and Fish Program. 86 pp. Adapted from Riparian and Wetland Research Program, School of Forestry. 2001. Lotic health assessments: Riparian Health Assessment for Streams and Small Rivers (Survey) User Guide. University of Montana, Missoula, Montana, January 2001.

Forcorp Solutions Inc. 2012. Regional Forest Landscape Assessment Upper Athabasca Region. Alberta Sustainable Resource Development, Forest Management Branch. Edmonton, AB. 97 pp.

Ford, B.S., P.S. Higgins, A.F. Lewis, K.L. Cooper, T.A. Watson, C.M. Gee, G.L. Ennis and R.L. Sweeting. 1995. Literature reviews of the life history, habitat requirements and mitigation/compensation strategies for thirteen fish species in the Peace, Liard and Columbia River drainages of British Columbia. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2321. 342 pp.

Fraser, F. 2000. Lesser Slave Lake Important Bird Area (IBA) Conservation Plan. Prepared for the Lesser Slave Lake IBA Stakeholders Committee, Slave Lake, AB. 22 pp + Appendix.

Golder Associates Ltd. 2004. Lesser Slave River Instream Flow Needs Scoping Study. Prepared for Alberta Environment, Northern Region. Peace River, AB. 155 pp.

Government of Alberta (GoA). 2008. Land-use Framework. Alberta Environment and Sustainable Resource Development, Edmonton, AB. 54 pp.

Government of Alberta (GoA). 2012a. Industry Standards and Guidelines: Enhanced Approval Process. Alberta Environment and Sustainable Resource Development, Edmonton, AB. 87 pp.

Government of Alberta (GoA). 2012b. Stepping Back from the Water: A Beneficial Management Practices Guide for New Development Near Water Bodies in Alberta's Settled Region. Queen's Printer for Alberta, Edmonton, AB. 86 pp.

Government of Alberta (GoA). 2013. Code of Practice for Watercourse Crossings. (Made under the *Water Act* and the Water (Ministerial) Regulation. Consolidated to include amendments in force as of June 24, 2013). Alberta Queen's Printer, 44 pp.

Government of Alberta (GoA). 2015a. Guide to Watershed Management Planning in Alberta. Edmonton, AB. 52 pp.

Government of Alberta (GoA). 2015b. Roadway Watercourse Crossing Inspection Manual. ISBN 978-1-4601-2038-5. 16 pp.

Hallett, J. 2011. Aerial Video Assessment of the Swan River System, Alberta. Peace River, Alberta. 13 pp.

Hutchinson Environmental Sciences Ltd. 2015. Technical Update for the Lesser Slave Watershed. Prepared for the Lesser Slave Watershed Council, High Prairie, AB. 121 pp. + Appendices.

Inskip, P.D. 1982. Habitat suitability index models: northern pike. United States Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.17. 40 pp.

Jamison, T. 2009. State of the Lesser Slave Watershed 2009. Carson Forestry Services Inc. Prepared for the Lesser Slave Watershed Council, High Prairie, AB. 116 pp.

Johns and Hallett. 2009. Aerial Videography Assessment for Selected Reaches of the South Heart and West Prairie Rivers, Alberta. Alberta Conservation Association. Peace River, Alberta. 19 pp.

Joynt, A. and M.G. Sullivan. 2003. Fish of Alberta. Lone Pine Publishing, Edmonton. 176 pp.

Krieger, D.A., J.W. Terrell and P.C. Nelson. 1983. Habitat suitability information: yellow perch. United States Department of the Interior, Fish and Wildlife Service. FWS/OBS-83/10.55. 37 pp.

Lesser Slave Watershed Council. 2008. LSWC Factsheet: Aquatic Environments and Fisheries. High Prairie, AB. 5 pp.

Lesser Slave Watershed Council (LSWC). 2009. Lesser Slave Water Management Plan: Phase I. High Prairie, AB. 39 pp. + Appendix.

Lesser Slave Watershed Council (LSWC). 2015. Lesser Slave Integrated Watershed Management Plan: Terms of Reference. Lesser Slave Watershed Council, High Prairie, AB. 43 pp.

Lesser Slave Watershed Council (LSWC). 2016. Lesser Slave Lake Stewardship Handbook. Lesser Slave Watershed Council. High Prairie, AB. 29 pp

Locke, A. and A.J. Paul. 2011. A Desk-top Method for Establishing Environmental Flows in Alberta Rivers and Streams, (Alberta Desktop Method). Alberta Environment and Alberta Sustainable Resource Development.

MacConnell, E., and E. R. Vincent. 2002. Review: The effects of *Myxobolus cerebralis* on the salmonid host. Pages 95-107 in J. L. Bartholomew and J. C. Wilson, editors. Whirling disease: Reviews and current topics. American Fisheries Society, Symposium 29, Bethesda, Maryland.

MacLock, R. B., B. Lyons, and E. Ellehoj. 1997. Environmental Overview of the Northern River Basins. (W. D. Gummer and M. Ouellette, Eds.). Northern River Basins Study, Edmonton, AB, Canada.

McMahon, T.E., J.W. Terrell and P.C. Nelson. 1984. Habitat suitability information: walleye. United States Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.56. 43 pp.

McPhail, J.D. 2007. The freshwater fishes of British Columbia. University of Alberta Press, Edmonton. 620 pp.

Miller, R.B. 1941. The Lesser Slave Lake investigation. Department of Zoology, University of Alberta. Unpublished Report.

Mitchell, P.A. and E. Prepas. 1990. Atlas of Alberta Lakes. University of Alberta Press. 675 pp.

Nelson, J.S. and M.J. Paetz. 1992. The fishes of Alberta, second edition. University of Alberta Press, Edmonton. 437 pp.

Natural Regions Committee (NRC). 2006. Natural Regions and Subregions of Alberta. Compiled by D.J. Downing and W.W. Pettapiece. Government of Alberta. Pub. No. T/852.

Noton, L. 1998. Water quality of Lesser Slave Lakes and its tributaries, 1991-93. Water Sciences Branch, Water Management Division. 100 pp.

Nurnberg, G. 1996. Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management. 12(4): 432-447.

Osokin, L. and J. Hallett. 2007. Aerial video assessment of Lesser Slave lake, Alberta. Alberta Conservation Association, Slave Lake, AB. 15 pp.

Osokin, L. and J. Tchir. 2006. South Heart River Walleye Project, 2004. Data report (D-2004-018). Alberta Conservation Association. Slave Lake, AB.

Partington, M, C. Gillies, B. Gingras, C. Smith and J. Morissette. 2016. Resource roads and wetlands: a guide for planning, construction and maintenance (Special Publication SP-530E). FP Innovations and Ducks Unlimited Canada. Pointe-Claire, Quebec. 86 pp. Available online at: https://fpinnovations.ca/Extranet/Pages/AssetDetails.aspx?item=/Extranet/Assets/ResearchReportsFO/SP-530E.pdf#.WH-c9ly87sw

Pettapiece, W., J. Robertson and D. Anderson. 2010. Cultivated Gray Luvisol Soils of the Prairie Region. Agricultural Soil of the Prairies. Prairie Soils and Crops Journal. 3: 73-83.

R.L. & L. 1996. An information review of four native sportfish species in west-central Alberta. Prepared for Foothills Model forest and the Fisheries Management and Enhancement Program. R.L. & L. Report No. 489F: 88 pp. + appendices.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada: Bulletin 184. Fisheries Research Board of Canada. Minister of Supply and Services Canada. 966 pp.

Tchir, J.P., P.J. Hvenegaard and GJ. Scrimgeour. 2004. Stream crossing inventories in the Swan and Notikewin river basins of northwest Alberta: resolution at the watershed scale. Pages 53-62 in G.J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita, Editors. Forest Land-Fish Conference II – Ecosystem Stewardship through Collaboration. Proceedings of the Forest-Land Fish Conference II, Aprl 26-28, 2004, Edmonton, Alberta.

USEPA (United States Environmental Protection Agency). 1978. Quality criteria for water. U.S. Government Printing Office. 256 pp.

van der Kamp, G. and M. Hayashi. 2009. Groundwater-wetland ecosystem interaction in the semiarid glaciated plains of North America. Hydrogeology Journal. 17:203-214.

Walker, J. 2005. Status of the Arctic grayling (Thymallus arcticus) in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, and Alberta Conservation Association, Wildlife Status Report No. 57, Edmonton, AB. 41 pp.

Weisgerber, J. 1977. A preliminary report on the limnology of Lesser Slave Lake. Alberta Fish & Wildlife Division. Unpubl. Report. 115 pp.

Wolanski, A. 2006. Lesser Slave Lake Results of Water Quality Survey Conducted by Alberta Environment In 2000-2002. Alberta Environment, Edmonton, AB. 20 pp. + Appendix.

12.0 GLOSSARY

Baseflow Portion of the stream discharge that is derived from natural storage (i.e., outflow from groundwater, large lakes or swamps), or sources other than rainfall that create surface runoff; discharge sustained in a stream channel, not a result of direct runoff and without regulation, diversion, or other human effects. Also referred to as sustaining, normal, dry-weather, ordinary or groundwater flow. (Armantrout 1998)

Benchmark A standard or point of reference against which things may be compared or assessed.

Channelization The mechanical alteration of a stream usually by deepening and straightening an existing stream channel or creating a new channel to facilitate the movement of water. (Armantrout 1998)

Core and Secondary Zones Inform the management of access planning and development in the Recovery Zone. It does not include protected areas that exclude industrial development such as National and Provincial Parks.

Cumulative Effects The combined effects of past, present and reasonably foreseeable land0use activities, over time, on the environment (Alberta Land-use Framework 2008).

Green Zone Public land owned by the Alberta government. The green zone (the forested portion) comprises most of northern Alberta as well as the mountain and foothill areas along the province's western boundary. In the Green Zone, public land is managed for timber production, watershed, wildlife and fisheries, recreation and other uses. Agricultural use is limited to grazing where it is compatible with other uses.

Habitat Linkage Identifies the highway corridors where there is need to maintain or enhance the ability of grizzly bears to move across the Habitat Linkage Zone between adjacent BMAs.

Instream Needs Instream needs are defined as the quantity and quality of water required to satisfy hydrological process demands instream and to protect river ecology and riparian environments. Instream needs include fish habitat, water quality, riparian vegetation, channel structure, human safety and recreational uses. Instream flow needs differ from water conservation objectives in that they are strictly a scientific assessment. Water conservation objectives, on the other hand, refer to the quantity of water that should be present in a stream to meet instream needs and socio-economic factors.

Low Impact Development A land planning and engineering design approach to managing stormwater runoff. The approach includes land use planning and conservation, as well as engineered hydrologic controls to replicate the pre-development hydrologic regime of watersheds by infiltrating, filtering, storing, evaporating, and detaining runoff close to its source.

Morphology From the Greek morphe, meaning ‘form’, a prefix meaning pertaining to form or shape (Allaby 1994).

Recovery Zone The geographic extent in Alberta where it is the intention of the Government of Alberta to recover Grizzly Bears.

Riparian Riparian lands are transitional areas between upland[1] and aquatic ecosystems. They have variable width and extent both above and below ground. These lands are influenced by and/or exert an influence on associated water bodies[2], which includes alluvial aquifers[3] and floodplains[4], when present. Riparian lands

usually have soil, biological, and other physical characteristics that reflect the influence of water and/or hydrological processes (Clare and Sass 2012).

[1] For the purpose of this definition, "upland" is considered to be the land that is at a higher elevation than the alluvial plain or stream terrace or similar areas next to still water bodies, which are considered to be "lowlands."
[2] A waterbody is 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, and includes but is not limited to wetlands and aquifers (generally excludes irrigation works). Source: *Water Act*.
[3] For the purpose of this definition, alluvial aquifers are defined as groundwater under the direct influence of surface water (GUDI).
[4] For the purpose of this definition, floodplain is synonymous with flood risk area. The flood risk area is the area that would be affected by a 100-year flood. This event has a 1% chance of being equaled or exceeded in any year.

Riparian Vegetation Vegetation growing on or near the banks of a stream or other water body that is more dependent on water than vegetation that is found further up slope. (Armantrout 1998)

Secchi Disk A white and black circular disk 30 cm in diameter used to measure water transparency or turbidity in bodies of water.

Sedimentation (1) Action or process of forming and depositing sediments. (2) Deposition of suspended matter by gravity when water velocity cannot transport the bed load. (Armantrout 1998)

Setback For the purposes of this document, a setback is a minimum distance that must be maintained between a land use or development and a waterbody. The distance is measured from the legal bank of the water body to the boundary line of the adjacent development.

Support Zone Intended to support the population of Grizzly Bears in the Recovery Zone by creating a priority area for the management of bear attractants and other sources of human-wildlife conflict adjacent to the Recovery Zone thereby improving the survival rate of grizzly bear, in particular females and females with cubs, that are moving between the Recovery Zone and the Support Zone.

