# Wetland Management and Monitoring Needs

## A Review of Alberta's Legislation, Regulations, and Policies Related to Wetland Management

Prepared for:
**Alberta Environmental Monitoring, Evaluation, and Reporting Agency**

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June 30th, 2016

## Executive Summary

Alberta's wetlands are complex and diverse in form, function, and distribution. Analogously, a host of federal and provincial legislation, policies, frameworks, and management actions aim to manage wetlands and govern actions on the landscape, which will be collectively referred to as the Wetland Management Framework. The government coordinates management of wetlands and shares the task among industries, non-governmental organizations, and Albertans through at least 11 international, federal, and provincial legislations, policies, and plans. As this requires partnerships and collaborations, it is important to develop a wetland monitoring program that supports Alberta's needs.

One of the goals in developing the Wetland Monitoring Program for the Oil Sands Region is to understand how such a program can complement, support, and be harmonized with the Wetland Management Framework. This report presents a non-exhaustive list of legislations at the international, federal, and provincial scales that address wetlands, along with the relevant governing bodies. It aims to describe the requirements for wetland monitoring and reporting in Alberta, and the processes by which those requirements are met.

In Table 1, we summarize reviewed the manadates, monitoring needs, and the explicit wetland metrics or indicators being monitored of each component of the Wetland Management Framework. This review of the Wetland Management Framework highlights key ways in which the Wetland Monitoring Program could support Alberta's wetland management and monitoring needs:

- Monitor natural wetlands of varying classes, forms, types, and hydroperiods. The classification of wetlands should be aligned with the Alberta Wetland Classification System.
- Provide baseline information on wetland condition and the natural variability of wetlands in the region.
- Track wetland change over time and understand the drivers of that change, which may include direct or indirect anthropogenic activities and/or environmental changes.
- Monitor policy-relevant variables that serve multiple legislations, policies, and frameworks.
- Establish partnerships among technical, regulatory, and stakeholder experts.
- Be adaptive and responsive to management needs.
- Make data publically available, where feasible, to allow equal access by all wetland experts and stakeholders. Data should be collected using standardized protocols.
- Alberta Wetland Policy
  - Monitor the location, extent, and classification of wetlands in the Green Area.
  - Conduct baseline monitoring to establish relative wetland values in the Oil Sands Region.
  - Contribute to the development of a wetland inventory and wetland value assessment system.
  - Monitor wetland function variables connected to water storage, water cooling, sediment retention and stabilization, phosphorous retention, nitrate removal and retention, organic nutrient export, fish habitat, invertebrate habitat, amphibian habitat, waterfowl habitat, mammal habitat, and human use.
- Land-use Framework's Regional Plans and Environmental Management Frameworks
  - Track the spatial relationship between land use activities and change in the condition of wetlands.

    - Monitor wetland-related indicators and variables selected by the draft Biodiversity Management Framework, e.g., Fen cover, Aquatic and wetland native cover, and Aquatic and wetland biodiversity intactness.
    - Where possible, align monitoring indicators and variables with Surface Water Quality and Groundwater Quality Management Frameworks.
- Environmental Impact Assessments and *Environmental Protection and Enhancement Act*'s Approval Conditions for oil sand mine operators
    - Use a monitoring approach, e.g., based on tiered-effects, that tracks and confirms change in wetland condition and investigates the extent, magnitude, and cause of the change.
    - Monitor the natural variability of wetlands and establish a baseline of wetland condition.
    - Monitor and assess the potential effects of aerial deposition from oil sand mines on wetlands.
    - Monitor and assess the potential effects of hydrologic alteration from oil sand mines on wetlands.

The Wetland Monitoring Program aims to link field measurements with remote sensing data to provide a multi-scale assessment of wetland conditions. Overall, it seeks to support and inform management decisions in the Oil Sands Region. Reviewing the extensive breadth of international, federal, and provincial legislations, policies, and framework has revealed the fundamental needs and interconnectedness of management frameworks in the Oil Sands Region and throughout Alberta. In developing the Wetland Monitoring Program, the needs of the Wetland Policy, *EPEA*, and Land-use Framework, as well as other federal and provincial policies, such as the Convention on Biodiversity Treaty, *Migratory Birds Convention Act*, *Species at Risk Act*, and wetland reclamation requirements, should be considered. A monitoring program that tracks policy-relevant variables, responds and adapts to change, and enhances collaboration and partnership will help fulfil the mandates of the Wetland Management Framework and inform management decisions.

**Table 1.** Summary table of wetland-related legislations, policies, and frameworks and their respective wetland management mandates, monitoring needs, and target variables and indicators.

| | Legislation, Policy, or Framework | Management Mandate for Wetlands | Wetland Monitoring Needs | Target Variables and Indicators |
|---|---|---|---|---|
| International | **Ramsar Convention on Wetlands of International Importance (1971)** | Conservation and wise use of wetlands and wetlands resources. | Monitor status of wetlands. | None explicitly mentioned. |
| | **Convention on Biological Diversity (1993)** | Conserve wetland biological diversity. | Identify activities that impact wetland biological diversity. | None explicitly mentioned. |
| Federal | **Federal Policy on Wetland Conservation (1991)** | No net loss of wetland function. | Establish wetland baseline and track change in area and function. | None explicitly mentioned. |
| | **Migratory Birds Treaty and the *Migratory Birds Convention Act* (1994)** | Protect migratory birds and their eggs and nests. | Track migratory bird population distribution and density and wetland habitat availability. | • Wetland habitat location and extent;<br>• Vegetation composition;<br>• Migratory bird population distribution and density. |
| | ***Species at Risk Act (2002)*** | Prevent wetland wildlife species from becoming extirpated, endangered, or threatened. | Monitor wetland species at risk. | Wetland species at risk, such as Yellow Rail (*Coturnicops noveboracensis).* |
| | ***Canadian Environmental Assessment Act (2012)*** | Protect the environment from significant adverse environmental effects caused by projects on federal land. | Monitor potential for environmental effects on wetlands through environmental assessments. | None explicitly mentioned. |
| Provincial Legislation | ***Environmental Protection and Enhancement Act* (1993)** | • Protect wetlands from impactful activities without an approval;<br>• Conduct environmental impacts assessments and reclamation activities. | None explicitly mentioned. | None explicitly mentioned. |
| | ***Municipal Government Act* (2000)** | Manage wetlands within a municipality and designate environmental reserves. | None explicitly mentioned. | None explicitly mentioned. |
| | ***Public Lands Act* (2000)** | Prevent disturbance of permanent and naturally occurring bodies of water. | None explicitly mentioned. | None explicitly mentioned. |
| | ***Wildlife Act* (2000)** | Support wetland wildlife management and protect species of concern. | Monitor endangered and/or threatened species population and habitat availability. | Wetland species of concern, such as Woodland Caribou (*Rangifer tarandus caribou*). |
| | ***Alberta Water Act* (2002)** | Conserve and manage of all forms of water from activities. Direct provincial water management planning frameworks and Alberta Wetland Policy. | None explicitly mentioned. | None explicitly mentioned. |
| | ***Alberta Land Stewardship Act* (2009)** | Establish the Land-use Framework. | None explicitly mentioned. | None explicitly mentioned. |
| | ***Responsible Energy Development Act* (2013** | Establish the Alberta Energy Regulator. | None explicitly mentioned. | None explicitly mentioned. |

**Table 1**. (Continued).

| | Legislation, Policy, or Framework | Management Mandate for Wetlands | Wetland Monitoring Needs | Variables and Indicators to Monitor |
|---|---|---|---|---|
| Provincial Policies, Frameworks, and Strategies | **Water Management Planning (1999)** | Establish a framework for water management planning and a strategy for protecting aquatic environments. | None explicitly mentioned. | None explicitly mentioned. |
| | **Water for Life Strategy (2003)** | Provide a strategy for healthy aquatic ecosystems and highlight the need for the Alberta Wetland Policy. | • Complete a wetland inventory;<br>• Develop and model indicators of wetland health. | • Wetland location, extent, and classification;<br>• Wetland condition and function. |
| | **Climate Change Strategy (2008)** | Vision for responsibility and action in climate change planning. | None explicitly mentioned. | None explicitly mentioned. |
| | **Land-use Framework (2008)** | Manage growth, minimize cumulative effects, and sustain environmental goals for biodiversity, air quality, surface water quality and quantity, and groundwater quality. | Monitor indicators to assess whether threshold is passed and management response is triggered. | • Wetland location, extent, and classification;<br>• Surface water chemistry and quality indicators;<br>• Groundwater quantity;<br>• Fen cover;<br>• Aquatic and wetland native cover;<br>• Aquatic and wetland biodiversity intactness. |
| | **Alberta Wetland Policy (2013)** | Maintain the ecological, social, and economic benefits of wetlands. | • Collect baseline data to characterize the natural variability of wetlands;<br>• Detect change in wetlands over time and identify the cause of change;<br>• Track the long-term trajectory of reclaimed wetlands;<br>• Assign relative wetland value through the ABWRET-A;<br>• Policy efficacy;<br>• Wetland inventory. | • Wetland location, extent and classification;<br>• Wetland function (water storage, water cooling, sediment retention and stabilization, phosphorous retention, nitrate removal and retention, organic nutrient export, fish habitat, invertebrate habitat, amphibian habitat, waterfowl habitat, mammal habitat, and human use). |
| | **Integrated Resource Management System (2015)** | Integrate and align environmental policies and adaptive management frameworks among governing bodies. | Provide open and transparent water, air, and biodiversity environment monitoring data. | None explicitly mentioned. |
| | **Tailing Management Framework for the Mineable Athabasca Oil Sands (2015)** | Provide direction to manage fluid tailings and decrease risk to environments like wetlands. | None explicitly mentioned. | None explicitly mentioned. |

**Table 1**. (Continued).

| | Legislation, Policy, or Framework | Management Mandate for Wetlands | Wetland Monitoring Needs | Variables and Indicators to Monitor |
|---|---|---|---|---|
| Provincial Requirements – Sector-specific | **Alberta Timber Harvest Planning and Operating Ground Rules Framework for Renewal** | Minimize potential for sedimentation to wetlands, maintain wetland habitat, and comply with the *Water Act.* | Monitor impacts to water quality, quantity, and flow, and soil quality. | • Wetland location, extent and classification;<br>• Surface water quality;<br>• Aquatic habitat. |
| | **Criteria and Indicators Framework for Oil Sands Mine Reclamation Certification** | Establish a process of reclaiming wetlands after oil sands mining. | • Collect baseline data to characterize the natural variability of wetlands;<br>• Track the long-term trajectory of reclaimed wetlands. | • Fen water quality;<br>• Wetland hydroperiod;<br>• Marsh open-water zone plant index of biotic integrity;<br>• Marsh wet meadow plant index of biotic integrity. |
| | **Environmental Impact Assessments – Oil Sands Mine Projects** | Identify the potential impacts of oil sands projects on wetlands. | • Collect baseline data to characterize the natural variability of wetlands. | • Wetland location, extent and classification;<br>• Vegetation community;<br>• Wildlife, bird, and fish habitats. |
| | ***EPEA* Approval Conditions – Oil Sands Mine Operators** | Establish the *EPEA* approval conditions for oil sands mine operators to protect the environment. | • Regional wetland monitoring program;<br>• Collect baseline data to characterize the natural variability of wetlands;<br>• Monitor hydrologic alteration impacts to wetlands including flow, connectivity, and depressurization of surface water and groundwater;<br>• Monitor aerial deposition impacts to wetlands from oil sands operations. | • Wetland location, extent and classification;<br>• Climate;<br>• Landscape attributes;<br>• Environmental indicators (Surface water quality, water quantity, stable isotopes, air quality);<br>• Biological indicators (Vegetation community diversity, amphibians, yellow rails, waterfowl, species of concern, and biodiversity). |
| | **Guidelines for Wetland Establishment on Reclaimed Oil Sands Leases** | Integrate approaches to the planning, design, construction, monitoring, adaptive management, and certification of wetlands reclaimed on surface-mined oil sands leases. | • Collect baseline data to characterize the natural variability of wetlands;<br>• Track the long-term trajectory of reclaimed wetlands. | • Watershed topography;<br>• Wetland boundaries ;<br>• Water elevation;<br>• Water quality;<br>• Groundwater saturation;<br>• Soil quality and peat thickness;<br>• Vegetation coverage and composition;<br>• Wildlife and habitat;<br>• Benthic invertebrate species. |

**Table 1**. (Conclusion).

| | Legislation, Policy, or Framework | Management Mandate for Wetlands | Wetland Monitoring Needs | Variables and Indicators to Monitor |
|---|---|---|---|---|
| Draft Provincial Requirements | **Draft Alberta's Biodiversity Policy** | Alignment of the biodiversity management frameworks to support the Land-use Framework and other provincial policies. | Monitor cumulative effects to wetland biodiversity. | None explicitly mentioned. |
| | **Draft Directive for the Assessment of Thermally-mobilized Constituents in Groundwater for Thermal Institute Operation** | Manage thermal impacts to groundwater quality, which may connect to wetlands and wetland complexes. | Monitor non-saline aquifers within aquifer management units at higher risk of discharging to wetlands or wetland complexes. | • Wetland extent;<br>• Wetland water quality and quantity;<br>• Hydrologic connectivity to non-saline aquifers. |
| | **Draft Water Conservation Policy for Upstream Oil and Gas Operations** | Reduce non-saline water and encourage the use of alternatives to non-saline sources. | Monitor the state of wetland quality and quantity in relation to saturation and hydrologic connectivity. | • Wetland water quality and quantity;<br>• Hydrologic connectivity. |

## Table of Contents

## 1. Introduction

Alberta's wetlands are complex and diverse in form, function, and distribution. Analogously, a host of legislations, policies, frameworks, and management actions aim to manage wetlands and govern actions on the landscape, which will be collectively referred to as the Wetland Management Framework. The government coordinates management of wetlands and shares the task among industries, non-governmental organizations, and Albertans through at least 11 international, federal, and provincial legislations, policies, and plans. As this requires partnerships and collaborations, it is important to develop a wetland monitoring program that supports Alberta's needs.

One of the goals in developing the Wetland Monitoring Program for the Oil Sands Region is to understand how such a program can complement, support, and be harmonized with existing water and wetland legislation, policies, and environmental management and monitoring frameworks. This report presents a non-exhaustive list of legislations at the international, federal, and provincial scales that address wetlands, along with the relevant governing bodies. It aims to describe the requirements for wetland monitoring and reporting in Alberta, and the processes by which those requirements are met.

More specifically, this report reviews legislation, policy, and commitments relevant to wetland management and monitoring in Alberta's Oil Sands Region (i.e., the Wetland Management Framework), regardless of whether the reference to wetlands is explicit or implicit. Wetland management and monitoring needs are addressed, for example, explicitly in the Alberta Wetland Policy, *Environmental Protection and Enhancement Act* approval conditions for the oils sands mining operators, and the Criteria and Indicators Framework for Oil Sands Mine Reclamation Certification. These documents directly specify the monitoring purpose and framework, and/or the indicators to be monitored. More commonly, however, reference to wetland monitoring is implicit and loosely described, e.g., as in the *Canadian Environmental Assessment Act* or Alberta's Water for Life Strategy. These implicit references often describe broad wetland components such as ecosystem health, biodiversity, contaminants, hydrology, or aquatic systems and resources.

In conjunction with a review the Wetland Management Framework, we conducted needs assessment interviews with 50 wetland experts and stakeholders, representing government (federal and provincial), industry (mining and forestry), academia, environmental consulting, environmental monitoring, and non-governmental organizations[1]. One of the six questions in each interview focused on wetland monitoring and management needs. Specifically, we asked each wetland expert and/or stakeholder, "What are the wetland management and monitoring needs of your sector?" As a follow up question, we also asked, "What are the legislations, policies, frameworks, and regulatory requirements should a wetland monitoring program support?" The interviews provided strong support for a review of Alberta's Wetland Management Framework. We summarize both a review of the Wetland Management Framework and the wetland interviews in Table 2.

With the goal to review and outline the Wetland Management Framework and identify how the Wetland Monitoring Program can fulfill Alberta's wetland management and monitoring needs, this report aims to achieve the following:

[1] For a detailed description of the needs assessment interviews as part of the Developing a Wetland Monitoring Program for the Oil Sands Region, see Supporting Document 1: Identifying the Scope and Objectives of the Wetland Monitoring Program – A Three-phased Stakeholder Engagement Process.

- Provide context to the scope, goals, objectives, and/or governance for each environmental legislation, policy, framework, etc. as it relates to wetlands;
- Identify how each reviewed environmental legislation, policy, framework, etc. relates to wetland protection, management, and reclamation or mitigation efforts;
- Identify the wetland management and monitoring needs of each reviewed environmental legislation, policy, framework, etc. as they relate to developing the Wetland Monitoring Program for the Oil Sands Region.

This report is organized to:

- Describe legislation, policies, and other commitments that call for data or information on wetlands in the Oil Sands Region;
- Summarize wetland management and monitoring needs through a review of the Wetland Management Framework and through interviews with wetland experts and stakeholders in the context of broad monitoring needs and questions that may be addressed through the Wetland Monitoring Program in the Oil Sands Region.

# 2. Wetland Management and Monitoring Needs

Most needs for wetland information in Alberta originate from federal and provincial statutes and policy, from sector specific actions, approvals, and restoration, and from mitigation, and reclamation efforts. This section describes federal, provincial and sector-specific requirements that directly relate to wetland management and monitoring and the key governing bodies and sectors with wetland management and/or monitoring responsibility.

## 2.1. Governing Bodies and Sectors in Alberta with Wetland Management and/or Monitoring Responsibility

In Alberta, several federal and provincial governing bodies administer legislation, policies, frameworks, and strategies to protect wetland ecosystems. Specific sectors and organizations manage wetlands at the site-specific level and comply with federal and provincial legislation. There are also organizations that provide monitoring and research tools to support wetland management decisions. This section reviews the following administrations, institutions, and organizations with wetland management and/or monitoring responsibilities in the Oil Sands Region:

- Environment and Climate Change Canada (Federal Government);
- Canadian Environmental Assessment Agency (Federal Government);
- Alberta Environment and Parks (Provincial Government);
- Alberta Energy Regulator;
- Alberta Environmental Monitoring, Evaluation, and Reporting Agency (as of July 2016, this changed to a new Monitoring Division within Alberta Environment and Parks);
- Canada's Oil Sands Innovation Alliance;
- Watershed Planning and Advisory Councils;
- Joint Oil Sands Monitoring;
- Cumulative Environmental Management Association.

### 2.1.1. Environment and Climate Change Canada

As part of the Government of Canada, Environment and Climate Change Canada's mandate is to:

- Preserve and enhance the quality of the natural environment, including water, air, soil, flora and fauna;
- Conserve Canada's renewable resources;
- Conserve and protect Canada's water resources;
- Forecast daily weather conditions and warnings, and provide detailed meteorological information to all of Canada;
- Enforce rules relating to boundary waters;
- Coordinate environmental policies and programs for the federal government (Environment and Climate Change Canada 2016).

The Environment and Climate Change Canada is an active partner with the Government of Alberta (GoA) to coordinate and implement environmental policies and regulations. Additionally, the Environment and Climate Change Canada is active in the Oil Sands Region as part of the Joint Oil Sands Monitoring (JOSM) Program.

### 2.1.2. Canadian Environmental Assessment Agency (CEAA)

As part of the Government of Canada, the Canadian Environmental Assessment Agency is the responsible authority for federal-level environmental assessment that contributes to informed decision making and helps to eliminate or reduce a project's potential environmental effects. The Canadian Environmental Assessment Agency manages the implementation of *Canadian Environmental Assessment Act* (*CEAA*) and provides uniformity and coordination of practices across Canada.

### 2.1.3. Alberta Environment and Parks (AEP)

The Alberta Environment and Parks (AEP), formerly the Environment and Sustainable Resource Development (ESRD), is a Ministry of the GoA and the principal air, land, water, and biodiversity management steward. The AEP aims to achieve environmental outcomes and sustainable development of natural resources. The AEP administers the Water for Life Strategy, Land-use Framework, the Wetland Policy, and Climate Change Strategy. For all activities outside of energy resources, the AEP administers approvals, licenses, and/or code of approvals for *Environmental Protection and Enhancement Act* (*EPEA)*, the *Water Act*, and the *Public Lands Act* approvals and/or licenses.

### 2.1.4. Alberta Energy Regulator (AER)

The Alberta Energy Regulator, formerly the Energy Resources Conservation Board (ERCB), is an arm's length provincial agency established in 2013 via the Responsible Energy Development Act. As the primary energy regulatory, AER aims to "ensure the safe, efficient, orderly, and environmentally responsible development of hydrocarbon resources over their entire life cycle" (AER 2015). To achieve this goal, the AER has authority over energy resource activities, and administers the regulatory functions of the *Water Act, EPEA,* and *Public Lands Act* that were previously held by the AEP.