Temporary Diversion Licence Licences usually issued for diversion of water (surface water and groundwater) for a maximum period of one year. Normally these are issued when there is a need for a short-term diversion and use of water for emergency water supply; for dust control and bridge washing; for drilling oil and gas wells (drilling fluid); and for other short-term uses (AEP).

Water Conservation Objective The amount and quality of water established by the Director under the *Water Act*, based on information available to the Director, to be necessary for the (i) protection of a natural water body or its aquatic environment, or for the (ii) protection of tourism, recreational, transportation or waste assimilation uses of water, or (iii) management of fish or wildlife, and may include water necessary for the rate of flow of water or water level requirements. (adapted from the *Water Act*)

White Zone Public land owned by the Alberta government. The White Zone (settled portion) consists of the populated central, southern and Peace River areas of the province. In the White Zone, public land is part of the agricultural landscape. It is managed for various uses including agriculture, recreation, soil and water conservation, and fish and wildlife habitat. Some parts of the province have large tracts of public land whereas other parts have very few scattered parcels. Most of the public land in the White Zone is under disposition or is otherwise committed.

13.0 APPENDIX

APPENDIX A. Summary of Previous Planning Initiatives

Frost Hills Local Integrated Resource Plan (1985)

The Frost Hills Local Integrated Resource Plan (IRP) was initiated in 1980 in response to local requests to expand the agricultural land base in the area. The intent of the Plan was to resolve conflict between a provincial government reforestation project and local desires for an expanded agricultural land base. The IRP focused on the provision of an expanded agricultural land base, while identifying areas to be retained for timber production and habitat retention. The planning team included provincial and municipal government staff and members of the public.

Provisions of the Plan were expected to facilitate the phased conversion of about 60,000 acres (24,200 ha) of forested public land to private agricultural holdings. The hamlet of Faust had requested that a 10.25-section block of land be made available exclusively for its use. This request, which includes provision of agricultural, recreational and country residential opportunities, was agreed to by the provincial government. This area would revert to normal disposition policy if sufficient interest in the special status lands was not displayed by Faust residents. The IRP identified conservation measures to protect stream channels and fish habitat.

Iroquois Creek Basin Study (1985)

The Iroquois Creek Basin Study considered drainage and flooding problems associated with land clearing and on-farm drainage improvements of the early 1970s. Landowners were interviewed and a drainage plan was produced that provided for future agricultural developments, including the delineation of a 1:10 year level of flood protection for the basin. Reservations were subsequently placed on Crown lands for watershed protection, and to prevent further land development that could increase the potential for flooding in the lower portion of the basin (excerpt from LSWC 2009).

Lesser Slave Lake Regulation Project (1984)

The Lesser Slave Lake Regulation Project was intended to reduce the severity of flooding of low-lying areas around the lake. While mean lake water levels decreased by about 0.3 m, the overall fluctuation of lake water levels was reduced from 3.5 m to 2.7 m. Although the effect of stabilizing water levels in the lake on downstream flows in the river was not directly considered in its design, the regulation project has altered flow rates in the river from the natural condition.

Buffalo Bay/Horse Lakes East/West Prairie Rivers Water Management Program (1992)

The Buffalo Bay/Horse Lakes Water Management Program was developed by a Public Advisory Committee supported by Alberta Environment. The study area included about 3,000 km^2 in the East Prairie and West Prairie river watersheds (the Headwaters), the Buffalo Bay/Horse Lakes delta complex (Bay area), and the lower reaches of the South Heart River (central area). The study noted that the physical processes in the study area are extremely dynamic and that the complete control of flooding and sedimentation may be virtually impossible.

Four goals, established in the plan, are relevant to the current planning initiative:

- Reduce the sediment loads in the East Prairie and West Prairie rivers to natural levels (e.g., prior to channelization)
- Reduce the extent of bed and bank erosion on the East Prairie and West Prairie rivers
- Reduce the damages caused by flooding
- Protect the unique habitat features of the Bay Area

River bed armouring was considered an appropriate method to reduce sediment loads in the East Prairie and West Prairie Rivers to levels that occurred naturally. The study found that the amount of sediment in the rivers was a continual problem. Forestry and agricultural activity were thought to increase sediment in the rivers. It was recommended that forestry and agricultural clearing practices be monitored and regulated closely to ensure that the sediment load to the rivers did not increase. Log and debris control (Project 10) was recommended, particularly the monitoring of logs and debris in the East and West Prairie rivers, along with eleven other individual monitoring programs.

Lesser Slave Lake Important Bird Area Conservation Plan (2000)

The Lesser Slave Lake region is a globally significant Important Bird Area (IBA). Up to 2% of North America's Tundra Swans (*Cygnus columbianus*) feed and stage on Lesser Slave Lake, Western Grebe nest in one or more colonies, with 400 - 650 active nests on the lake, and greater than 10,000 waterfowl feed and rest on the lake during the spring and fall migration (Fraser 2000). The Lesser Slave Lake IBA Committee, represented by the Lesser Slave Lake Bird Observatory, Lesser Slave Lake Provincial Park, and Alberta Environment (AENV), formed to assist with development of the IBA conservation plan. Conservation goals and objectives included education, habitat protection/enhancement, enforcement and research.

Recommendations related to habitat protection/enhancement in the Conservation Plan are:

1) IBA Stewards and IBA Conservation Educator will work with AENV staff to protect undisturbed shoreline habitat (including natural treed buffers, water levels, water quality, etc.). The economic value and ecological benefits of undisturbed shoreline habitat will be discussed with appropriate private landowners, businesses, developers, Municipal Districts and Hamlets. Violations of habitat protection laws will be passed on to local authorities. Stewards and Educator will try to increase public understanding of related regulations.
2) Work with government (Alberta Environment, Provincial Parks, and Environment Canada) to secure and enhance staging habitat. Strategies include Conservation Easements, Nature Conservancy properties, boater education campaign at marinas, public boat launches, joint boater education programs with AENV Fisheries staff using government vessels, and joint program with AENV Fish and Wildlife staff to survey known and identify new staging areas using fixed wing aircraft, helicopters, and airboat.

Lesser Slave River Water Management Plan (Phase I) (2009)

The Lesser Slave Watershed Council developed the Lesser Slave River Water Management Plan (WMP) to address low water levels in the lake and consequently low flows in the Lesser Slave River. In November 1999, water levels in Lesser Slave Lake dropped below the weir level, preventing flows from the lake to the Lesser Slave River from November 21 to 24, threatening water supplies and the health of the aquatic environment. Emergency measures were implemented to restore flow to the river, including

the dredging of the channel at the lake outlet and the installation of siphons to convey water over the weir. In November 2006, a combination of silt, low temperatures and resulting ice formation blocked the weir and the outflow from the lake to the river. Emergency measures were again taken in the form of dredging and siphoning of water over the weir. The WMP established a minimum flow of 6 m^3/s in the Lesser Slave River.

In March 2016, a modification was made to the weir which provides the ability to compensate the shortage in riparian flow (also aquatic needs) downstream. A gate was installed at lower elevation on one side of the weir and can be opened only when the lake level drops below the weir. There is no formal Operations Plan for the weir or requirement to regulate this weir as there are no mechanical controls to regulate the flows over the weir. However, during the low flow situation (i.e., less than 6 m^3/s over the weir), an operations plan for the gate will be prepared to maintain the minimum flows downstream until water is available at the weir (C. Ali, pers. comm.).

APPENDIX B: Relevant Legislation, Policies, Strategies and Guidelines

This compilation of relevant legislation, policies, strategies and guidelines was modified from descriptions provided in the Lower Athabasca Regional Plan management frameworks (ESRD 2012, ESRD 2013 and ESRD 2014) and other documents and is intended as a general reference. Consult the original documents when applying the legislation, policies and guidelines described below.

B-1. Federal

Legislation, Policy, Strategies and Guidelines	Description
Canadian Environmental Protection Act	The primary purpose of CEPA is to contribute to sustainable development through pollution prevention, and the protection of the environment and human health. CEPA sets environmental objectives, guidelines and codes of practice that are used by provincial jurisdiction to develop provincial objectives and standards. Of significance is the *Canadian Water Quality Guidelines* that provide parameters to manage water resources to meet specific uses. CEPA can be used to inform the process of setting outcomes, limits and thresholds in watershed management plans.
Canadian Environmental Assessment Act (2012)	Establishes federal requirements for the environmental assessment and review of projects that have the potential to cause significant adverse environmental effects in areas of federal jurisdiction. Regulations set out a list of physical activities that will or may require an environmental assessment pursuant to CEAA. The Minister of the Environment may designate a physical activity that is not included in the Regulations if he is of the opinion that it warrants an environmental assessment under the Act.
Fisheries Act (Department of Fisheries and Oceans Canada (DFO))	Contains two key provisions on conservation and protection of fish habitat essential to sustaining freshwater fish species. DFO administers section 35, the key habitat protection provision, prohibiting any work or undertaking that would cause the harmful alteration, disruption or destruction of fish habitat. Environment and Climate Change Canada administers section 36, the key pollution prevention provision, prohibiting the deposit of deleterious substances into waters frequented by fish, unless authorized by regulations under the *Fisheries Act* or other federal legislation. A deleterious substance can be any substance that, if added to any water, would degrade or alter its quality such that it could be harmful to fish, fish habitat or the use of fish by people. Regulations include the Pulp and Paper Effluent Regulation.
Migratory Birds Convention Act	Implemented to protect and conserve migratory birds, as populations and individual birds, and their nests.
Species at Risk Act (SARA)	The purposes of SARA are to prevent wildlife species in Canada from disappearing, to provide for the recovery of wildlife species that are extirpated (no longer exist in the wild in Canada), endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened. When a species is listed as endangered, threatened or extirpated under *SARA* it becomes illegal to kill, harm, harass, capture or take an individual. A recovery strategy and one or more action plans based on the recovery strategy must be prepared.
Accord for the Protection of Species at Risk	The Accord outlines commitments to designate species at risk, protect their habitats and develop recovery plans.

Legislation, Policy, Strategies and Guidelines	Description
National Framework for Species at Risk Conservation	Supports the implementation of the 1996 Accord for the Protection of Species at Risk by providing a set of common principles, objectives and overarching approaches for species at risk conservation that all participants can share and work toward in a collaborative way.
Canadian Biodiversity Strategy	Alberta is a signatory to the Canadian Biodiversity Strategy (1995), a commitment under the 1992 United Nations Convention on Biological Diversity that Canada signed. Alberta, and other Canadian jurisdictions, agreed to use the Strategy and the Biodiversity Outcomes Framework for Canada (2006) as guides for actions to conserve biodiversity and to use biological resources in a sustainable manner.
Canadian Environmental Quality Guidelines (Canadian Council of Ministers of the Environment (CCME))	CCME is the primary minister-led intergovernmental forum for collective action on environmental issues of national and international concern. CCME is comprised of the environment ministers from the federal, provincial and territorial governments. It provides science-based goals for the quality of aquatic and terrestrial ecosystems, especially water and soil quality guidelines.
Guidelines for Canadian Drinking Water (Health Canada)	The Guidelines for Canadian Drinking Water Quality are established by the Federal-Provincial-Territorial Committee on Drinking Water (CDW) and published by Health Canada.
Guidelines for Canadian Recreational Water Quality (Health Canada)	The main purpose is the protection of public health and safety and is aimed primarily at responsible authorities and decision-makers. It provides guidance on factors that can interfere with the safety of recreational waters from a human health perspective. It recommends the adoption of a preventive risk management strategy that focuses on the identification and control of water quality hazards prior to the point of contact with the recreational water user. It also recommends the use of a multi-barrier approach as the most effective means for protecting users from exposure to water quality hazards in recreational waters.
Programs	
Habitat Stewardship Program for Species at Risk	The goal of the HSP program is to contribute to the recovery of endangered, threatened, and other species at risk, and to prevent other species from becoming a conservation concern, by engaging Canadians from all walks of life in conservation actions to benefit wildlife.