### 2.1.5. Alberta Environmental Monitoring, Evaluation, and Reporting Agency (AEMERA)

Formed in 2014 from the Protecting Alberta's Environment Act, AEMERA is the arm's length provincial agency responsible for monitoring, evaluating, and reporting on air, water, land, and biodiversity (GoA 2014c). AEMERA's mandate is to provide open and transparent access to scientific data and information on Alberta's environmental condition and cumulative effects at the provincial and site-specific scale. The monitoring functions of AEMERA had previously been conducted by the GoA. After June 30, 2016, the AEMERA will be reincorporated to the GoA as part the Monitoring and Science Division of the AEP (Bill 18).

### 2.1.6. Canada's Oil Sands Innovation Alliance (COSIA)

Canada's Oil Sands Innovation Alliance (COSIA) is an alliance of 13 oil sands producers. COSIA is "focused on accelerating the pace of improvement in environmental performance in Canada's oil sands through collaborative action and innovation" by bringing together individuals from industry, government, academia and the public (COSIA 2012). The goal of the organization is to improve measurement, accountability, and environmental performance in the Oil Sands Region, with a focus on tailings, water, land, and greenhouse gases. COSIA has a Monitoring Working Group, which is open to non-COSIA companies that participate in funding the Joint Oil Sands Monitoring (JOSM) program with $50M a year. Currently 17 companies participate in the Monitoring Working Group, of which 10 participate in a Wetlands Monitoring Sub-Group.

### 2.1.7. Watershed Planning and Advisory Councils (WPAC)

The Water for Life strategy established the need for Watershed Planning and Advisory Councils (WPACs). The WPACs are multi-stakeholder, non-profit organizations that assess the conditions of their watershed and develop plans and activities to address watershed issues. At present, there are 11 watersheds with the WPACs. The Athabasca Watershed Council and the Beaver River Watershed Alliance are the two situated within the Oil Sands Region.

### 2.1.8. Joint Oil Sands Monitoring (JOSM)

In 2012, the Government of Canada and Alberta jointly committed to implement a scientifically rigorous, integrated, and transparent environmental monitoring of the Oil Sands Region through the Joint Canada/Alberta Implementation Plan for Oil Sands Monitoring (JOSM Implementation Plan). The JOSM Implementation Plan sets forth a structure for enhanced monitoring activities from 2012–2015. Monitoring focused on four components: Air; Biodiversity and Disturbance; Water; and Wildlife Contaminants. Monitoring activities for each component are designed to track the environmental effects and cumulative effects of oil sands development. Each monitoring component is led by a Component Advisory Committee (CAC) to ensure that multi-stakeholder perspectives are integrated into the planning process.

Through the JOSM Implementation Plan and the CACs, the JOSM aims to:

- Support sound decision-making by governments as well as stakeholders;
- Ensure transparency through accessible, comparable and quality-assured data;
- Enhance science-based monitoring for improved characterization of the state of the environment and collect information necessary to understanding cumulative effects;
- Improve analysis of existing monitoring data to develop a better understanding of historical baselines and changes;
- Reflect the trans-boundary nature of the issue and promote collaboration with the Governments of Saskatchewan and the Northwest Territories (Governments of Canada and Alberta 2012).

Under the JOSM umbrella, many organizations have been brought together to complete diverse projects. These partnerships include, but are not limited to: Environment and Climate Change Canada, AEMERA, AEP, the Alberta Biodiversity Monitoring Institute (ABMI), Lakeland Industry & Community Association (LICA), Wood Buffalo Environmental Association (WBEA), Peace River Area Monitoring Program (PRAMP), Boreal Avian Modelling (BAM) project, Regional Aquatic Monitoring Program (RAMP), Ecological Monitoring Committee for the Lower Athabasca (EMCLA), Ducks Unlimited Canada (DUC), University of Alberta and other universities, COSIA, and First Nations and Métis communities.

### 2.1.9. Cumulative Environmental Management Association (CEMA)

The Cumulative Environmental Management Association (CEMA) was “an independent collaborative organization established [in 2004] to develop management recommendations on how best to reduce potential long-term environmental impacts due to industrial development in north-eastern Alberta” (CEMA 2014a). The CEMA ceased operations on April 1, 2016, and it was comprised more than 55 members and organizations. The CEMA's role in the Oil Sands Region was to produce recommendations and management frameworks to address the cumulative impacts of oil sands development. These recommendations and frameworks were provided to

the provincial and federal government regulators to implement, if approved. The CEMA focused on issues in four broad categories: land, water, air, and reclamation.

## 2.2. International

Canada has ratified numerous international conventions, treaties, and engagements that directly or indirectly relate to wetland management in Alberta. In general, multilateral and international agreements set the broad scope for Canadian and Alberta-specific legislation and regulations that support international goals. This section addresses those that directly apply to wetland management in Alberta and in the Oil Sands Region:

- Ramsar Convention on Wetlands of International Importance (1971);
- Convention on Biological Diversity (1992).

### 2.2.1. Ramsar Convention on Wetlands of International Importance

Signed at a United Nations (UN) meeting held in Ramsar, Iran, in 1971, the Convention is an intergovernmental treaty that provides a framework for national action and international cooperation for the "conservation and wise use of wetlands and wetlands resources" (Ramsar 1971). Since its adoption, nearly 90% of the UN member states have become Contracting Parties. The Convention broadly defines wetlands to include lakes, rivers, aquifers, swamps, marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans.

Designation as a Ramsar site does not in and of itself legally protect the wetland from all development. However, it should be a high priority consideration when engaging with development interests. The Contracting Parties commit to three pillars of action:

1. Work toward the wise use of all their wetlands through national plans, policies and legislation, management actions and public education;
2. Designate suitable wetlands for the list of Wetlands of International Importance (the "Ramsar List") and ensure their effective management;
3. Cooperate internationally on transboundary wetlands, shared wetland systems, shared species, and development projects that may affect wetlands (Ramsar 1971).

In Alberta, three wetland areas are designated as Ramsar sites for their uniqueness, value for supporting flora and fauna, and other criteria. One is the Peace-Athabasca Delta, part of Wood Buffalo National Park. While the Peace-Athabasca Delta is outside and north-east of the defined Oil Sands Region, it is the downstream terminus of the Athabasca River Watershed. Understanding the potential influence of upstream natural and anthropogenic disturbances is an important component of conserving the Peace-Athabasca Delta. The Convention calls for an increase in knowledge and awareness of wetland values and for wetland status monitoring. Thus, monitoring wetlands in the Oil Sands Region to reduce the sector-specific and cumulative effects of anthropogenic activities may support the Convention's mandate.

### 2.2.2. Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is a multilateral UN treaty that took effect in December 1993 following the Earth Summit in Rio Janeiro in June 1992. The CBD has three main objectives:

1. Conservation of biological diversity;
2. Sustainable use of its components;
3. Fair and equitable sharing of the benefits arising out of the utilization of genetic resources (Government of Canada 1992).

The CBD supports programs that aim to "monitor, through sampling and other techniques, the components of biological diversity" (e.g., wetland ecosystems) and to "identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity" (Government of Canada 1992). With globally significant biodiversity hotspots and iconic wildlife, Canada is an active participant within the CBD. The Environment and Climate Change Canada represents the government in its routine dealings with the CBD Secretariat, including responding to requests, disseminating information, attending meetings, and promoting and facilitating national implementation.

## 2.3. Federal

This section reviews federal statutes, policies, and plans for wetland information needs. Included in the review are:

- Federal Policy on Wetland Conservation (1991);
- Migratory Birds Treaty and the *Migratory Birds Convention Act* (1994);
- *Species at Risk Act* (2002);
- *Canadian Environmental Assessment Act* (2012).

### 2.3.1. Federal Policy on Wetland Conservation

The Federal Policy on Wetland Conservation is Canada's response to the Ramsar Convention. In 1991, Canada adopted this wetland conservation strategy in all federal programs to address the loss and degradation of national wetland resources. Canada treats wetlands as valued natural ecosystems as they maintain the quality of the environment, migratory bird populations, inland and ocean fisheries, and international or transboundary resources such as water and wildlife. The goals include:

- Maintenance of the functions and values derived from wetlands throughout Canada;
- No net loss of wetland functions on all federal lands and waters;
- Enhancement and rehabilitation of wetlands in areas where the continuing loss or degradation of wetlands or their functions have reached critical levels;
- Recognition of wetland functions in resource planning, management and economic decision-making with regard to all federal programs, policies and activities (Government of Canada 1991).

The Federal Policy on Wetland Conservation recognizes that monitoring is central to collecting information and making more informed decisions to achieve the "no net loss" goal (Government of Canada 1991). The Federal Policy on Wetland Conservation enlists the federal government as a continuing partner in joint federal, provincial and territorial monitoring programs in support of

"the identification of geographic areas within which the continuing loss or degradation of wetlands has reached critical levels" (Government of Canada 1991). It further promotes "a nationally standardized approach to consistent and comparable wetland inventories, monitoring, and evaluations to guide the use, management and conservation of wetlands across Canada". The Federal Policy on Wetland Conservation also ensures that wetland management decisions are made with a sound scientific basis by supporting "the development and application of standards and guidelines for wetland conservation" and monitoring wetland trends from "regional perspectives so as to establish wetland baselines" (Government of Canada 1991).

### 2.3.2. Migratory Birds Treaty and the Migratory Birds Convention Act

The Migratory Birds Treaty (amended 1994) between Canada and the United States of America commits each country to the long-term conservation of migratory bird species. As part of this treaty, both countries have agreed to meet regularly to review the status of migratory bird populations and habitats, and the effectiveness of management actions. Monitoring is encouraged as a tool for pursuing the conservation principles.

To implement the treaty, the *Migratory Birds Convention Act* was established in 1917 and updated in 1994 to protect migratory birds and their eggs and nests from hunting, trafficking, and commercialization (Government of Canada 1994a). The Act enacts two main regulatory bodies: the *Migratory Bird Sanctuary Regulations*, which apply to only federally designated migratory bird sanctuaries, and the *Migratory Birds Regulations*, which apply everywhere else (Government of Canada 1994b and 1994c). Both regulatory bodies focus on prohibiting hunting of a migratory bird without a permit. Hunting is broadly defined to include both direct and indirect take, where indirect take can apply to industrial and development activities. As wetlands provide nesting and breeding grounds for many migratory birds, this *Migratory Birds Convention Act* and related regulations focus on to wetland conservation. Thus, monitoring migratory bird population distribution and density, and the availability of suitable habitats, is needed to support the management mandates of these regulations.