B-2 Provincial

Legislation, Policy, Strategies and Guidelines	Description
Agricultural Operations Practices Act (AOPA)	Provides the framework for resolving conflicts between agricultural producers and urban/rural non-agricultural producers.
Alberta Land Stewardship Act (ALSA)	The legal basis for regional land-use planning in Alberta; it authorizes the provincial Cabinet to establish planning regions and adopt a statutory plan for each region.
Environmental Protection and	Supports and promotes the protection, enhancement and wise use of the environment and provides a framework for

Legislation, Policy, Strategies and Guidelines	Description
Enhancement Act (EPEA)	evaluating and controlling the environmental impacts of development. It includes a broad regulatory framework consisting of detailed regulations and codes of practice. EPEA regulates activities that could adversely affect the environment, provides requirements for land conservation and reclamation of industrial activities and contaminated sites, and sets out the criteria and methods when an Environmental Impact Assessment is required. Some aspects of EPEA apply directly to water management and these include the regulation of the drilling of water wells and groundwater protection, the treatment and supply of water for human consumption, and the regulation and management of wastewater and storm water. The Act expressly dictates that "no person shall knowingly release or permit the release of a substance into the environment in an amount, concentration or level or at a rate of release that is in excess of that expressly prescribed by an approval, a code of practice or the regulations"
Water Act	To support and promote the conservation and management of water, including the wise allocation and use of water. This legislation is the primary regulatory mechanism for the management of water resources in the province. The Act sets out rules for the water management planning, environmental assessments, rights to divert and use, priority rights and security of use, transfer of water allocations, approvals for working in and around water, water management works and undertakings, dispute resolution, enforcement. The Act is supported by regulations and codes of practice.
Fisheries (Alberta) Act and General Fisheries (Alberta) Regulation	The *Alberta Fishery Regulations* (1998) was made pursuant to the Federal *Fisheries Act* by the federal government and regulates sport and commercial fisheries in Alberta. The *Fisheries Alberta Act* does not regulate catch limits, restrictions, or fisheries in Alberta, rather this act regulates licensing and regulation of fish buyers and processors, aquaculture operations, and the appointment of fisheries officers for the administration of the Federal *Fisheries Act.*
Forests Act and Timber Management Regulation	Provides the legal framework for the management of forests on public land, including rules for tenure, policies and regulations for acceptable logging methods, standards for wood utilization, and the management of non-timber values. The Timber Management Regulation and Timber Harvest Planning & Operating Ground Rules set forth standards and guidelines for timber harvest planning and specifically stipulate setbacks for timber harvest adjacent to any water body. See Table 2.3 for more detailed information about timber harvest riparian setback operating ground rules. (Fiera – Riparian Lands)
Forest and Prairie Protection Act	Establishes regulations in regard to fire control, prevention and education in the forested and prairie land in Alberta.
Municipal Government Act	Provides municipalities with the authority to regulate water on municipal lands, manage private land to control non-point source pollution, and regulates land use practices for the protection of aquatic environment. Includes the Subdivision & Development Regulation, Land Use Bylaw; Intermunicipal Development Plan, Municipal Development Plan, Area Structure Plan, Area Redevelopment Plan
Provincial Parks Act	Provides the regulatory tools and mechanisms to establish and maintain parks and recreational areas. It specifies the conditions for the establishment of parks, the rules for the acquisition of lands, land dispositions and prohibition of activities for the protection of natural and cultural resources.
Public Health Act	Prevention and suppression of disease. Groundwater and surface water are sources of drinking water and provide for recreational water uses. Maintaining these waters in an uncontaminated state, free from chemical or bacterial pollution, helps

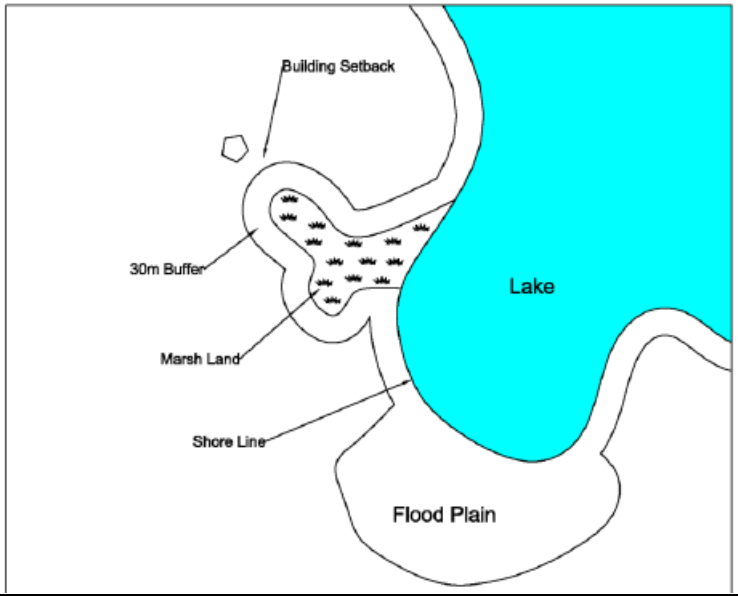
Legislation, Policy, Strategies and Guidelines	Description
	ensure the prevention or suppression of disease. Private drinking water wells and sanitary systems need to be privately managed to ensure health standards and regulations are being achieved.
Public Lands Act and Public Lands Administration Regulation	This Act provides for the disposition of all provincial public lands in the white zone of Alberta under the administration of the Minister. This Act and its regulations empower the Minister and his/her officers to regulate public lands, to determine their appropriate use, considering all aspects of their physical, economic and environmental constraints. In Alberta, the Province owns most of the beds and shores of all naturally occurring lakes, rivers and streams. Approvals may be required for activities that may impact the bed and shore of a waterbody.
Provincial Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act	Provides the regulatory tools and mechanisms to establish and maintain ecological reserves, natural areas and heritage rangelands. It specifies the conditions for their designation and establishment, and the rules for land dispositions and prohibition of activities for the protection of natural and cultural resources.
Wildlife Act and Wildlife Regulation	When a wildlife species has been designated as endangered or threatened under the *Wildlife Act* it becomes illegal to harvest, traffic, and disturb the nest or den of that species. For endangered and threatened species, a recovery plan will be produced, often involving advice from a recovery team.
Policy	
Alberta Wetland Policy	The Alberta Wetland Policy provides the strategic direction and tools required to: allow for continued growth and economic development in the province; make informed management decisions in the long-term interest of Albertans; and minimize the loss and degradation of wetlands. The goal is to conserve, restore, protect and manage Alberta's wetlands to sustain the benefits they provide to the environment, society and economy.
Industrial Release Limits Policy	Outlines the approach followed by Alberta Environment and Parks (AEP) staff to develop industrial release limits for approvals under the Environmental Protection and Enhancement Act.
Woodland Caribou Policy for Alberta	A provincial policy that guides implementation plans for caribou ranges to maintain and restore habitat and carefully manage wildlife that may impact Woodland Caribou populations.
Alberta's Biodiversity Policy (under development)	Sets the provincial direction for biodiversity management frameworks in Alberta. It states Alberta's commitment to the conservation of biodiversity and the sustainable use of biological resources for the continuing benefit of society. The policy will provide high-level guidance for other activities affecting biodiversity (e.g., species management, forest management and energy sector planning and development)
Water Conservation and Allocation Policy for Oilfield Injection (2006)	The goal of the policy and guideline is to reduce or eliminate allocation of non-saline (fresh) water for oilfield injection, while respecting the rights of current licence holders.
Strategies	
Water for Life: Renewal (2008)	Review and reaffirm the GOAs commitment to managing water quality and quantity wisely to benefit current and future generations. It reaffirms the three goals of *Water for Life*: safe, secure drinking water supply; healthy aquatic ecosystems; and reliable quality water supplies for a sustainable economy. The renewal also calls for integration of watershed planning with

Legislation, Policy, Strategies and Guidelines	Description
	regional planning under the Land Use Framework and sets clear direction for improved watershed management. This includes: increased focus on regional drinking water and wastewater solutions; accelerated action on achieving aquatic ecosystem goals; development and implementation of a viable governance system to support sustainable water management; and improved monitoring, evaluation and reporting.
Strategy for the Protection of the Aquatic Environment	A requirement of the *Water Act* and major component of the Framework for Water Management Planning. The strategy details the GOA's commitment to maintaining, restoring or enhancing the condition of the aquatic environment, and considers: • The amount of water available or water quantity; • The chemical, microbiological and physical characteristics of the water or water quality; • The physical and biological structure of the water body and the land surrounding it or habitat; and • The plants and animals living in or associated with water bodies, wetlands and riparian areas or aquatic species. The strategy represents an integrated approach to water management in Alberta and applies to all activities and decision-making that could affect the aquatic environment.
Alberta's Strategy for the Management of Species at Risk (2009-2014)	The strategy provides direction for Alberta government staff involved in species at risk management. It is useful to Alberta residents particularly those involved with recovery teams, advisory committees and project partnerships, by helping them understand species at risk program processes, priorities and activities. The goal of the strategy is to ensure that populations of all wild species are protected from severe decline and that viable populations are maintained, and where possible, restored.
Fish Conservation and Management Strategy for Alberta (2014)	Sets out ESRD's vision and mission statements, guiding principles, and goals and objectives for fisheries management. The strategy describes what ESRD will do to manage Alberta's fisheries resources for conservation and sustainable use. It commits ESRD to maintaining biodiversity with respect to fish populations, including species diversity, genetic diversity, and ecosystem diversity.
Alberta's Forest Strategy (under development)	Sets direction for the long-term sustainable management of Alberta's forests through an integrated planning approach incorporating wildfire management and forest health considerations along with the performance measures set out in the Alberta Forest Management Planning Standard.
Guidance Documents	
Alberta Surface Water Quality Guidelines (2014)	Water quality guidelines are science-based numeric concentrations or narrative statements that are recommended to protect various water uses (aquatic life, agriculture (livestock watering and irrigation), recreation and aesthetics.
Stepping Back from the Water	Assists municipalities, watershed groups, developers and landowners in Alberta's settled region determine appropriate water body setbacks for development around our lakes, rivers and wetlands.
Integrated Standards and Guidelines – Enhanced Approval Process (2013)	In collaboration with industry, ESRD consolidated more than 200 guidelines to allow for consistent application of standards across the province, and clarity of regulator expectation on industry. The EAP allows industry to self-attest to achieving stated long-term environmental outcomes and objectives, and the province the ability to provide timely review/approval of proposed developments. Enhancements to the *Public Lands Act* provide government with tools to take appropriate action if industry does not comply with the process.

Legislation, Policy, Strategies and Guidelines	Description
Water Quality Based Effluent Limits Procedures Manual	This manual describes procedures for setting water quality-based effluent limits for industrial and municipal discharges in Alberta.
Alberta Soil and Groundwater Remediation Guidelines (2014)	The intent is to maintain soil and groundwater to the highest quality, applying codes of practice, guidelines, policies, and programs to protect them. Assessment and monitoring tools for restoring the quality of soil and groundwater are also developed.
Frameworks	
Framework for Water Management Planning	This tool outlines the process for water management planning and the components required for water management plans in the province. It is intended to provide general guidance for the planning process. This framework was developed for water management planning under the Water Act rather than the watershed management planning outlined in Water for Life.
Alberta Timber Harvest Planning and Operating Ground Rules Framework for Renewal	Provide direction to forest companies and government for planning, implementing and monitoring timber harvesting operations on timber disposition areas in Alberta.
Alberta's Land-use Framework (LUF) (2008)	Sets out a new approach for managing Alberta's land and natural resources to achieve long-term economic, environmental and social goals. The LUF established land-use regions and called for regional plans.
Plans	
Plan for Parks	Provides a blueprint to guide decisions for managing parks. This long-term plan will help: ensure the sustainability of natural landscapes; enhance recreational opportunities; help to improve the quality of life for Albertans; and ensure the province's parks and recreation areas remain protected yet accessible to Alberta's growing population.
Programs	
Aquatic Invasive Species Program	Campaign to help protect provincial water bodies from aquatic invasive species (e.g., zebra and quagga mussels). The GOA has developed educational materials (e.g., Clean, Drain, Dry, Pull the Plug, and Don't Let It Loose). Print materials (e.g., quick facts, posters, and signage) are available. The program continues to identify the public's role in helping with solutions, working with stakeholder groups to coordinate control efforts, and enhancing legislation, regulations and risk assessment tools.
Environmental Flows Program	Provides policy recommendations, conducts environmental flow studies researches aquatic and riparian habitat, reviews water licence applications, works with other agencies and WPACs to set flow and water standards that support healthy fish and wildlife populations.
Other	
Licences, approvals, monitoring and reporting requirements; Compliance and enforcement	

B-3 Municipal

Plans, Policies and Strategies	Description
Statutory Plans (MGA Sections 631-638)	Provide general development policies for all or part of the municipality. Legislation provides for four statutory plans: Municipal Development Plans, Intermunicipal Development Plans, Areas Structure Plans and Area Redevelopment Plans.
Municipal Development Plans (MDPs)	Plan adopted by council that establishes policies for land use. Required by the MGA where population greater than 3500. Recommended for municipalities where population is less than 3500.
Intermunicipal Development Plans (IDPs)	Adopted by two or more municipalities for shared interest in land management (e.g., fringe area within urban/rural municipalities or where municipalities share natural features, such as lakes).
Area Structure Plans (ASPs)	Establish the general land use, transportation and servicing framework for specific areas undergoing substantial new development.
Area Redevelopment Plans	Outline proposals for addressing planning issues when rejuvenating existing developed areas.
Land Use Bylaws (MGA Sections 639-640)	Regulate the use and development of parcels of land. Development is defined as an excavation or stockpile, construction, renovation or repairs to a building, a change in the use of land or intensity in the use of land. All municipalities are required to adopt a land use bylaw. The land use bylaw divides the municipality into districts, prescribing permitted and/or discretionary uses for each district. The bylaw establishes development standards within each district and provides for a system for issuing development permits.
Subdivision Control (MGA Sections 652-670)	To create one or more lots from a parcel of land a subdivision approval from the municipal subdivision authority must be obtained. Conditions may be attached to a subdivision approval, such as: 1. Provide land as environmental reserve (MGA Section 664). 2. Provide up to 30% of the land, less any land taken for environmental reserve or environmental reserve easement, for roads and public utilities. 3. Provide up to 10% of the land for municipal and/or school reserves. 4. Enter agreement to construct or pay for the construction of roads, walkways, public utilities, or off-street parking necessary to serve the development. 5. Pay an off-site levy for the capital cost of water, sanitary sewer, or drainage facilities.
Excerpts from Municipal Statutory Plans and Land Use Bylaws related to water and land management.	
Municipality	
Big Lakes County	**MD of Big Lakes Land Use Bylaw No 16-2010** **7.18) ENVIRONMENTALLY SENSITIVE LANDS** (1) Development on Environmentally Sensitive Lands shall be limited to: (a) existing extensive agricultural operations, (b) passive recreational development, or (c) development that is consistent with the range of development options allowed within Municipal Reserve and Environmental Reserve properties as defined under the *Act*. (2) Property line setbacks for development as provided in Part 9 of this Bylaw are modified on lands that are on or in proximity

Plans, Policies and Strategies	Description
	to Environmentally Sensitive Lands. Subject to variance provisions included within Section 2.10 of the Municipal District of Big Lakes Municipal Development Plan, minimum setbacks for development other than as described in (1) above shall be the greater of: (a) 10 metres (32.8 ft.) where the property line is the bed and shore of a watercourse and the setback is to provide for existing or future public access or to reduce the flow of soils, nutrients, fertilizers and pesticides into a watercourse; (b) 30 metres (98.4 ft.) from the shoreline of a lake, marsh or slough; (c) All land within land that has been identified as a 1 in 100 year flood plain; (d) All land that features a slope in excess of 15% unless the stability of the slope is proven developable through a geotechnical analysis; (e) A distance 1.5 times the height of a slope unless a lesser distance is supported by a qualified professional engineering report to allow for a reduced setback; and (f) All land within an identified valley of a stream or watercourse from the bed and shore to a point a minimum of 2.0 metres (6.5 ft.) beyond the upper breaks of the said valley; and are added to the minimum setback provided for in the applicable Land Use District. **SHORELINE SETBACKS:** 

Plans, Policies and Strategies	Description
	(3) As part of a development permit review on a parcel that includes Environmentally Sensitive Land, the M.D. may require the landowner to enter into an Environmental Conservation Agreement or other similar agreement that will support the protection of environmentally sensitive lands without unduly impacting lands that are developable. (4) As part of a development permit application, the Development Officer may require a Geo-technical study, prepared by a qualified geo-technical engineer, addressing the proposed development. The geo-technical study will recommend development setbacks from property lines based upon land characteristics of the subject property. (5) As part of a development permit application, the Development Officer may require a professional biologist to prepare a biophysical report to address biophysical issues on the subject property and to recommend appropriate development setbacks from property lines. (6) In addition to the list of development permit conditions provided in Part 14, the Development Officer shall consider: a) the impact of the proposed development on the subject and surrounding lands, and b) professional recommendations including those of geotechnical engineers, biologists, Alberta Sustainable Resources and Alberta Environment. and may require measures as conditions of development approval which will mitigate the impact of the proposed development upon the biodiversity and/or stability of the parcel and adjoining lands. (7) Notwithstanding (1), redevelopment of environmentally sensitive lands may be considered by the Development Officer provided appropriate and reasonable measures are undertaken to minimize risk. This may include, but not be limited to: a) the creation of a building site a minimum of 0.5 metres (1.6 ft.) above the 1 in 100 year flood plain elevation, b) the inclusion of Federally and Provincially approved flood reduction building standards, and c) ensuring that access points to water wells and sewage holding tanks are above the flood plain elevation. (8) When considering approval of a development permit application on or in proximity to environmentally sensitive lands, the Development Officer may require the registration of a restrictive covenant against the certificate of title for the subject property related to the development. **7.19) HAZARDOUS LANDS** The following regulations apply to Hazardous Land identified in the MD of Big Lakes: (1) Notwithstanding any other provision of this Bylaw, Council may declare a moratorium on the subdivision and development of lands that have been identified as hazardous to the environment and human settlement. Where an appropriate land use district amendment has been completed, the buffer distances provided in (2)(a) through (2)(d) may be extended to ensure that existing waste-water lagoons, landfills and waste-transfer stations may expand. …
MD of Lesser Slave Lake	**MD of Lesser Slave River No. 124 – Land Use Bylaw # 2004-06 (Amended 2009)** **8.4 SITE CONDITIONS** 1. Development shall not be allowed on unstable slopes, land characterized by soil instability, or land exhibiting evidence of poor drainage or flooding unless it can be demonstrated to the satisfaction of the Development Authority that unique site requirements warrant otherwise. 2. Development Near Waterbodies and Watercourses (a) Where a parcel of land borders on or contains a coulee, ravine or valley, without a watercourse, the minimum required

Plans, Policies and Strategies	Description
	setback of a building from the coulee, ravine or valley shall be 7.5 m (25 ft) or three (3) times the depth of the coulee, ravine or valley, whichever is the greater distance, unless the Development Authority is satisfied through the submission of a detailed geotechnical engineering study from a registered professional engineer that a lesser setback is warranted. (b) A minimum setback of 30 m (100 ft) shall be provided for all buildings from the top of bank of any watercourse, from the top of the ravine or other topographical feature in which a watercourse is located, or from any water body unless the Development Authority is satisfied through the submission of a detailed geotechnical engineering study from a registered professional engineer that a lesser setback is warranted. This requirement shall not apply to fences, boat houses or swimming facilities, which may be allowed within this strip. (c) The Development Authority may increase any minimum yard or setback requirement, where any permitted or discretionary use or ancillary development may be detrimental to the preservation of shoreland, or adversely affected by reason of such use being in a floodplain, or in proximity to lands with unstable or steep slopes. 3. Lands Subject to Flooding or Subsidence (a) Notwithstanding that a proposed development is a permitted use, or conforms in all respects with this Bylaw, where the application is for development on lands that are or may be subject to flooding or subsidence, or in an area potentially subject to a 1:100 year flood, the Development Authority shall not approve a development permit unless the applicant can demonstrate that preventive engineering and construction measures can be instituted to make the site suitable for the proposed development or to protect the development from the potential flooding hazard. 4. The Development Authority may impose conditions on the approval of a development permit requiring the retention of trees, or additional planting of such a type and extent that is considered necessary. 5. The Development Authority may prescribe setback and/or buffering requirements for uses which may be incompatible with adjacent land uses. **MD of Lesser Slave River – Strategic Plan 2016** **Vision**…Plan our communities with consideration for environmental impact, design integrity… **Land Use and Economic Strategies** • Develop the criteria for a Municipal District approach to provincial land use and watershed planning (ALUS) • Develop a recreational access to rivers, lakes, beaches, and lands strategy (methodology)
Town of Slave Lake	**Town of Slave Lake Land Use Bylaw #22-2007, Updated March 26, 2015.** **Section 27 – Lands Subject to Flooding or Near Slopes** Section 27 (4) All new developments abutting Sawridge Creek must provide adequate setback from the Creek to prevent the possibility of causing instability, erosion, etc. of the creek banks, to the satisfaction of the Development Officer. Section 27 (5) Notwithstanding the District rules, no development may be allowed within 30 m (99 ft.) from the top or bottom of any steep slope, as surveyed by an Alberta Land Surveyor, where the grade exceeds 30% … **Section 36 STORM WATER MANAGEMENT** For all permitted use and discretionary use developments, the developer shall construct drainage works satisfactory to the

Plans, Policies and Strategies	Description
	Town and in accordance with the approved Storm Water Management Plans. Section 114 ENVIRONMENT DISTRICT E (1) General Purpose To establish an area of public open space for the protection and preservation of scenic and natural landscape features and areas and/or lands that are environmentally sensitive. Development in this district will be limited to passive and/or light recreational uses. (2) Discretionary Uses : Nature interpretation, Public open spaces, Trail systems, Walkways, Wildlife management In addition to the General Rules for Special Districts, the following rules shall apply: (3) All proposed uses for this district shall be reviewed by the Community Services Board and the board shall provide a recommendation on approval to the Municipal Planning Commission. (4) Refer to Part 7 of this Bylaw for the Special Provisions, which may affect development in this district.
Tri-Council Regional Growth Plan for Sawridge First Nation, M.D. of Lesser Slave River and Town of Slave Lake. (EIDOS 2015)	**3.2 Environmental Stewardship Goals, Objectives and Policies** **GOAL:** Protect natural systems, environmentally significant areas and other open spaces that help define the character of the region. OBJECTIVE ES ES1: Continue to protect, monitor and evaluate the environmental health of the region. ES-1.1: Pursue partnerships with neighbouring jurisdictions, regional organizations and other levels of government to create more effective regional resource and ecosystem management and conservation programs. ES-1.2: Promote baseline monitoring to establish benchmarks for the environmental health of the region's land, air, water and biodiversity resources. ES-1.3: Represent as intervener, the Tri -Council regional interests and concerns on regulatory hearings of the Natural Resources Conservation Board (NRCB) for regulated uses affecting the watershed of Lesser Slave Lake. ES-1.4: Encourage compact and clustered development that reduces the overall footprint of developed areas and retains a greater amount of land in its natural state. Incentives to encourage more compact development may include: a)Establish minimum density requirements tied to servicing availability; b)Establish incentives (reduced fees, expedited reviews, etc.) for implementing comprehensive subdivision design in rural areas; c) Establish incentives through reduced development levies for proposed development within established target growth areas (e.g. this could include reduced off-site levies for higher density, downtown development.) ES-1.5: Emphasize the importance of riparian and wetland areas and collaborate on their preservation as part of the development review process within the RGP area. Collaboration among jurisdictions and landowners should include the following: a) Follow best practices on retaining native vegetation; b) Providing adequate buffer zones based on the classification of the adjacent watercourse; Communication of best practices with landowners; and

Plans, Policies and Strategies	Description
	d) Facilitate the establishment of conservation easements with landowners. ES-1.5: Consider the use of minimum distance separations for residential development adjacent active agricultural lands to minimize the potential conflict between agricultural and non-agricultural uses. ES-1.6: Coordinate the shared use of environmentally significant area mapping and environmental data as part of development applications and the review process. Explore collaborative efforts to standardize the following: a) Environmental data collection; b) GIS and mapping software; and c) Planning and Development environmental requirements. **OBJECTIVE ES-2:** Protect the region from flooding and reduce development pressure within flood hazard areas. ES-2.1: Work with municipal and provincial levels of government to assemble relevant data to define flood hazard areas and avoid environmentally unsound development in flood hazard areas. ES-2.2: Ensure the submission of a flood hazard assessment and flood mitigation measures as part of development applications in defined flood prone areas. ES-2.3: Prohibit development in mapped flood hazard areas unless the project can demonstrate: a) Compliance with provincial policies with respect to development in mapped flood hazard areas. b) Flood mitigation measures designed by an Alberta registered professional engineer precede development ES-2.4: Promote land conservation of mapped flood hazard areas through available means including environmental reserves, conservation easements, and land trusts. **OBJECTIVE ES-3:** Maintain healthy water bodies focusing on water quality preservation within the Lesser Slave Lake watershed. ES-3.1: Collaborate with the Lesser Slave Watershed Council on the development of a watershed management plan to better protect shorelands and lake water quality of Lesser Slave Lake. ES-3.2: Collaborate with the Lesser Slave Watershed Council, to institute Beneficial Management Practices for development in the vicinity of sensitive Lesser Slave Lake shorelands, tributaries and wetlands that function to filter pollutants and nutrients from the lake.