### 2.3.3. Species at Risk Act (SARA)

As a commitment to the Convention on Biological Diversity, the *Species at Risk Act* (*SARA*) became law in 2002. The goal of *SARA* is to "prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened" (Government of Canada 2002). It also formally establishes the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and extends protection to COSEWIC-listed species and their critical habitat. The *SARA* "requires that the best available knowledge be used to define long- and short-term objectives in a recovery strategy for endangered and threatened species" (Government of Canada 2002). The *SARA* has provisions for monitoring the status of species at risk and species that are not yet at risk, and requires that general reports on the status of wild species be completed every five years.

In the Oil Sands Region, there are several wetland-related species at risk. For example, the Yellow Rail (*Coturnicops noveboracensis*) is designated as a species of concern and protected under the *Migratory Birds Convention Act* (Environment and Climate Change Canada 2013). Monitoring of wetland species at risk is needed to support the management mandates of *SARA*.

### 2.3.4. Canadian Environmental Assessment Act (CEAA)

The *CEAA* was originally passed by the Government of Canada in 1992, a version which was repealed and reintroduced in 2012. The purpose of *CEAA* is to "protect the components of the environment that are within the legislative authority of Parliament from significant adverse environmental effects caused by a designated project", where a designated project is a physical activity carried out on federal land (Government of Canada 2012). *CEAA* promotes cooperation and coordination between environmental assessments at the federal and provincial levels, encourages the dual goals of a healthy environment and healthy economy, and supports the study of cumulative effects of regional activities.

The *CEAA* requires that environmental effects of a designated project must be taken into account when a change may be caused to "fish and fish habitat as defined in subsection 2(1) of the *Fisheries Act*," "aquatic species as defined in subsection 2(1) of the *Species at Risk Act*," "migratory birds as defined in subsection 2(1) of the *Migratory Birds Convention Act*, 1994", and on federal lands (Government of Canada 2012). The *CEAA* requires that the environmental effects of a project be considered in relation to existing environmental conditions, project alternatives, and cumulative environmental effects of the project. These assessments are conducted as environmental assessments. In Alberta, environmental assessments are administered through the *Environmental Protection and Enhancement Act* and *Water Act*.

No explicit wetland monitoring is required through the *CEAA*; however, if a designated project has potential environmental effects on a wetland then monitoring via an environmental assessment may be required. Through the *EPEA,* larger environmental assessments in Alberta and in the Oil Sands Region may require information on wetlands and their associated wildlife, vegetation, hydrologic, and aquatic resources.

## 2.4. Provincial Legislation

In Alberta, multiple pieces of legislation extend from federal policies and legislation to protect and manage water, wetlands, and aquatic ecosystem resources. These pieces of legislation form the basis of legal requirements for activities on the landscape. This section reviews the following provincial legislation for wetland management and monitoring needs:

- *Environmental Protection and Enhancement Act* (1993);
- *Municipal Government Act* (2000);
- *Public Lands Act* (2000);
- *Wildlife Act* (2000);
- *Alberta Water Act* (2002);
- *Alberta Land Stewardship Act* (2009);
- *Responsible Energy Development Act* (2013).

### 2.4.1. Environmental Protection and Enhancement Act (EPEA)

The *EPEA* is the main environmental statute in Alberta and it took effect in September 1993. The *EPEA* focuses on the protection, enhancement, and sustainable use of environmental resources. The *EPEA* prohibits certain activities that affect the environment unless approval is obtained. Under the *EPEA*, wetlands are included in decision making through environmental impact assessments, reclamation, and conservation easements, as well as through the management of wastewater, storm water, and substance releases. The AER administers the industry sector's *EPEA* regulatory approvals, while the AEP administers all other sector *EPEA* approvals.

Three major components extend from the *EPEA*, and are discussed below (Figure 1).


**Figure 1.** Three components that extend from the *EPEA* related to wetlands.

### *Environmental Impact Assessments*

To protect the environment and regulate industrial activities, under Part 2, Division 1 of the *EPEA* and Part 2, Division 2 of the *Water Act*, project proponents must prepare an environmental assessment. Environmental assessments are the first of four regulatory steps in a project's life cycle, and are followed by public interest decision, approval with conditions, and compliance. The purpose of the environmental assessment is to determine and assess a project's potential environmental, social, economic, and health implications. This is approached with three goals in mind: to gather information, engage public involvement, and support sustainable development.

An environmental assessment generally comprises six components:

1. A detailed description of the project;
2. The location and environmental setting for the project;
3. Baseline environmental, social, and cultural information;
4. The potential positive and negative environmental, health, social, economic, and cultural effects of the proposed activity as well as an assessment of cumulative effects;
5. Plans to mitigate potential adverse effects and to respond to emergencies;
6. Information on public and First Nations and Métis consultation (GoA 2015a).

In the Oil Sands Region, project proponents start with an environmental impact assessment. There are no specific regulations for monitoring wetlands associated with this act. However, government, industry, and other local stakeholders have developed a strategy for sustainable development through the Regional Sustainable Development Strategy for the Athabasca Oil Sands Area and implemented in partnership with CEMA. The purpose is "to ensure implementation of adaptive management approaches that address regional cumulative environmental effects, environmental thresholds, appropriate monitoring techniques, resource management approaches, knowledge gaps and research to fill gaps" (GoA 1999b). Further discussion of the specific wetland monitoring needs is found in Section 2.5.3 Environmental Impact Assessments – Oil Sands Projects.

### *EPEA Approval Conditions*

When applications for resource development are approved, they are subject to a series of conditions that are described in a Project Approval. Project Approvals are generated for every development application and are legal documents that have enforceable requirements to be met during the life for the project.

For the Oil Sands Region, the *EPEA* approval conditions are administered and renewed every 10 years. Each *EPEA* approval applies to a number of potential environmental impacts with site-specific terms and conditions, where wetland requirements are just one component. While each *EPEA* approval varies in timing and site-specific requirements among oil sands mines and in situ projects, there are two main wetland-related compliance monitoring components: regional wetland monitoring requirements and wetland reclamation requirements. More detail on the specific requirements and needs for wetland reclamation is found in Section 2.6.4. *EPEA* Approval Conditions – Regional Monitoring.

### *Wetland Reclamation Requirements*

The *EPEA* requires that at the end of mining activities oil sands mine operators must undergo a reclamation certification process, which applies to specified land being used for the construction, operation, or reclamation of a mine or plant site (GoA 2000a). For wetlands in the Oil Sands Region, project proponents are responsible for reclaiming lost wetland areas and are responsible for the land until certified and returned to the Crown. The environmental impact assessments and the *EPEA* approval conditions discuss options for reclaiming the landscape and mitigating impacts.

Wetland reclamation, especially in the Oil Sands Region, can be complex, requiring an integrated approach from planning to certification. This requires understanding the baseline conditions of reference wetlands and tracking the long-term trajectory of the wetlands being reclaimed (GoA 2013b). More detail on the specific requirements and needs for wetland reclamation is found in Section 2.6.5 Guidelines for Wetland Establishment on Reclaimed Oil Sands Leases.

## 2.4.2. Municipal Government Act

Since 2000, the *Municipal Government Act* has governed how municipalities can manage their land. It provides municipal governments control and management responsibilities over bodies of water within their municipality:

> Subject to any other enactment, a municipality has the direction, control and management of the rivers, streams, watercourses, lakes and other natural bodies of water within the municipality, including the air space above and the ground below (GoA 2000b).

Although the municipality owns the land and technically can manage a wetland, permanent wetlands that are found on municipal land are still property of the provincial Crown. Additionally, the *Municipal Government Act* also allows the municipality to designate land as an environmental reserve. While the *Municipal Government Act* does not provide direct wetland monitoring requirements, monitoring the status of wetlands within municipalities and environmental reserves can provide information to support the management mandates of the *Municipal Government Act*.

### 2.4.3. Public Lands Act

Through the *Public Lands Act* of 2000, the Crown is the owner of the beds and shores of all permanent and naturally occurring bodies of water:

> Subject to subsection (2) but notwithstanding any other law, the title to the beds and shores of (a) all permanent and naturally occurring bodies of water, and (b) all naturally occurring rivers, streams, watercourses and lakes, is vested in the Crown in right of Alberta and a grant or certificate of title made or issued before, on or after May 31, 1984 does not convey title to those beds or shores (GoA 2000c).

The *Public Lands Act* prohibits disturbance to public lands that may result in damage to the bed or shore of any body of water, or watershed capacity. Further, the *Public Lands Act* regulates and enforces activates affecting Crown-owned water bodies' beds and shores. As such, an activity[2] that has the current or future potential to impact shorelines or beds requires approval before the work is undertaken. The Wetland Policy sets up a process for the *Water Act* and the *Public Lands Act* application to align with policy mandates. While the *Public Lands Act* does not provide wetland monitoring requirements, monitoring the status of wetlands on public lands, which are prevalent in the Oil Sands Region, provides information to support the management mandates of the *Public Lands Act* and implementation of the Wetland Policy.

### 2.4.4. Wildlife Act

Established in 2000, the *Wildlife Act* supports wildlife management and complements the *SARA* to assess the risk of species to being endangered or threatened. The *Wildlife Act* established an Endangered Species Conservation Committee and Scientific Subcommittee, which create detailed status assessments out of the general status process. From the detailed status assessment, a species can be designed as endangered, threatened, or of special concern. Once a species has been designated as endangered or threatened under the *Wildlife Act* it becomes illegal to harvest or traffic the species or to disturb its nest or den. A recovery plan with monitoring is then produced and implemented for all endangered and threatened species (GoA 2000e). Monitoring of endangered and/or threatened species could overlap with wetlands monitoring in the Oil Sands Region. For example, the Woodland Caribou (*Rangifer tarandus caribou*) is a threatened species that uses peatlands of the boreal region for its feeding activities (Bradshaw et al. 1995; GoA 2014d).