APPENDIX C. Detailed Summary of the IWMP Process and Engagement

Engagement Activity	Purpose	Location and Date
Stakeholder Workshops - Vision and Identify Issues	Workshops were held to establish a vision for the watershed, and to identify local watershed concerns. Three areas of concern were identified: 1) aquatic ecosystem health, 2) water quality, and 3) water quantity (Abells and Henry 2012, 2013). Future engagement needs were identified: 1) find a meaningful and respectful way to engage First Nations, and 2) actively engage and find roles for young people, who are interested and understand the importance of a healthy watershed (Abells and Henry 2013).	2012, 2013
Stakeholder Workshop - Terms of Reference	The LSWC invited representatives of 12 stakeholder groups to a Terms of Reference workshop. Participants were asked to identify the value of healthy aquatic ecosystems, water quality, and water quantity from their perspectives (Aquality Environmental Consulting Ltd. 2013). These discussions formed the basis of the IWMP Terms of Reference (LSWC 2015).	High Prairie, Sep 19, 2013
Communication and Engagement Strategy	A communication and engagement strategy was prepared (CPP Environmental 2015). This strategy included a risk assessment for preliminary issues identified in the watershed, and a list of initial collaborating stakeholders.	2015
Circulate Terms of Reference	The LSWC mailed the Terms of Reference and other IWMP background information to stakeholders.	Fall 2015
Technical Advisory Committee	The LSWC established the Technical Advisory Committee (TAC), to provide technical and professional advice in support of the IWMP. An inaugural virtual meeting was held.	Fall 2015
Stakeholder Engagement – Re-affirm Issues, Roles and Responsibilities	Two workshops were held to 1) Seek stakeholder advice and input on solutions to problems and issues, and identify who should implement them, and 2) Seek stakeholder input on how their agency or organization is already addressing issues in the watershed. An online response form was also used to collect feedback (Alan Dolan & Associates 2015).	High Prairie and Slave Lake, Oct-Nov 2015
TAC	Second meeting of the TAC.	May 31, 2016
Municipal Working Group	A Municipal Working Group (MWG) was formed to directly engage with municipalities during the development and implementation of the IWMP.	Slave Lake, Jul 2016
TAC	Third Meeting of the TAC.	Sep 26, 2016
Stakeholder Engagement – Early Draft Plan	Two workshops were held to present and seek feedback on an early draft of the IWMP, including indicators, targets and thresholds, and recommendations. An online response form was also used to collect feedback (Alan Dolan & Associates 2017a).	High Prairie, Oct 18, 2016; Slave Lake, Oct 19, 2016
Municipal Working Group	A meeting was held to review recommendations and seek early input into the IWMP.	Kinuso, Oct 20, 2016
TAC	Fourth meeting of the TAC.	Jan 25, 2017
Municipal Working Group	A meeting was held to review IWMP Working Draft II.	Kinuso, Mar 9, 2017
TAC	Fifth meeting of the TAC.	Mar 24, 2017
Stakeholder Engagement – Draft Plan	Publish IWMP Working Draft III and seek feedback using an online response form (online Alan Dolan & Associates 2017b).	May 19 – Jun 27, 2017

Engagement Activity	Purpose	Location and Date
TAC	TAC submits written comments on IWMP working draft III	mid-Jul 2017
GOA staff (AEP, AAF)	GOA submits written comments on IWMP working draft III	late-Aug 2017
MD of Lesser Slave River	MD of Lesser Slave River submits written comments on IWMP working draft III	Jan 10, 2018
Cross Ministry Review Team	LSWC present final draft IWMP to the Cross Ministry Review Team	Mar 22, 2018
Big Lakes County	Meet with Big Lakes County to review and discuss the IWMP and implementation priorities	Sep 13, 2018

APPENDIX D: Instream Flow Needs Work Plan - status (LSWC 2009)

A River 2D model was completed for habitat as well as water quality modelling.

ASPECT	SCOPE	ACTION	PROJECT STATUS
HYDROLOGY			
Integrated hydrological model	Watershed	Contract completion 2008	Complete
MORPHOLOGY			
Ice monitoring	LS River	Completed by Fish and Wildlife 2007	Complete
GIS tool (assess existing accuracy)	LS Lake	Completed by SRD mapping unit, Peace River - 2008	Complete
Shoreland elevation	LS Lake	Lidar survey by SRD Sep 2008	Complete
Bathymetry Update	LS Lake	Proposed contract 2009 Update: Littoral zone completed on two sections of the SW shore (AMEC 2014); Current bathymetry from 1970.	Partial
WATER QUALITY			
Integration of WQ Model for IFN	LS River	Proposed completion by AENV 2009	Undetermined
BIOLOGY			
Riparian Assessment	LS River	Proposed Project 2009	Undetermined
Invertebrate Assessment	LS River	Proposed Project 2009	Undetermined
Mesohabitat Mapping	LS River	Completed by Fish and Wildlife 2007	Complete
Hydraulic Surveys Open-Water	LS River	Contract completed for Saulteaux-Driftwood segment 2008	Complete
		Contract proposed for additional river segments 2009/10	Undetermined
Hydraulic Surveys Ice-Covered	LS River	Contract completed for additional Saulteaux-Driftwood segment 2008	Complete
		Contract proposed for additional river segments 2009/10	Undetermined
Hydraulic modelling	LS River	Contract completed for Saulteaux-Driftwood segment 2008	Complete
Hydraulic Surveys Spawning	S Heart	Contract completed 2008	Complete
Hydraulic Modelling	S Heart	Contract completed 2008	Complete
Mesohabitat analysis	LS River	Fish and Wildlife 2009	Undetermined
Spawning habitat analysis	S Heart	Fish and Wildlife 2009	Undetermined
Habitat Workshop	Rivers		Undetermined
Fish Population Data	LS Lake	Fish and Wildlife 2007	Undetermined
Fish Population Analysis	LS Lake	Fish and Wildlife 2008	Undetermined
Habitat Workshop	LS Lake		Undetermined
CONNECTIVITY			
Cut-off Channel Assessment		Fish and Wildlife – 2009/10	Undetermined
IFN INTEGRATION			
IFN Determination Report		2010/11	Incomplete

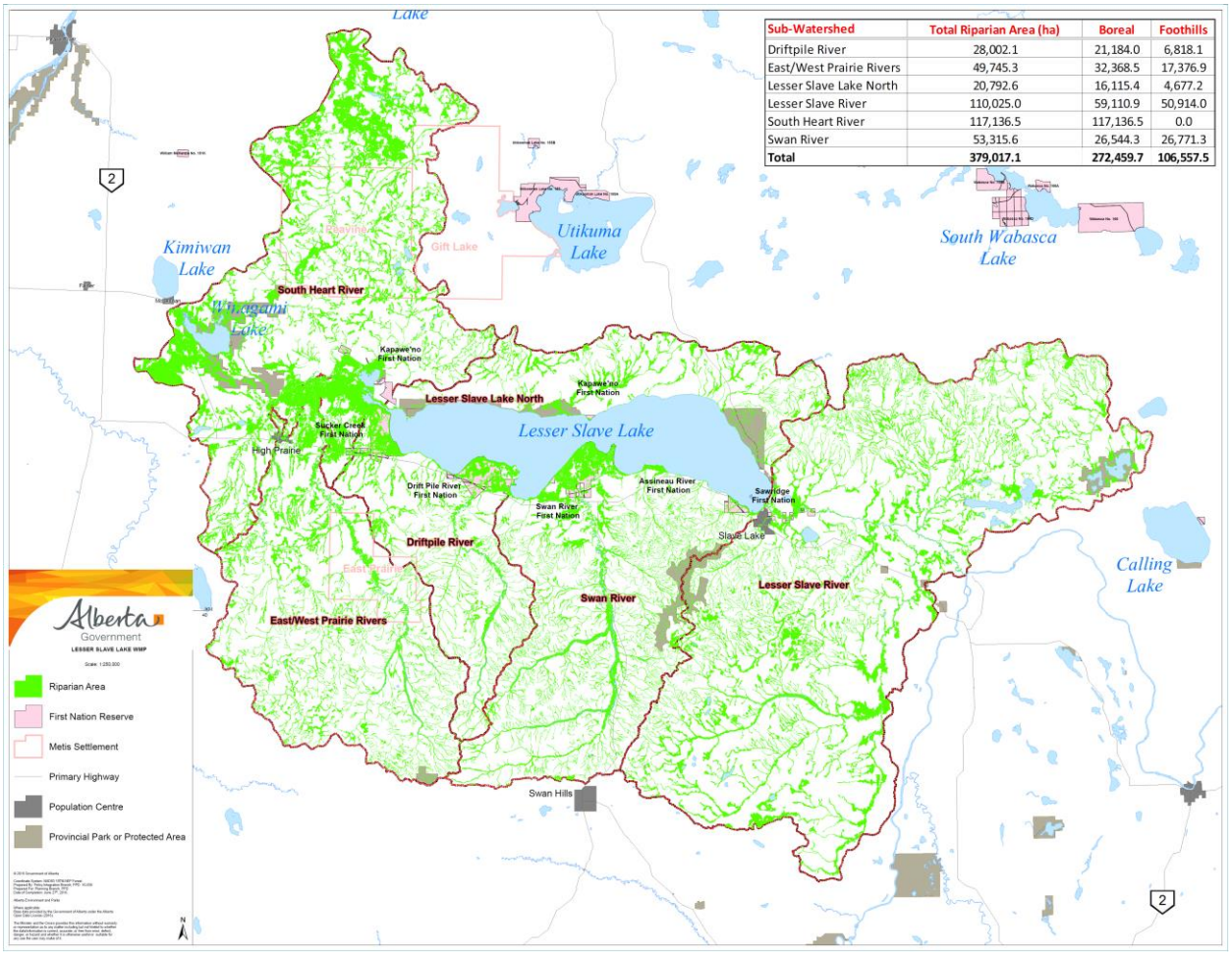
APPENDIX E. Streamflow and water quality monitoring stations in the Lesser Slave watershed

WATER BODY	AGENCY	STATION ID	LOCATIONS	DISCHARGE	WATER QUALITY	SEDIMENT	RECORD	OPERATION	LATITUDE	LONGITUDE
South Heart River	WSC	07BF004	At High Prairie	X		No	1921-30	Seasonal	55°32'05" N	116°28'58" W
	AEP	AB07BF0015	Upstream of confluence with WPR		X		2007-08 2010		55.5088	116.5263
	WSC	07BF905	Near Big Prairie Settlement (~ 3 km upstream of Buffalo Bay)	X		Yes	2005-17	Continuous (Real-Time)	55°34'47" N	116°17'44" W
	AEP	AB07BF0030			X		1991-92 2007-08 2010 2012-13		55.59167	116.2089
West Prairie River	WSC	07BF002	Near High Prairie	X		Yes	1921-31 1959-17	Seasonal	55°26'53" N	116°29'33" W
	AEP	AB07BF0165			X		2007-08 2010 2012-13		55.44844	116.49332
East Prairie River	WSC	07BF001	Near Enilda At Hwy 2 Bridge			Yes	1921-31 1959-17	Seasonal	55°25'03" N	116°20'24" W
	AEP	AB07BF0285			X		2007-10 2012-13		55.41827	116.3392
Driftpile River	WSC	07BH003	Near Driftpile	X		Yes	1972-86 2013-17	Seasonal	55°20'47" N	115°47'47" W
	AEP	AB07BH0010	At Hwy 2 Near Driftpile		X		1990 1998 1991-92		55.345	115.7961
	AEP	AB07BH0020	Near confluence with LSL		X		2007-08 2010 2012-13		55.36716	115.6937
Swan River	WSC	07BJ003	Near Swan Hills at Hwy 33		X	No	1970-17	Seasonal	54°48'09" N	115°28'12" W
	AEP	AB07BJ0190			X		1997		53.65736	114.652
	AEP	AB07BJ0215	At House Mtn Road Bridge		X		2007-10		54.99204	115.3003
	WSC	07BJ001	At Hwy 2 Near Kinuso	X		Yes	1915-17 1961-17	Seasonal to 1970 Annual since 1970	55°18'55" N	115°25'01" W
	AEP	AB07BJ0010			X		1990-93		55.31583	115.4153
	AEP	AB07BJ0020	Near confluence with LSL		X		2007-10 2012-13		55.38344	115.3323

Annual operation means data collected from January to December. Seasonal operation means a truncated monitoring season, generally March or April to October.

APPENDIX F. Riparian Areas

Riparian areas, including flowing (lotic) areas and non-flowing (lentic) areas (wetlands) are important components of the Lesser Slave watershed. Functioning riparian areas reduce streambank and shoreline erosion, reduce sediment transport, maintain water quality, store water to minimize the impacts of drought and to mitigate floods, and provide forage and shelter for wildlife and domestic livestock. All these functions are important to maintain a healthy Lesser Slave watershed and to preserve and/or increase biodiversity in the region.



Sub-Watershed	Total Riparian Area (ha)	Boreal	Foothills
Driftpile River	28,002.1	21,184.0	6,818.1
East/West Prairie Rivers	49,745.3	32,368.5	17,376.9
Lesser Slave Lake North	20,792.6	16,115.4	4,677.2
Lesser Slave River	110,025.0	59,110.9	50,914.0
South Heart River	117,136.5	117,136.5	0.0
Swan River	53,315.6	26,544.3	26,771.3
Total	**379,017.1**	**272,459.7**	**106,557.5**

Figure F.1. Riparian areas in the Lesser Slave watershed.

F.1. Riparian Health Assessment

Aerial videography was used to assess riparian health in select reaches of the South Heart and West Prairie rivers in 2006. A variety of indicators was used including some of those listed in Table F.1. At the South Heart River (90 km assessed), 62% of the riparian area was in good condition, 13% of the riparian area was in fair condition, and 25% was in poor condition (Johns and Hallett 2009). The healthiest scores were reported for the area within Winagami Lake Provincial Park while the lowest scores were reported for the reach east of Winagami Wildand Park and the channelized reaches of the river. Low scores were

attributed to bank erosion, encroachment of cropland into riparian areas, unrestricted cattle access, and intensive agricultural practices next to stream banks (Osokin and Hallett 2007). At the West Prairie River (16 km assessed), 43% of the area was in good condition, 30% was in fair condition, and 27% was in poor condition. Low scores were reported for portions of the river within the Town of High Prairie. Similar to the South Heart River, low scores at West Prairie River were attributed to channelization and agricultural practices.