### 2.4.5. Alberta Water Act

The *Alberta Water Act* (*Water Act*) governs how Alberta supports and promotes "conservation and management of water, including the wise allocation and use of water," (GoA 2000d). The *Water Act* defines water as "all water on or under the surface of the ground, whether in liquid or solid state" (GoA 2000d). Thus, the definition includes water found in a wetland irrespective of the duration of standing water. The *Water Act* requires that an approval be obtained before undertaking an activity in a water body and/or a license be obtained before diverting water.

> "Activity" means (*Water Act*: Section 1(1) (b)):

[2] Temporary, seasonal docks/piers and associated mooring structures, pipeline watercourse crossings, and road allowances on beds and shores are exempted from Public Lands Act approvals.

(i) placing, constructing, operating, maintaining, removing or disturbing works, maintaining, removing or disturbing ground, vegetation or other material, or carrying out any undertaking, including but not limited to groundwater exploration, in or on any land, water or water body, that:

(A) alters, may alter or may become capable of altering the flow or level of water, whether temporarily or permanently, including but not limited to water in a water body, by any means, including drainage;

(B) changes, may change or may become capable of changing the location of water or the direction temporarily or permanently, including but not limited to water in a water body, by any means, including drainage, of flow of water, including water in a water body, by drainage or otherwise;

(C) causes, may cause or may become capable of causing the siltation of water or the erosion of any bed or shore of a water body, or;

(D) causes, may cause or may become capable of causing an effect on the aquatic environment;

(ii) altering the flow, direction of flow or level of water or changing the location of water for the purposes of removing an ice jam, drainage, flood control, erosion control or channel realignment or for a similar purpose;

(iii) drilling or reclaiming a water well or borehole;

(iv) anything defined as an activity in the regulations for the purposes of this Act but does not include an activity described in sub clause (i) or (ii) that is conducted by a licensee in a works that is owned by the licensee, unless specified in the regulations. (GoA 2000d)

Similar to the *EPEA*, Part 2, Division 2 of the *Water Act* specifies that project proponents may need to prepare an impact assessment if wetlands are to be impacted by the proposed activity. Impact assessments must address how the wetlands may be altered and/or impacted by the proposed activity. If there are impacts to wetlands, compensation or mitigation may be required and guided by the Wetland Policy.

The *Water Act* recognizes that the province's rivers, lakes, riparian (bank or shoreline) areas, and wetlands are important for recreational uses, as an aesthetic resource, and as habitat to support biological diversity. Biological diversity, as defined in the *Water Act*, is "the variability among living organisms and the ecological complexes of which they are a part, and includes diversity within and between species and ecosystems" (GoA 2000d). While the *Water Act* does not outline specific wetland monitoring requirements, the *Water Act* sets the direction for provincial water management planning frameworks and the Wetland Policy, which have wetland monitoring requirements.

### 2.4.6. Alberta Land Stewardship Act

Established in 2009, the *Alberta Land Stewardship Act* (*ALSA*) provides the legal basis for the Land-use Framework. Its purpose is to:

- Provide a means by which government can give direction and provide leadership in identifying the objectives of the province, including economic, environmental and social objectives;
- Provide a means to plan for the future, recognizing needs of current and future Albertans;
- Provide for coordination of decisions by decision-makers concerning land, species, human settlement, natural resources and the environment;
- Create legislation and policy that enable sustainable development by taking into account and responding to cumulative effects of human endeavour and other events (GoA 2009a).

The *ALSA* sets the guidelines the regional plans. A regional plan can set "thresholds for the purpose of achieving or maintaining an objective for the planning region," and further "describe or specify the monitoring required of thresholds, indicators and policies, who will do the monitoring and when, and to whom the monitoring will be reported" (GoA 2009a). The Oil Sands Region is mostly situated within the Lower Athabasca Region (LAR), and several wetland-related indicators require monitoring support. These needs are discussed further in Section 2.5.3 Land-use Framework.

### 2.4.7. Responsible Energy Development Act (REDA)

In 2013, the *Responsible Energy Development Act* (*REDA*) established the AER to "provide for the efficient, safe, orderly, and environmentally responsible development of energy resources in Alberta" (GoA 2013c). The AER is the sole energy regulator from application to remediation (AER 2015). The *REDA* also applies to wetland management and monitoring, as the AER has authority over energy resource activities and administers the regulatory functions under the *Water Act*, *EPEA*, and *Public Lands Act* that were previously held by the AEP, the former Environment and Sustainable Resource Development.

## 2.5. Provincial Policies, Frameworks, and Strategies

Alberta has developed a number of policies, frameworks, and strategies to support legislation. Together, these set the foundation to manage land and natural resources with overlapping interests and achieve Alberta's long-term economic, environmental and social goals. They provide guidance for decision-making and the implementation of multiple legislations and regulatory instruments. Additionally, they set both 1) high-level goals at a provincial and/or regional level and 2) a process, along with the necessary tools, for achieving those goals. This section reviews the wetland management and monitoring needs for the following provincial policies, frameworks, and strategies:

- Water Management Planning (1999);
- Water for Life Strategy (2003);
- Climate Change Strategy (2008);
- Land-use Framework and associated environmental management frameworks (2008);
- Alberta Wetland Policy (2013);
- Integrated Resource Management System (2015).

### 2.5.1. Water Management Planning

The *Water Act* focuses on water management planning and aquatic environment protection. Part 2, Division 1 of the *Water Act* directs the Minister to establish a framework for water management planning and a strategy for protecting aquatic environments. Water management plans are developed to guide regulatory decisions for the water body, such as minimum in-stream flows, conditions on diversions, and other strategies for protecting the aquatic environment. When a water management plan is approved by the Lieutenant Governor in Council, it becomes an approved water management plan and must be considered when making water approval decisions (GoA 2000d).

In 1999, the GoA provided guidance through the Framework for Water Management Planning and the Strategy for the Protection of the Aquatic Environment. This provided requirements for each water management plan:

- A summary of the issues considered;
- A description of the area in which the Water Management Plan applies;
- A summary of the information assembled as part of the planning process;
- The relationship of the Water Management Plan to regional strategies or other planning initiatives;
- The recommended options and strategies to address the issues;
- A list of performance monitoring requirements (Framework for Water Management Planning 1999).

The Framework for Water Management Planning stresses the importance of environmental health and the commitment to protecting the aquatic environment through "maintaining, restoring, or enhancing the current conditions" (GoA 1999a). To achieve this aim, there is a recognized need for monitoring and inventory programs to collect data through collaborations and partnerships with the government and other organizations.

Currently, there are eight approved water management plans, three of which are in the Oil Sands Region: the Athabasca River Water Management Framework, Cold Lake – Beaver River Water Management Plan, and the Muskeg River Interim Management Framework. While these Water Management Frameworks and Plans recognize the importance of wetlands in the region, they do not establish wetland objectives or outline wetland monitoring or indicator guidelines.

### 2.5.2. Water for Life Strategy

In 2003, the GoA first released the Water for Life strategy as a provincial action plan for the management of Alberta's water resources. The strategy was updated with the Water for Life: A Renewal in 2008 to report on the progress of key initiatives, and the Water for Life: Action Plan in 2009 with revised short-, medium-, and long-term actions and increased consistency with other strategic policies. The strategy has three core goals:

1. Safe, secure drinking water supply;
2. Healthy aquatic ecosystems;
3. Reliable, quality water supplies for a sustainable economy (GoA 2003).

Toward achieving these goals, Alberta is committed to maintaining and protecting the province's aquatic ecosystems and developing the knowledge and research to support decision making.

The Water for Life: Action Plan sets the following key short-, medium-, and long-term actions to support wetlands and aquatic ecosystem monitoring:

**Short-Term** (by 2012)

- Finalize and implement a new wetland policy for Alberta;
- Protect Alberta's critical aquatic ecosystems and develop a provincial action plan to improve the health of significantly impacted aquatic ecosystems;
- Define criteria and identify critical and significantly impacted aquatic ecosystems.

**Medium-Term** (by 2015)

- Complete an Alberta wetlands inventory;
- Apply research and knowledge to develop and model indicators of wetland health;
- Maintain or improve the health of critical and impacted aquatic ecosystems through legislation, watershed and regional planning, and conservation organizations;
- Establish a data management support and reporting system integrated with Land-use Framework and cumulative effects information systems.

**Long-Term** (by 2019)

- Monitor, report, and adjust, where necessary, to ensure the health of aquatic ecosystems is maintained or improved;
- Enhance the provincial water monitoring and evaluation program to include information on wetlands, groundwater, aquatic health, water quality and quantity (GoA 2009b).

The Water for Life Strategy is a cornerstone strategy for water and watershed management and planning in Alberta. The Wetland Policy and the WPACs are an extension of the Water for Life Strategy, and the regional planning and cumulative effects management based in the Land Use Framework are complementary to the goals of the Water for Life Strategy.

### 2.5.3. Climate Change Strategy

In 2008, the GoA released a Climate Change Strategy that broadly commits Alberta to being part of the climate change solution. The Climate Change Strategy aims to provide a vision for how to take responsibility while providing leadership and action to conserve and use energy efficiently, implement carbon capture and storage, and introduce sustainable energy production practices in order to reduce emission by 200 megatonnes by 2050 (GoA 2008a).

The intended focus of the Climate Change Adaption Strategy is on water, biodiversity, energy, municipal infrastructure, agriculture, and forestry, and on developing appropriate responses to adapt to climate change. While wetlands are threatened by climate change and increasing temperatures (Tarnocai 2006; IPCC 2014), the Climate Change Strategy does not address specific wetland monitoring needs. The Climate Change Strategy, however, calls for the development of a provincial Climate Change Adaption Strategy to "provide overall direction, identify measures and indicators of climate change, provide a source of information about the impacts, and identify risks and vulnerabilities" (GoA 2008a). As wetlands are a dominant ecosystem in Alberta, monitoring information will likely be important to describing the state of wetland

quantity and quality under increasing pressure from climate change, and to developing adaptive management strategies.

### 2.5.4. Land-use Framework

Released in 2008, the Land-use Framework sets the approach for managing Alberta's growth while sustaining social and environmental goals. The Land-use Framework established seven land use planning regions in Alberta based on the province's major watersheds and related regional priorities. For each region, regional plans have been or will be developed to assess and manage the cumulative effects of development on land, water, and air and promote efficient use of land to reduce the footprint of human activities on Alberta's landscape (GoA 2008b). Five of the seven planning regions overlap with the Oil Sands Region (Figure 2): the 1) LAR, 2) Upper Athabasca Region, 3) Lower Peace Region, 4) Upper Peace Region, and 5) North Saskatchewan Region.