The human footprint data (ABMI 2015) was applied to the riparian area map to determine current riparian condition. It was estimated that 22% of riparian areas have been impacted by human activity in some way (e.g., encroached on, altered) (Figure F.2.)

Table F.1. Riparian health inventory and assessment indicators and their significance

Riparian Health Indicators	Significance
Vegetative Cover of Floodplain and Streambanks	Native plants provide deep binding root masses to maintain streambanks, slow the flow of overland runoff to facilitate water quality improvements, and provide summer and winter forage for wildlife and livestock.
Preferred Tree and Shrub Establishment and Regeneration	The root systems of woody species stabilize streambanks, while their spreading canopies provide protection to soil, water, wildlife and livestock.
Standing Decadent and Dead Woody Material	The amount of decadent and dead woody material may indicate a change in water flow due to human or natural causes; dewatering of a reach can change vegetation from riparian to upland species; flooding of a reach or a persistent high water table can kill or eliminate some species, or leadto chronic overuse of browse, physical damage such as rubbing and trampling and climatic impacts.
Utilisation of Preferred Trees and Shrubs	The root systems of woody species provide streambank stability. Removal of this material reduces stability, causes loss of preferred woody species and leads to invasion of disturbance and weed species.
Occurrence of Invasive Plant Species	Invasive plants do not provide deep-binding root mass for bank protection, and provide minimal structural and habitat diversity when present in high densities. Weeds impact wildlife/livestock by replacing vegetation used for shelter/food.
Disturbance-Increaser Undesirable Herbaceous Species	Disturbance plants generally do not have deep binding root masses to protect streambanks and they provide minimal structural and habitat diversity when present in high densities. These plants are not as palatable to wildlife and livestock.
Streambank Root Mass Protection	Root masses provided by native vegetation act similar to Rebar holding streambanks together, preventing erosion and limiting lateral cutting.
Human-Caused Bare Ground	Bare ground is void of plants, plant litter, woody material or large rocks and is more susceptible to erosion processes. Human-caused bare ground may be caused by livestock, recreationists and vehicle traffic. It provides an opportunity for disturbance or weed species.
Streambanks Structurally Altered by Human Activity	Structural alterations of the streambanks (e.g., mechanically broken down by livestock activity or vehicle traffic) increase the potential for erosion while inhibiting the establishment of riparian vegetation.
Human Physical Alteration to the Rest of the Polygon	Stable streambanks maintain channel configuration and bank shape. Altered streambanks may increase erosion and mobilize channel and bank materials. Water quality can deteriorate and instability can increase downstream.
Stream Channel Incisement (Vertical Stability)	Incisement can increase stream energy by reducing sinuosity, water retention and storage and increase erosion.

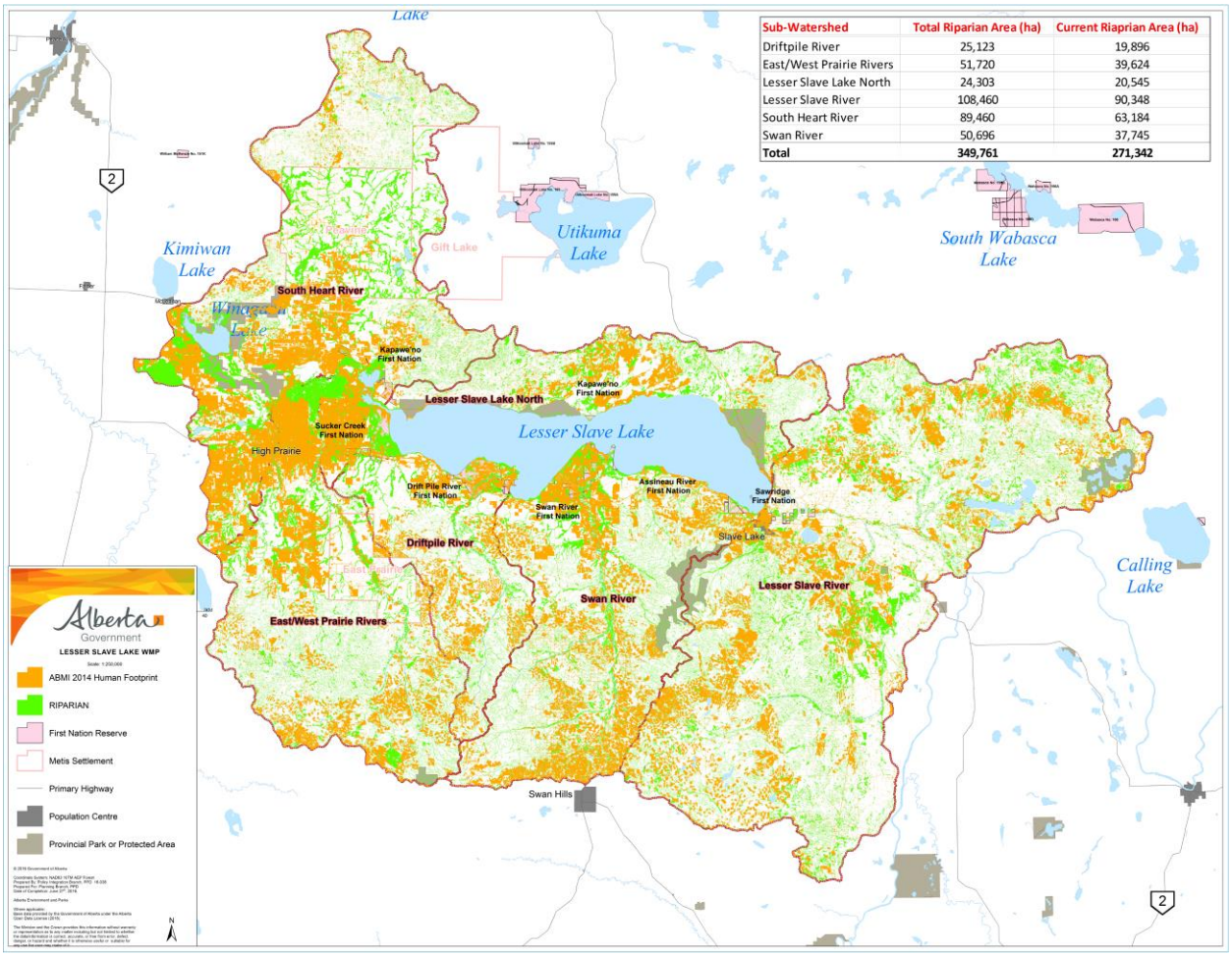


Figure F.2. Riparian areas negatively impacted by human activity (ABMI 2015; AEP 2017).

F.2 Riparian Protection and Management

Riparian setbacks are applied to land use activities by government, industry and landowners to minimize environmental impacts, risks to infrastructure, pollution prevention, and to maintain public safety. Setbacks from water are regulated by industry to prevent contamination of water from industrial practices, maintain stable streambanks to minimize erosion, and to support biodiversity. Industries have developed setback practices unique to their industry, and are bound by provincial acts and rules (e.g., AOPA, operating ground rules) to abide by these setbacks. The MGA stipulates a minimum setback of 6 m for development from water, however numerous municipalities have recognized that this is not sufficient to mitigate impacts of flooding to infrastructure, or for pollution prevention. The following highlights riparian setback guidelines for development (G-1), and regulatory requirements for agriculture (AOPA) (G-2), forestry (G-3) and oil and gas activity (G-4).

F.2.1 Development Setbacks

Stepping Back from the Water, GOA 2012

Table F.2. Summary of riparian setback guidelines (GOA 2012).

Waterbody	Substrate	Width	Modifiers	Notes
Permanent Water Bodies Lakes, Rivers, Streams, Seeps, Springs Class III - VII Wetlands	Glacial till	20 m	If the average slope of the strip is more than 5%, increase the width of the strip by 1.5 m for every 1% of slope over 5%	Slopes >25% are not credited toward the filter strip.
	Coarse textured sands and gravels, alluvial sediments	50 m	None	Conserve native riparian vegetation and natural flood regimes
Ephemeral and Intermittent Streams, Gullies	Not specified	6 m strip of native vegetation or perennial grasses adjacent to the stream channel crest	If the average slope of the strip is more than 5%, increase the width of the strip by 1.5 m for every 1% of slope over 5%	Maintain continuous native vegetation cover along channels and slopes
Class I & II Wetlands	Not specified	10 m strip of willow and perennial grasses adjacent to water body	None	Maintain and conserve native wetland or marshland plants on legal bed and

Riparian Setback Matrix Model (Aquality 2012)

The Riparian Setback Matrix Model (RSMM) can be used to establish site-specific, defensible Environmental Reserve setbacks, and to determine development setbacks and land uses for private lands located adjacent to environmentally sensitive areas and/or significant lands within a municipality (Aquality 2012). Input measures include slope of land, height of bank, groundwater table level, groundwater risk, soil type and texture, and vegetation/ground cover. Application of the RSMM generally results in a development setback of 10 m to 60 m in width (possibly greater, depending on local site conditions).

Example Setback Calculation 1. A completely forested site, with zero slope, low groundwater risk and peat soils, results in a 10 m setback.

Example Setback Calculation 2. A site with 100% impermeable surface area, 15% slope, high groundwater risk, and silt soils results in a setback of 60 m.
Sites having slope >15% are reviewed separately by a geotechnical engineer. Additional development restrictions may apply in the 1:100 year flood-prone zone (mapped at the provincial level) if the setback width does not encompass this width. The RSMM requires a Professional Biologist or QWAES to apply the model to individual sites, working with a land surveyor and others as required.

F.3. Setbacks Associated with Agricultural Activity (GOA 2008). Refer to the relevant legislation (i.e., *AOPA*, *EPEA*) for additional and the most recent requirements.

Table F.3. Excerpt of setback requirements for agriculture industry.

Activity	Setback Requirement
Manure Storage Facilities and Manure Collection Areas	**Common Body of Water**[a] Manure storage facilities[b] or manure collection areas[c] must be constructed at least 30 m (98 ft) away from a common body of water. This does not apply if the owner or operator demonstrates to the NRCB, prior to construction, that either: • The natural drainage from the facility or area is away from the common body of water, or • A berm or other secondary protection for the common body of water constructed by the owner or operator protects the common body of water from contamination. **Flooded Areas** A manure storage facility or manure collection area must not be in an area that floods. • The 1:25 year maximum flood level at a manure storage facility or manure collection area must not be less than one metre below any part of the facility where run-on can come into contact with the stored manure. • If the 1:25 year maximum flood level cannot be determined, the manure storage facility or manure collection area must be not less than one metre below any part of the facility where run-on from the highest known flood level can come into contact with the stored manure. **Natural Water and Wells** Manure storage facilities and manure collection areas must be constructed at least 100 m (328 ft) away from a spring or water well. This does not apply if the owner or operator: • Demonstrates to the NRCB, prior to construction, that an aquifer from which the spring rises, or into which the water well is drilled, is not likely to be contaminated by the facility, and • Implements a groundwater monitoring program if required by NRCB.
Groundwater Resource Protection	• All manure storage facilities and manure collection areas must have either a protective layer or liner that lays below the bottom of the facility and above the uppermost groundwater resource of the site and also meets regulatory requirements. • Solid Manure Storage Facility or Collection Area – The liner must be at least 0.5 m (1.6 ft) in depth with a hydraulic conductivity of not more than 5×10^{-7} cm/s.
Surface Water Control Systems	Surface water control systems are required to minimize run-on flowing through and runoff leaving a manure storage facility or manure collection area. These systems must not significantly alter regular water flow, must not affect or alter a non-flowing water body and must not be located on a fish-bearing water body. The NRCB will determine if the system has to be designed and certified by a professional engineer.
Runoff Control Catch Basin	Runoff control catch basins must have the following: • A storage capacity to accommodate a 1:30 year one-day rainfall, • A visible marker that clearly indicates the minimum volume possible to accommodate the 1:30 year one-day rainfall event, • A freeboard of not less than 0.5 m (1.6 ft) when the basin is filled to capacity.
Short-Term Solid Manure Storage	Short-term solid manure storage sites can only be used for an accumulated total of 7 months within a 3-year period regardless of the amount of manure stored. Feedlot pens are not considered short-term manure storage sites and must meet the requirements for a manure storage facility. Short-term solid manure storage sites must be located at least: • 150 m (492 ft) from a residence or occupied building that the producer does not own • 100 m (328 ft) from a spring or water well • 1 m (3.3 ft) above the water table