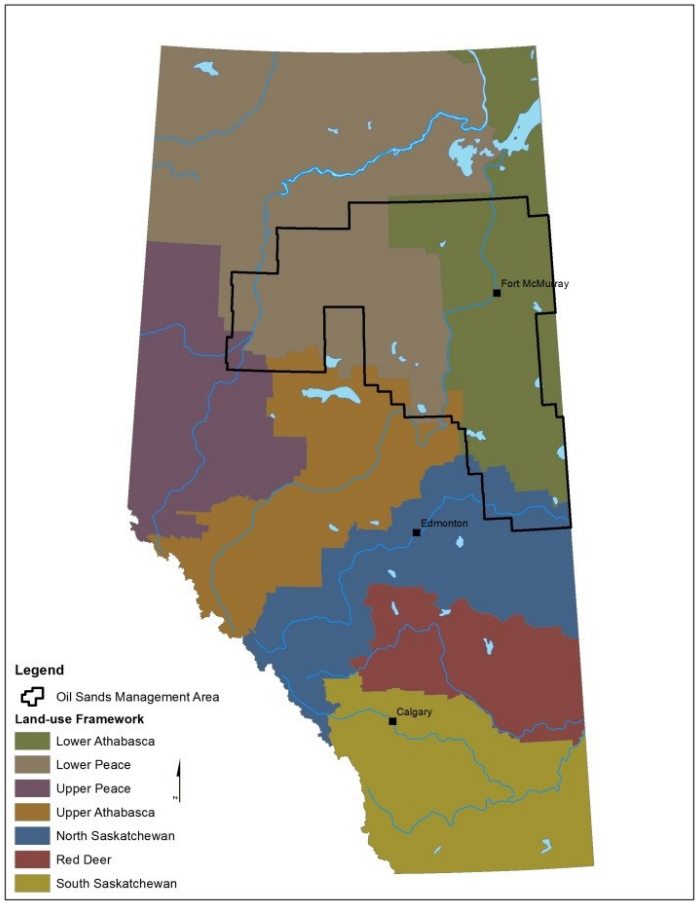


**Figure 2.** Land-use Framework Planning Regions within the Oil Sands Region.

Integrated with the regional plans are environmental management frameworks related to biodiversity, air quality, surface water quality, and groundwater quality. Management frameworks are a key tool for managing the long-term cumulative effects of development on the environment at a regional scale. They build on existing environmental policies, legislations, and regulations and provide an improved understanding of the current state of the

environment, as well as emerging trends, challenges, and opportunities. Each management framework includes: desired regional objectives, regional thresholds and triggers for management responses for a set of key indicators (or plans to set them), actions to achieve objectives, and an approach for monitoring, evaluation, reporting, and communication.

In the Oil Sands Region, the Lower Athabasca Regional Plan (LARP) took effect on September 1, 2012 and to date it is the only approved regional plan in the region. The LARP has five approved environmental management frameworks: Air Quality, Surface Water Quantity[3], Surface Water Quality, Tailings Management, and Groundwater. The Biodiversity Management Framework (BMF) is still under development. With respect to the other planning regions that overlap with the Oil Sands Region (also known as the JOSM region), Phase 1 Consultation for the North Saskatchewan Region has been completed, while regional plan development for the Lower Peace, Upper Peace, and Upper Athabasca has yet to begin[4].

The management framework approach for land use planning follows a three-tiered process. First, indicators are chosen, and triggers and thresholds are set for each indicator to initiate an appropriate management response. Second, the quality and/or quantity of the air, surface water, groundwater, and biodiversity indicators are continuously assessed through monitoring and modelling where appropriate. Third, if monitoring reveals a negative change then management response is triggered. As wetlands are dominant ecosystems in the Lower Athabasca Region, monitoring various facets of wetlands is important and required to effectively manage the cumulative effects of land use activities in the region.

### *Groundwater Management Framework*

The Lower Athabasca Region Groundwater Management Framework (Groundwater Framework) was completed on September 1, 2012. The goals of the Groundwater Framework are to:

1. Establish the baseline groundwater conditions and range of natural variability in the Lower Athabasca Region to facilitate enhanced knowledge and detection of change;
2. Provide a consistent approach to understanding potential effects from all development activities on the surrounding environment;
3. Facilitate projections of change based on future scenarios, such as expanding development or climate variability and change;
4. Support and supplement the current pollution prevention and risk management principles as part of groundwater quality and quantity management (GoA 2012c).

To achieve these goals, the Groundwater Framework establishes indicators of groundwater quality and quantity and methods for developing triggers and limits. The Groundwater Framework focuses on three areas: the North Athabasca Oil Sands Area, the South Athabasca Oil Sands Area, and the Cold Lake-Beaver River Area. The Groundwater Framework sets primary, secondary, and tertiary indicators associated with mining operations, in situ development, and other influences (human and natural) for groundwater quality and quantity. Primary indicators

[3]The Air Quality and Surface Water Quantity do not apply to wetlands and, thus, not discussed in this report.
[4] Outside of the Oil Sands Region, the South Saskatchewan Regional Plan became effective on September 1, 2016 and Phase 1, 2, and 3 consultation sessions have been completed. The regional plan developed for the Red Deer Region has yet to be started.

are selected as an initial suite of screening tools, and if subsequent investigation is required then secondary and tertiary indicators are used. Wetlands are a secondary indicator. For instance, for mining and in situ operations, a secondary groundwater quality indicator is "impact to sensitive water body or wetland as demonstrated by water level changes" (GoA 2012c). For other influences, a secondary groundwater quality indicator is "measureable impact to sensitive water body or wetland as demonstrated by water level changes" (GoA 2012c). As such, the Groundwater Framework identifies a clear need to monitor wetland saturation and hydrologic connectivity within the Oil Sands Region.

### *Surface Water Quality Management Framework*

The Surface Water Quality Management Framework for the Lower Athabasca River (Surface Water Quality Framework) was completed on September 1, 2012. The Surface Water Quality Framework has two main goals:

1. Identify ambient surface water quality triggers and ambient surface water quality limits to protect surface water quality, clarify Government of Alberta expectations, address cumulative effects, and support pollution prevention and proactive management strategies
2. Enhance transparency and assurance through regular monitoring, evaluation and reporting on ambient surface water quality conditions within the lower Athabasca River from downstream of the Grand Rapids to the Athabasca River Delta (GoA 2012d).

To achieve these goals, the Surface Water Quality Framework sets surface water triggers and limits for 38 indicators (11 general water quality indicators and 27 metal-specific indicators) measured at the Old Fort monitoring station on the Lower Athabasca River region. These indicators were selected to monitor for wastewater loading and exhibit a downstream increase in the Lower Athabasca River (refer to the Surface Water Quality Framework for the Lower Athabasca River 2012 for the full list of indicators).

The Surface Water Quality Framework could guide the selection of water quality parameters where monitoring objectives are similar and overlap with those selected for the Wetland Monitoring Program. Monitoring similar indicators in wetlands could be conducted to provide a comparison and linkage between cumulative effects of land use on wetlands and downstream effects in the Lower Athabasca River.

### *Tailings Management Framework for the Mineable Athabasca Oil Sands*

As part of the LARP, the GoA developed the Tailings Management Framework for the Mineable Athabasca Oil Sands (Tailings Framework) to provide "direction to manage fluid tailing volumes during and after mine operation in order to manage and decrease liability and environmental risk resulting from the accumulation of fluid tailings on the landscape" (GoA 2015f). The key objective is that "fluid tailings accumulation is minimized by ensuring that fluid tailings are treated and reclaimed progressively during the life of a project and all fluid tailings associated with a project are ready-to-reclaim within 10 years of the end of the mine life of that project" (GoA 2015f). There is an emphasis on restoring the tailing mine land to enable a range of future land use options, even if they differ from the original land use.

The Tailings Framework lays out management directions for tailings that will support other policies and lead to the development of more detailed guidelines. While the Tailings Framework

does not explicitly mention wetland monitoring, wetland reclamation may be a future component in the progressive reclamation of fluid tailings. With wetland reclamation, monitoring will be important to assessing wetland status and the efficacy of the Tailings Framework process.

### *Draft Biodiversity Management Framework (BMF)*

The BMF aims to support key terrestrial and aquatic species, habitats and landscapes important to sustaining long-term ecosystem health. The draft LAR BMF is currently under review by the GoA (GoA 2014b).

The draft LAR BMF aims to establish a set of indicators for four categories of indicator pyramids to assess biodiversity: Aquatic habitat, Terrestrial habitat, Aquatic species, and Terrestrial species (Figure 3, GoA 2014b). Each pyramid is subdivided into four tiers. Tier 1 houses composite indicators that communicate the general state of biodiversity and are aimed to be consistent throughout all planning regions. Tier 2 indicators are indicators of regional significance. Tier 3 indicators support Tiers 1 and 2 indicators. Tier 4 houses supporting data and information. All indicators are monitored, but Tiers 1 and 2 indicators have management triggers associated with the status and trend of a given indicator. The triggers will act as early warning signs, and if an indicator is performing poorly and crosses a threshold, a management response is triggered.

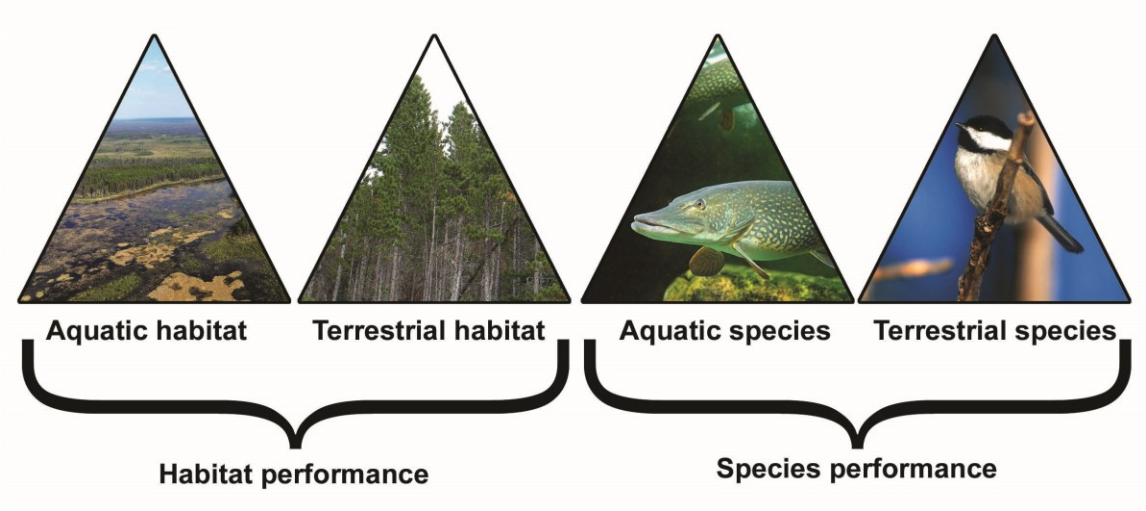


**Figure 3**. Draft indicator pyramids (GoA LAR BMF in prep).

The draft LAR BMF proposed three indicators associated with wetlands in the Oil Sands Region. Aquatic and wetland native cover and Fen cover are the respective Tier 1 and Tier 2 indicators proposed under the Aquatic habitat pyramid. Aquatic and wetland native cover is calculated as the percentage of lowland/wetland area free of human footprint[5], which includes major water bodies, wetlands, and riparian habitats (GoA 2014b). Fen cover is calculated as the percent area within the region of interest that is free of human footprint (GoA 2014b). Aquatic and wetland

[5] Human footprint is the visible conversion of native ecosystem to temporary or permanent residential, recreation, or industrial land uses.

biodiversity intactness is a proposed Tier 1 indicator under the Aquatic species pyramid (GoA 2014b). Once a BMF is established in the LAR, continuous monitoring of wetland-related indicators will be important to supporting the mandates of the BMF and LARP and to supporting management response/action and land use planning.

### 2.5.5. Alberta Wetland Policy

Recognizing that Alberta's wetlands are integral to watershed health and to the achievement of all three goals of the Water for Life strategy, the Alberta Wetland Policy (Wetland Policy) was released in 2012. This policy is provincial in scope and replaces the Wetland Management in Settled Areas of Alberta – An Interim Policy (GoA 1993). The Alberta Wetland Policy's goal is to:

> [M]aintain wetland areas in Alberta such that the ecological, social, and economic benefits that wetlands provide are maintained and ensure that Albertans have healthy watersheds that provide safe and secure drinking water supplies and healthy aquatic ecosystems (GoA 2013a).

To achieve this goal, the Wetland Policy focuses on four main outcomes:

1. Wetlands of the highest value are protected for the long-term benefit of Albertans;
2. Wetlands and their benefits are conserved and restored in areas where losses have been high;
3. Wetlands are managed by avoiding, minimizing and, if necessary, replacing lost wetland value;
4. Wetland management is framed within a regional context (GoA 2013a).

The Wetland Policy applies to the following wetlands in Alberta: natural wetlands, restored natural wetlands, and wetlands constructed for the purpose of wetland replacement. The Wetland Policy is designed to provide a framework for sound and robust wetland management and integrates five key concepts: 1) relative wetland value, 2) wetland mitigation, 3) knowledge and information systems, 4) performance measures, monitoring and reporting, and 5) wetland stewardship.

#### *Relative Wetland Value*

The Wetland Policy recognizes that wetlands are diverse in form, function, use, and distribution. The Wetland Policy takes a functional approach to managing wetlands by aiming to assign a "relative wetland value" to a wetland (GoA 2013a). Assigning "relative wetland value" is based on a combination of five wetland value functional groups: 1) biodiversity & ecological health, 2) water quality improvement, 3) hydrologic function, 4) human use, and 5) relative abundance (GoA 2013a; Figure 4). By combining these value criteria, a wetland can be placed into one of four categories of relative wetland value – "A", "B", "C", or "D", where A represents the highest value. The relative wetland value then informs wetland mitigation strategies and decisions, if an impact cannot be avoided or minimized (GoA 2013a).

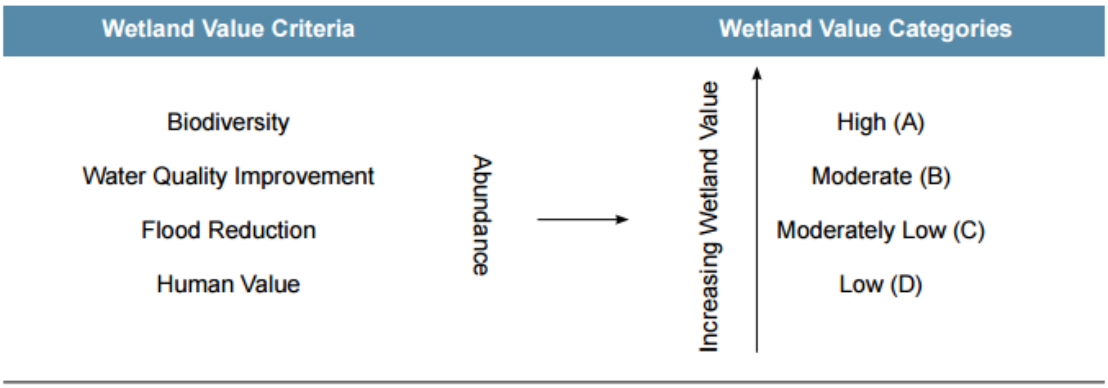


**Figure 4.** Conceptual translation of the wetland value functional groups and abundance to relative wetland value categories (GoA 2013a).

Since 2015, wetland relative value in the White Area has been determined through a wetland value assessment tool called the Alberta Wetland Rapid Evaluation Tool – Actual (ABWRET-A). ABWRET-A is a standardized and rapid approach to assessing wetland function from GIS-based data, on-site observations, and logic-based models (GoA 2015d). ABWRET-A focuses on 13 categories of wetland function and human uses: 1) water storage and delay, 2) stream flow support, 3) water cooling, 4) sediment retention and stabilization, 5) phosphorus retention, 6) nitrate removal and retention, 7) organic nutrient export, 8) fish habitat, 9) invertebrate habitat, 10) amphibian habitat, 11) waterbird habitat, 12) songbird, raptor, and pollinator habitat, and 13) human use such as low-intensity regulation, education, and research (GoA 2015d). The ABWRET-A assessment is conducted with 69 function indicators and nine different stressor indicators. A wetland value assessment tool for wetlands in the Green Area is anticipated to be available from the GoA in 2016.

### *Wetland Mitigation*

If an activity or water diversion has the potential to impact a wetland, then a *Water Act* or a *Public Land Act* approval must be granted. The wetland's relative value is information that is used as part of the approval application process. The Wetland Policy establishes a three-tiered wetland mitigation directive (Figure 5). Wetland mitigation includes management activities undertaken to avoid or minimize negative impacts on wetlands, and to replace lost wetlands where and when necessary. The primary and preferred response is to avoid impacts to wetlands. Where avoidance is not possible, impacts on wetlands must be minimized. As a last resort, where avoidance and minimization efforts are not feasible or prove ineffective, wetland replacement is required.

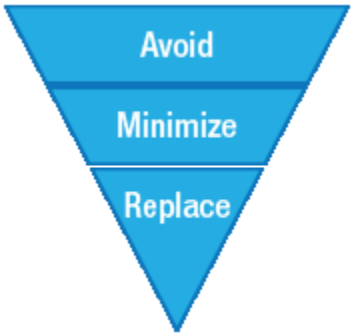


**Figure 5.** Wetland mitigation hierarchy (GoA 2013a).

When applying for *Water Act* or *Public Lands Act* approvals, the project proponents must assess the relative wetland value and demonstrate actions or attempts to avoid or minimize impacts to wetlands. If adverse effects to a wetland cannot be avoided or minimized, and those effects will result in permanent loss of wetland area, then the project proponents must submit a proposal

to replace lost wetland area. If the replacement proposal is approved, there are three replacement options: a wetland offset registry, in-lieu fee, or permittee-responsible replacement. Wetland replacement entails costs for both restoration work and monitoring restoration success. Wetlands with a relative wetland value of "A" are not eligible for replacement. Regardless of wetland value, the Wetland Offset Program is under development.

#### *Knowledge and Information Systems*

The Wetland Policy establishes a framework for wetland management. To this end, the Wetland Policy outlines a broad range of integrated data products needed to support the Wetland Policy's goals. Some of the knowledge and information systems include the development and continuous improvement of a provincial wetland inventory, wetland value assessment tools and system, and a wetland database and reporting tool. In addition to the development of knowledge and information systems, the Wetland Policy specifies that monitoring is necessary for evaluating the effectiveness of Wetland Policy at meeting the stated goals and outcomes, and for supporting adaptive wetland management.

#### *Alberta Wetland Classification System*

The Wetland Policy and wetland management requires a consistent classification system that uses criteria based on Alberta's flora, fauna, geology, hydrology, and environmental characteristics. To address this need, in 2015 the GoA released the Alberta Wetland Classification System (AWCS), to be applied across the province. The AWCS is compatible with existing classification systems, such as the Canadian Wetland Classification System (National Wetland Working Group 1997) and the Alberta Wetland Inventory (Halsey et al. 2003).

The AWCS defines five main classes of wetlands: bogs, fens, swamps, marshes, and shallow/open water, which are located across Alberta's diverse landscapes and climatic conditions. Peatland wetlands such as bogs, fens, and swamps are the most common types in the Oil Sands Region and in northern Alberta, whereas mineral wetlands are more common in southern Alberta (Vitt et al. 1996). However, all five classes of wetlands are present in the Oil Sands Region. Wetlands are characterized and influenced by several processes: peat[6] accumulation, water regime, chemical gradients, soil characteristics, and vegetation structure. Wetlands are also characterized by their water permanence or time inundated by water. The AWCS distinguishes five levels of water permanence, known as hydroperiod[7]: permanent, semi-permanent, seasonal, temporary, and ephemeral.

### 2.5.6. Integrated Resource Management System (IRMS)

Through the provincial policies and frameworks, the GoA is striving towards an Integrated Resource Management System (IRMS) to manage natural resource management by recognizing that those resources drive Alberta's economy. The IRMS looks at all current and potential future land use activities and their cumulative impacts to proactively plan for the future. The IRMS aims to:

- Integrate and align natural resource and environmental policies;

[6] Ground composed of partially decomposed plant material that accumulates in some wetlands under saturated conditions; peat accumulation differentiates peatlands from mineral wetlands.
[7] The length of time the water table is at or above the ground surface in a wetland.

- Provide clear environmental, economic, and social outcomes to guide all parties operating on the landscape;
- Assure the outcomes, policies, and plans advance the public interest;
- Create a robust program to measure, evaluate and report environmental, economic, and social conditions and outcomes;
- Build strong relationships with partners and stakeholders through meaningful engagement;
- Provide open and transparent environmental, economic, and social data to assist natural resource management decision-making;
- Use Alberta's experience and innovation, as well as the expertise and experiences of others, to continually improve the system (GoA 2015e).