Activity	Setback Requirement
	• 1 metre above the 1-in-25 year maximum flood level or 1 m (3.3 ft) above the highest known flood level if the 1-in-25 year flood level is not known. If the land slopes towards a common body of water, the following setback distances must be observed: **Mean slope** — **Setback** 4% or less - 30 m (98 ft) Greater than 4% to less than 6% - 60 m (197 ft) 6% or greater, but less than 12% - 90 m (295 ft) If the mean slope is 12% or greater, do not apply or store manure on the land.
Seasonal Feeding and Bedding (Wintering) Sites and Livestock Corrals	Seasonal feeding and bedding sites (wintering sites) and livestock corrals do not require a permit but must be sited and managed to protect surface waterbodies. A seasonal feeding and bedding site or livestock corral must be located at least 30 m (98 ft) away from a common body of water. If this cannot be achieved, the operator must either design the site to divert runoff away from the common body of water or move the manure to an appropriate location away from the common body of water prior to a runoff event.
Manure Incorporation	Manure must be incorporated within 48 hrs when applied to cultivated land except when applied to forages or direct-seeded crops, frozen or snow-covered land or unless an operation has a permit that specifies additional requirements.
Setbacks for Manure Application	Setback distances are required to reduce nuisance impacts on neighbours and to minimize the risk of manure leaving the land on which it is applied and entering a common body of water. Manure must be applied at least: • 150 m (492 ft) away from a residence or other occupied building if the manure is not incorporated • 30 m (98 ft) away from a water well • 10 m (33 ft) away from a common body of water if subsurface injection is used • 30 m (98 ft) away from a common body of water if manure is surface-applied and incorporated within 48 hrs of application, except when applied on forage, direct-seeded crops, frozen or snow-covered land. *The setbacks outlined in “short-term solid manure storage” for lands that slope to a common body of water also apply.
Inorganic Fertilizer Application	**Prohibited releases** *EPEA* prohibits operators from releasing into the environment a substance in an amount, concentration or level or at a rate of release that causes or may cause a significant adverse effect on the environment. An "adverse effect" is broadly defined to mean the "impairment of, or damage to, the environment, human health or safety or property." For example, if a farm operator spreads manure on land at a rate that will overload the nutrient levels in the soil, or releases manure on land where the manure will run into a water body, the operator is in violation of EPEA. **Best management practices** • Apply fertilizer rinsate to a cropped area at a distance greater than 10 m (33 ft) from any surface water source and greater than 60 m (197 ft) from any well. (http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex9398) • Storage facilities should be located more than 100 m (328 ft) from water wells and more than 20 m (66 ft) from surface water bodies. • Ensure that loading takes place at least 30 m (98 ft) away from a well or surface water (AARD 2004).
Pesticide Use, Application, Storage or	The use, application, storage or washing of equipment within 30 horizontal metres of an ‘open body of water’[d] are regulated activities in Alberta. Pesticides include herbicides, insecticides, fungicides, rodenticides, and algaecides. Pesticide treatments must be in accordance with the

Activity	Setback Requirement
Washing of Equipment	*Environmental Code of Practice for Pesticides* as regulated by ESRD. Regulations concerning pesticide use near an open body of water apply only to undisturbed vegetation along rivers, streams and lakes. Persons applying a pesticide on cultivated land (cropland, improved pasture, managed turf and landscaped areas) must follow pesticide label directions including any buffers specified for open bodies of water. A sufficient buffer of natural vegetation should be left (similar to the buffers identified in *the Environmental Code of Practice for Pesticides*) between cultivated land and open bodies of water. Generally, - Application must not result in the deposit of pesticides into or onto any open body of water except in accordance with subsection 16(12). - Applications must not be made within 250 m (820 ft) upstream of any surface water intake of a waterworks system. - Aerial applications of pesticides to land must not be conducted while flying directly over an open body of water. - Herbicides must not be deposited on areas that have slumped, been washed out or are subject to soil erosion into the water body. Setback distances for pesticide application within 30 horizontal metres (98 ft) of an open body of water is generally determined by the type of pesticide being used, the application rate, type of weed listed under the *Weeds Control Act*, method of application and percentage of the infected area that receives application in a given year. Setbacks are variable but generally range from the edge of the bed and shore to 5 m (16 ft)) (*Environmental Code of Practice for Pesticides* 2010). Applicators may apply the herbicides aminopyralid (when used up to a maximum application rate of 0.12 kg/ha), chlorsulfuron, clopyralid, glyphosate, metsulfuron-methyl (when used up to a maximum application rate of 0.09 kg/ha) and triclopyr (when used up to a maximum application rate of 1.92 kg/ha) no closer than 1 horizontal metre (3.3 ft) from an open body of water (unless otherwise specified on the manufacturer's product label) provided that no more than 10% of any 100 m^2 (1,076 ft^2) in the zone 1 m to 5 m (3.3 to 16.0 ft) from an open body of water receives treatment in any calendar year.

[a]**Common body of water** includes the bed and shore of a water body that is shared by (common to) more than one landowner.

[b]**Manure storage facility** is a facility for composting or storing manure, composting material or compost (does not include facilities at an equestrian stable, auction market, racetrack or exhibition ground).

[c]**Manure collection area** refers to the floor or under-floor pits of a barn, the floor of a feedlot pen and a catch basin where manure collects (not including the floor of a livestock corral).

[d]**Open body of water i**ncludes lakes, streams, rivers, irrigation canals and other natural water bodies. An "open body of water" does not include ponds or dugouts that have no outlet, are completely surrounded by private land, and are less than 4 hectares (10 acres) in area on private land or are less than 0.4 hectares on Public Land. Roadside ditches and small (less than 0.5 m (1.6 ft) wide), dry intermittent streams are also not considered open bodies of water (GOA 2013).

F.4. Setbacks and Other Watershed Protection Measures Associated with Forestry Activity

Timber Harvest Planning and Operating Ground Rules (Feb 2015) pertaining to riparian management and overall watershed protection

Ground Rule 3.5.5 Any changes that could adversely affect buffers established for the protection of riparian areas, wildlife sites, historical resources, or aesthetic values or any changes not listed will be considered a Major Amendment.

Ground Rule 4.2.7 All trees/pieces used in the construction of crossing structures may be scattered or piled along the ROW or in the harvest area, but they shall not be piled in riparian areas if any chance of re-entering the watercourse.

Forest Harvest Plans

3.4.7 The company shall follow existing integrated landscape management (ILM) or access development strategies when developing DLO roads. Alberta may approve deviations from these strategies after discussions with the company.

3.4.8 Individual block maps or shape files shall be provided depicting all blocks, watercourses, crossings and buffers. The following information shall be mapped and/or described for each affected block by:

a) layout bordering and encompassing riparian management zones when different than the standards in section 6.0;
b) watercourse classification and protective buffer;
c) layout bordering restricted areas (e.g., PSPs, private land);
d) identification of understorey (see section 7.5);
e) harvest area-specific structure retention and woody debris management strategies;
f) tactics to address forest health issues;
g) protection of roadside vegetation - applicable or not, and how to be done;
h) strategies to address sight distance concerns with an attempt to maintain sight distance of 400 m or less from Class I, II or III roads;
i) important wildlife sites as defined in section 7.7.7 (this information shall be made available for resource planning purposes only through Fish and Wildlife);
j) historical site considerations;
k) soil protection measures when any of the following are present:
• identified unstable areas, water-source areas, springs or seepages;
• steep or sustained slopes or grades (>30%);

3.4.9 Detailed block plans (DBP) are required when there is higher than average potential for environmental damage. Circumstances that merit DBPs are:

a) areas of steep topography requiring specific road location and construction or specialized harvesting equipment;
b) unstable slopes are generally to be avoided but if this is not possible it is necessary to plan operations carefully to minimize impacts;
c) harvest areas with numerous water source areas, seepages, intermittent, or ephemeral watercourses;
d) harvest areas that contain or border sensitive wildlife or fisheries areas;
e) harvest areas requiring understorey protection using protection techniques (see section 7.5);
f) harvest areas located near high-value recreation areas, tourism areas, and facilities;
g) partial harvests, excluding commercial thinning (CT) and pre-commercial thinning (PCT);
h) when harvesting is used as a tool to control insects (excluding mountain pine beetle (MPB)) and disease infestations;

The detailed block plan (DBP) shall include a map of appropriate scale to the issue(s) and describe how the concern will be addressed in operations. DBPs are not submitted to Alberta but must be available upon request.

3.4.10 Where a temporary field authority (TFA) is required to open access for the layout of harvest areas, this access shall be incorporated into the road system of the FHP.

Watershed Protection

PURPOSE
To manage the implications of timber operations on water quality, quantity, and flow regime by:

- minimizing the potential for sedimentation in watercourses;
- preventing soil, logging debris and deleterious substances from entering watercourses;
- maintaining aquatic and terrestrial habitat;
- complying with the *Water Act*.

6.0.2 Where an approved FMP does not provide an estimate of water yield, the following applies:

- watersheds shall not be unduly affected by large harvest areas or harvesting large amounts of timber in a watershed unless otherwise approved in the FMP;
- predicted average annual water yield increases should not exceed 15 percent within third-order streams;
- companies will report the increase in water yield annually in a mutually agreeable format.

6.0.3 Measures must be implemented, including temporary and permanent erosion control measures, to minimize erosion and sedimentation into the watercourse or waterbody.
6.0.4 Riparian protection areas shall be established as in Table 2, Standards and Guidelines for Operating Beside Watercourses. Where uncertainty exists on the classification of the watercourse, the watercourse protection area shall be that required by the higher class of watercourse.
6.0.5 All unmapped or incorrectly classified watercourses encountered during operations shall be given the appropriate protection as described in Table 2.
6.0.6 Unless otherwise approved in an FMP, variances from the standards in Table 2 must demonstrate that aquatic and terrestrial objectives are met. Any such proposals shall undergo a full review by Alberta prior to being considered for approval.
6.0.7 Sediment, logging debris or deleterious materials (e.g., fuels, oils, greases, industrial or household chemicals or refuse) shall not be deposited into the water or onto the ice of any watercourse or water body during road construction, maintenance, harvesting, reclamation or silviculture operations.
6.0.8 Equipment shall cross watercourses only at approved crossings.
6.0.9 Logs shall not be decked in watercourses, riparian areas, or seepage areas.
6.0.10 Authorized in-stream activities in fish-bearing watercourses shall be scheduled to avoid disturbing migration, spawning and incubation of fish species, and carried out in such a manner as to avoid stream sedimentation.
6.0.11 Beaver ponds shall have a minimum buffer of 20 m or a buffer for the same classification as the watercourse flowing out of the pond, whichever is larger, as measured at a representative width within 50 m of the dam.
6.0.12 Harvesting is not permitted within water source areas during non-frozen periods.

Table F.4. Forestry Standards and Guidelines for Operating Beside Watercourses

Watercourse Classification	Roads, Landings, Decking and Bared Areas	Watercourse Protection Areas	Operating Conditions Within Riparian Areas and Water Source Areas Where Operations are Approved	
			Tree Felling	Equipment Operation
Class "A" Waterbodies	Not permitted within 100 m of high water mark. Any existing roads may be maintained at present classification standards. Any proposed watercourse crossings within 2 km upstream must be specifically approved in the AOP	No disturbance or removal of timber within 100 m of the high water mark; No duff disturbance of intermittent (min 10 m vegetated buffer) or ephemeral drainages (minimum 5 m vegetated buffer) within 2 km upstream of Class A waterbody.	Not permitted without specific Alberta approval	Not allowed without specific Alberta approval.
Class "B" Waterbodies	Not permitted within 60 m of high water mark. Any existing roads may be maintained at present classification standards. Any watercourse crossings within 500 m upstream must be specifically approved in the AOP	No disturbance or removal of timber within the appropriate riparian area specified by stream type unless specifically approved in the AOP; No duff disturbance of intermittent (minimum 10m vegetated buffer) or ephemeral drainages (minimum 5m vegetated buffer) within 500 m upstream of Class B waterbody.	Trees shall be felled so that they do not enter watercourse. Should slash or debris enter the watercourse immediate removal is required without a machine entering the watercourse.	Where removal of timber within 60 m is approved, no machinery is permitted within 30 m of the high water mark.

F.5. Setbacks Associated with Oil and Gas Activity (DACC 2015)

Table F.5. Watercourses

Type	Watercourse Width	Channel Characteristics	Setback Requirements[1]
Large Permanent[2]	> 5 m	Defined channel	100 m
Small Permanent[2]	0.7 – 5 m	Defined channel	45 m
Intermittent/Spring[2]	< 0.7 m	Defined channel	45 m
Ephemeral	-	No defined channel	15 m

Table F.6. Waterbodies

Type	Basin Characteristics	Setback Requirements[3]
Lakes	Open water (> 2 m depth)	100 m
Permanent Shallow Open Water Ponds (S&K V[4])	Open water (> 2 m depth) Deep marsh margin	100 m
Semi-permanent Ponds/wetlands (S&K IV[4])	Emergent deep marsh throughout	100 m
Non-permanent Seasonal Wetlands (S&K III[4])	Shallow marsh	45 m
Non-permanent Temporary Wetlands (S&K II[4])	Wet meadow	15 m setback requirement for well sites and pipelines
Fens	No defined channel; Slow flowing	No specific setback; attempt to leave undisturbed
Bogs	Peatland; Acidic wetland	No specific setback

[1]The setback for watercourses is measured from top of break (valley), or where undefined, from the top of the bank.
[2]May or may not contain continuous flow
[3]The setback from the defined bank of the waterbody or the outer margin of the last zone of vegetation that is not defined/bounded by upland vegetation communities.
[4]Steward, R.E., and H.A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. Resource Publication 92, Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C. Northern Prairie Wildlife Research Centre Online, found at Norther Prairie Wildlife Research Centre.

Standard 100.9.6.2: Wellsites, pipeline installations, plant sites and camps shall maintain a minimum 100 m buffer to the edge of valley breaks. In the absence of well-defined watercourse valley breaks a 100 m buffer from the permanent watercourse bank applies.

APPENDIX G: Wetlands

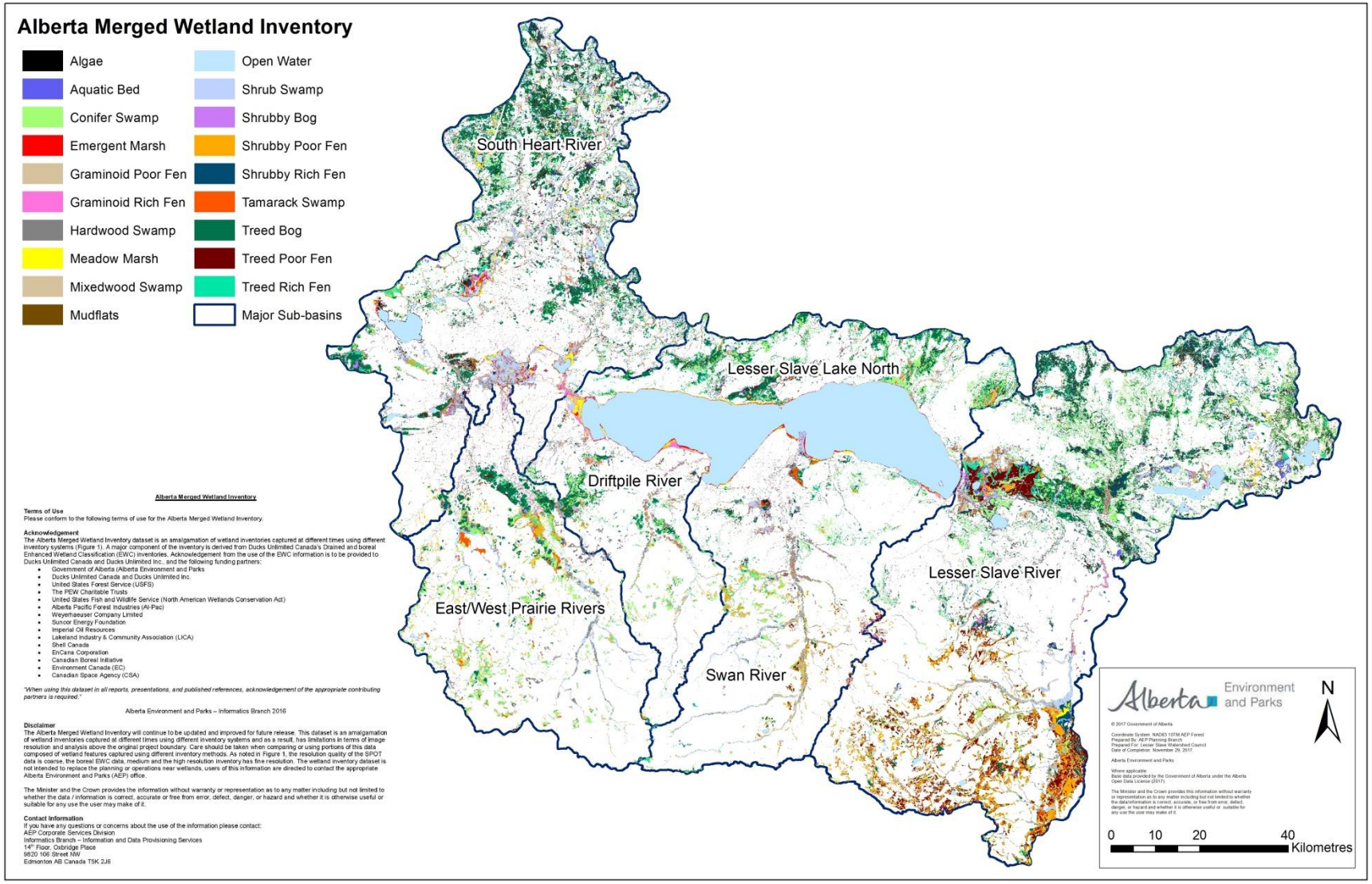


Figure G.1. Merged Wetland Inventory map (enhanced classification) (AEP 2017). A larger, higher resolution map is at www.lswc.ca.

Table G-1. Summary of wetland area (ha) in the Lesser Slave watershed by sub-watershed (Alberta Merged Wetland Inventory (AEP 2017).

Type	Driftpile River	East/West Prairie River	Lesser Slave Lake North	Lesser Slave River	South Heart River	Swan River	Total
Total Wetland Area	42,386	49,430	99,270	197,898	132,264	69,023	590,271
Emergent Marsh	896	640	486	1,181	3,181	894	7,278
Meadow Marsh	1,177	1,068	765	940	3,672	656	8,278
Shrubby Bog	718	1,586	872	2,909	3,314	1,296	10,695
Treed Bog	4,678	7,887	13,869	36,678	41,203	3,121	107,436
Graminoid Poor Fen	808	4,331	447	110	454	943	7,093
Graminoid Rich Fen	991	275	586	1,707	2,509	551	6,619
Shrubby Poor Fen	1,320	5,756	1,017	25,691	4,663	4,262	42,709
Shrubby Rich Fen	698	585	1,415	12,252	5,475	1,356	21,781
Treed Poor Fen	689	819	1,916	31,506	9,232	1,960	46,122
Treed Rich Fen	1,567	3,494	3,493	11,349	8,323	2,655	30,881
Conifer Swamp	4,258	8,180	11,208	34,989	11,344	4,306	74,285
Shrub Swamp	2,410	5,655	1,084	9,568	15,950	3,896	38,563
Tamarack Swamp	635	2,072	569	2,489	2,301	1,099	9,165
Hardwood Swamp	1,690	3,582	203	5,114	3,078	2,305	15,972
Mixedwood Swamp	644	169	658	7,710	1,874	2,988	14,043
Algae	-	37	-	130	958	7	1,132
Aquatic Bed	237	214	391	1,922	1,644	339	4,747
Mudflats	57	257	-	70	127	371	882
Open Water	18,913	2,823	60,292	11,581	12,962	36,018	142,589

Table G.2. Wetland habitat definitions (Ducks Unlimited Canada 2014).

Wetland Type	General Characteristics	Minor Classes
Marsh	Wetland Group: Mineral Nutrient Regime: Rich to Hyper Water Table: Inundated above the surface Hydrodynamic Regime: Moving to very dynamic Moisture Regime: Hydric to Very Hydric Hydrologic/Nutrient Input: Precipitation, Groundwater, Surface Flow	**Emergent Marsh** – Vegetation composed of >25% emergent species, 25% graminoid/forb **Meadow Marsh** – Vegetation composed of > species
Bog	Wetland Group: Peatland Nutrient Regime: Very Poor to Poor Water Table: At or slightly below surface Hydrologic Regime: Moderate to Imperfect Moisture Regime: Subhygric to Hygric Hydrologic/Nutrient Input: Precipitation	**Treed Bog** – Trees >25% cover **Shrubby Bog** – >25% Shrub cover, <25% Tree cover **Open Bog** – >25% cover Bryophytes/Herbaceous/Forb, <25% Shrub cover, <25% Tree cover
Fen	Wetland Group: Peatland Nutrient Regime: Poor to Rich Water Table: At or above the surface Hydrodynamic Regime: Stagnant to moving Moisture Regime: Hygric to Hydric Hydrologic/Nutrient Input: Precipitation, Groundwater, Surface flow	**Rich Fen** – Peatland wetlands with trees in lowland forms (*Picea mariana* or *Larix laricina*) <10 m, canopy covers <60%, shrub layer containing shrub birch (*Betula pumila*, *Betula glandulosa*), minerotrophic indicators present, hygric to hydric moisture regime (moisture code 7-9), hydrologic inputs primarily surface and groundwater, medium to rich nutrient regimes **Graminoid Rich Fen** – >25% Bryophytes/Herbaceous/Forb cover, <25% Shrub cover, <25% Tree cover **Shrubby Rich Fen** – >25% Shrub cover, <25% Tree cover **Treed Rich Fen** – Trees >25% cover **Poor Fen** – Peatland wetlands with some mineral-rich water inputs, mesic to hygric moisture regimes (moisture code 6-8), more species-rich vegetation assemblages than bogs, trees, if present, contain both *Picea mariana* (lowland form) and *Larix laricina* at <60% cover and <10 m in height, shrub layer contains a mixture of ericaceous shrubs, dwarf willows, and shrub birch (*Betula pumila*, *Betula glandulosa*) typically at heights of <2 m, graminoid layer typically has a large component of litter **Graminoid Poor Fen** – >25% Bryophytes/Herbaceous/Forb cover, <25% Shrub cover, <25% tree cover **Shrubby Poor Fen** – >25% Shrub cover, <25% Tree Cover **Treed Poor Fen** – Trees >25% cover

Wetland Type	General Characteristics	Minor Classes
Swamp	Wetland Group: Peatland, Mineral (Conifer, Tamarack), Mineral (Hardwood, Mixedwood, Shrub)	**Conifer Swamp** – Peatland wetlands with predominantly fibric or woody-based peat accumulation; *Picea mariana* dominant tree layer with heights >10 m, canopy closure >60%; hummocky terrain with pools of water may exist, rooting zone in contact mineralrich water; ground cover a mixture of feather mosses and some *Sphagnum* **Tamarack Swamp** – Peatlands with *Larix laricina* trees >10 m tall, canopies >60% cover, hummocky terrain with pools of water, and swamp indicator species **Mixedwood Swamp** – Wetlands with hardwood (*Betula papyrifera*) and/or conifer (*Larix larcina*, *Picea mariana*) present with no dominance of either (<80% single tree type in canopy), trees ≥10 m and canopy closure >60%, moisture regimes 7-9, nutrient regimes rich to very rich **Hardwood Swamp** – Hardwood dominated (primarily *Betula papyrifera* in upland transitional environments or *Populus balsamifera* in floodplain environments) wetlands with trees >10 m and canopy closures >60%, moisture regimes 7-9, nutrient regimes rich to very rich **Shrub (Thicket) Swamp** - Wetlands with trees <25% cover, shrubs >25% cover, shrub vegetation primarily tall form (*Salix* spp., *Alnus rugosa*, *Cornus stolonifera*) >2 m, with species-rich herbaceous/forb understory
	Nutrient Regime: Poor to Very Rich	
	Water Table: Above, at, or below the surface	
	Hydrodynamic Regime: Stagnant to Moving	
	Moisture Regime: Hygric to Hydric	
	Hydrologic/Nutrient Input: Precipitation, Groundwater, Surface Flow	
Shallow/ Open Water	Wetland Group: Mineral	**Aquatic Bed** – Floating or submerged vegetation >25% cover **Mudflats** – Exposed mud, sand, gravel, or rock substrate >25% cover Shallow/Open Water – No vegetation present, permanent to semi-permanent water table
	Nutrient Regime: Poor to Hyper	
	Water Table: Inundated	
	Hydrodynamic Regime: Moving to Very Dynamic	
	Moisture Regime: Very Hydric	
	Hydrologic/Nutrient Input: Precipitation, Groundwater, Surface Flow	

APPENDIX H: Wetlands and the Biodiversity Value Calculation Matrix

Habitat loss and fragmentation pose a high risk to several species in the watershed. There is a need to identify which ecosystems have the highest biodiversity potential and make the necessary effort to conserve or restore those systems. A total of 188 birds, 46 mammals, five amphibians, and one reptile are identified as potentially inhabiting the Alberta Boreal Region, as either permanent residents, migrants, or over-wintering species. Wetlands provide valuable habitat for many of these boreal species. To determine the value of wetlands to biodiversity in the Lesser Slave watershed, listed or threatened species were used as a 'Key Category' in the Biodiversity Value Calculation Matrix. The biodiversity value was based on three indices derived from the biodiversity matrices, which included species richness, species overlap, and rare species potential.

Although the results varied for individual species groupings, patterns were evident for habitats which consistently had a high or low biodiversity value. Habitats of high value (score 9 to 12), and in order of relative importance, included Open Water, Emergent Marsh, Rivers, Conifer/Tamarack Swamp, Mixedwood Swamp, and Meadow Marsh. Moderate-high values (score 4 to 7) were also common for Mixedwood Upland, Aquatic Bed, Treed Fen, Treed Bog, Graminoid Fen, Shrub Fen, and Hardwood Swamp. Habitats that had consistently low biodiversity values (score 0-3) included Burn, Cutblock, Mudflat, Open Bog, Shrub Bog, Shrub Swamp. Deciduous Upland habitat classes generally resulted in moderate-to-low biodiversity values.

Lesser Slave Watershed Council

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