The IRMS is composed of four priority areas. First, the AEP regulates non-energy activities in accordance with regional plans, develops regional plans with environmental limits, and contributes to sub-regional planning to address specific concerns. Second, the AER provides regulatory oversight over the full-lifecycle of upstream coal, oil, and gas development. They watch to ensure that energy resource development complies with provincial legislation and regional plan limits. Third, AEMERA is responsible for monitoring the conditions of air, water, land, and biodiversity in Alberta for policy assurance and stewardship. However, after June 30, 2016, the duties of AEMERA will be conducted as part of AEP (Bill 18). Fourth, the Aboriginal Consultation Office is responsible for consulting with First Nations and Métis on energy-related developments and their traditional lands (GoA 2015e).

Under the IRMS, water, air, and biodiversity environmental monitoring data are critical inputs that allow for continuous improvement and adaption of natural resource management. In the Oil Sands Region, wetlands are a dominant ecosystem and are managed and monitored via multiple legislations and policies.

## 2.6. Provincial Requirements – Sector Specific

Federal and provincial legislations and policies are implemented at the sector-specific level. In the Oil Sands Region, industrial activities, such as forestry, mining, and oil and gas exploration, are key activities that must comply with specific requirements to operate. This section reviews the following sector-specific requirements in the Oil Sands Region related to wetland management and monitoring:

- Alberta Timber Harvest Planning and Operating Ground Rules Framework for Renewal (Forestry Sector);
- Criteria and Indicators Framework for Oil Sands Mine Reclamation Certification (Energy Sector);
- Environmental Impact Assessments – Oil Sands Projects (Energy Sector);
- *EPEA* Approval Conditions – Regional Monitoring (Energy Sector);
- Guidelines for Wetland Establishment on Reclaimed Oil Sands Leases (Energy Sector).

### 2.6.1. Alberta Timber Harvest Planning and Operating Ground Rules Framework for Renewal

Every 5 to 10 years, each of the Forest Management Agreement (FMA) holders in Alberta is required to update their forest management plan (FMP) according to guidelines set out in the Alberta Forest Management Planning Manual – Consultation Draft (GoA 2004). Forest management plans describe how FMA holders will manage and evaluate timber and non-timber

values on their land base. In the event that a strategic plan does not exist, the Alberta Timber Harvest Planning and Operating Ground Rules Framework (Ground Rules Framework) establishes "practices that minimize the potential of negative impacts from roads, timber harvesting, and forest management operations and activities" (GoA 2012a).

For watershed protection of all water body types on a land base, there are ground rules in place to manage impacts 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* (GoA 2012a).

Effective watershed protection and wetland management requires mapping and classification of water bodies on the land base. This is important as each water body type has a particular set of applicable ground rules. Additionally, to ensure adherence to the ground rules on watershed protection, timber operations must monitor and report their activities and compliance with the forestry management plans.

### 2.6.2. Criteria and Indicators Framework for Oil Sands Mine Reclamation Certification

The *EPEA* requires that at the end of mining activities, oil sands mine operators undergo a reclamation certification process, which applies to specified land being used for the construction, operation, or reclamation of a mine or plant site (GoA 2000a). In that process, reclamation must be undertaken on disturbed land, and the operator is responsible for leased land until granted a reclamation certificate. While the *EPEA* defines the requirements for a reclamation certificate application, the specific criteria for informing a decision of reclamation certification is provided through GoA-approved recommendations by the CEMA. The specific criteria are defined in the report, Criteria and Indicators Framework for Oil Sands Mine Reclamation Certification (GoA 2013b). The Framework for Reclamation Certification includes:

- Reclamation objectives, criteria, indicators, measures, and methods based on current knowledge, best practices and technology;
- A management system to guide the use of criteria and indicators, compatible within Alberta's regulator environment, to support oil sands mine reclamation certification decisions (GoA 2013b).

As wetlands are a common feature on the Oil Sands Regional landscape, several of the reclamation objectives, criteria, indicators, and measures proposed in the Framework for Reclamation Certification encompass wetlands, including:

**Objective 2** –Natural ecosystem functions are established on the reclaimed landscape.

**Criteria 2.1** –Reclaimed landforms have the required water quality.

**Indicator 2.1.2** – Fen water quality.

**Criteria 2.2** –Reclaimed landforms have the required water quantity.

**Indicator 2.2.2** – Wetland hydroperiod.

**Criteria 2.4** – Ecosystem productivity is established on the reclaimed landscape.

**Indicator 2.4.1** – Marsh open-water zone plant index of biotic integrity;

**Indicator 2.4.2** – Marsh wet meadow plant index of biotic integrity (GoA 2013b).

In the Framework for Reclamation Certification, monitoring is a key component to "the determination of a state, and/or change over time, to evaluate reclamation success, and to inform adaptive management responses" (GoA 2013b). For these indicators, it is important to monitor spatial and temporal change through time. Indicators such as fen water quality and marsh wet meadow plant index of biotic integrity, need to be monitored to track the attainment of each specified threshold range. The other indicators, such as wetland hydroperiod and marsh open-water zone plant index of biotic integrity, must be monitored to track temporal trends at both the reclaimed areas and when compared to natural reference trends during the same period of time (GoA 2013b). Monitoring has a site specific and regional scale component, and can be supplemented by research to support the development of new indicators, methodology, and technology.

### 2.6.3. Environmental Impact Assessments – Oil Sands Projects

For Alberta's oil sands projects (in-situ and oil sands mines), environmental impact assessments are required to assess and understand the potential the environmental consequences of the project's development, operation, and reclamation by:

1. Identifying environmental impacts of the project including regional, temporal, and cumulative effects;
2. Presenting impact predictions in terms of magnitude, frequency, duration, seasonal timing, reversibility and geographic extent;
3. Discussing proposed mitigation measures, protection plans, monitoring or research programs, and other follow-up actions related to proposed activities, environmental performance objectives, and anticipated regulatory requirements.

Specifically, oil sands environmental impact assessments are expected to report on wetlands in several ways. Environmental impact assessments have sections designed to describe aquatic and terrestrial resources in the study area. Related to aquatic resources, this can include hydrology, water quality, and aquatic health and habitat, all of which could include wetlands. Related to resources, this can include soils and terrain, wetland resources, wildlife and habitat, and biodiversity, all of which include wetland features. Wetlands are discussed in the reclamation and closure sections of an environmental assessment. The project proponent should describe how naturally functioning watercourses, vegetation communities, and wildlife habitat will be re-established, and what type of monitoring efforts will be used to ensure reclamation and closure objectives are achieved.

Environmental impact assessments establish the foundation for approval conditions that must be met by the project proponent through the life of the project. They require extensive monitoring to determine the existing environmental conditions, predict potential impacts, and provide mitigation opportunities those impacts. For approved oil sands projects, the approval

conditions extend from the environmental impact assessments. Regarding wetlands, the *EPEA* approval conditions are centered on the regional monitoring program conditions, as outlined in Ciborowski et al. (2012) and discussed in Section 2.3.3, and post-activity reclamation, as discussed in Section 2.5.2.

### 2.6.4. *EPEA* Approval Conditions – Regional Monitoring

In the Oil Sands Region, oil sands mine and in situ projects have *EPEA* operating approval requirements. Eight oil sands mine projects[8] have *EPEA* approval conditions focused on wetland monitoring program requirements. The goal of the approval conditions is to address concerns raised in the environmental impact assessments and provide a monitoring program to track the potential impacts on wetlands. While each *EPEA* approval condition varies for each of the mines, the wetland monitoring program requirements are similar among mines as captured by the following reference:

> The Wetland Monitoring Program proposal shall include, at a minimum, all of the following:
> (a) A plan to monitor natural wetlands for natural variability; (b) A plan to determine and monitor the potential effect of dewatering and mine development on wetland communities; and (c) Corrective measures, where appropriate, to protect affected wetland communities (Ko 2016).

These *EPEA* approval conditions require many monitoring facets. To monitor natural wetlands for natural variability, there is a two-fold need: 1) to understand whether effects are due to mine development or natural environmental drivers, and 2) to determine if the change is outside the range of natural variability. This requires collecting baseline data to characterize natural wetland condition and both spatial and temporal variability. To monitor the potential effects of dewatering and mine development on wetland communities, there is a need for: 1) the assessment of cause-effect relationships, 2) validation and understanding of the key drivers and stressors associated with development and dewatering, and 3) development of biological endpoints to help interpret driver – stressor pathways.

In 2012, the CEMA proposed a framework for a regional wetland monitoring program (Ciborowski et al. 2012). The CEMA work recommended three areas for monitoring: disturbed area zone, focal monitoring areas, and reference monitoring areas. The CEMA work has also provided recommendations for suggested sampling approaches in each area and broad recommendations for variables and indicators to monitor. This work did not outline methods or an implementation plan; therefore, in 2013, the energy industry submitted its own plan,

[8] *EPEA* approvals are as follows:

- Syncrude Mildred Lake and Aurora EPEA Approval 26-02-00, as amended, Wetland Monitoring Plan, Conditions 6.1.66–6.1.68;
- Suncor Base Plant EPEA Approval 94-02-00, as amended, Wetland Monitoring Plan, Conditions 6.1.70–6.1.72;
- Imperial Kearl EPEA Approval 46586-00-00, as amended, Wetland Monitoring Plan, Conditions 6.1.66–6.1.68;
- Suncor Fort Hills EPEA Approval 151469-01-00, as amended, Wetland Monitoring Plan, Conditions 6.3.7–6.3.11;
- Shell Muskeg River Mine EPEA Approval 20809-01-00, as amended, Wetland Monitoring Plan, Conditions 6.1.66–6.1.68;
- CNRL Horizon Mine EPEA Approval 149968-01-00, as amended, Wetland Monitoring Plan, Conditions 6.3.7–6.3.11;
- Total Joslyn Mine EPEA Approval 228044-00-00, as amended, Wetland Monitoring Plan, Conditions 6.4.20–6.4.22; and
- Shell Jackpine Mine EPEA Approval 153125-00-00, as amended.

"Operational Regional Wetlands Monitoring Program" prepared by CH2MHill, as an implementation plan based on the CEMA's recommended framework (CH2MHill 2013).

In 2015, the AER initiated an EPEA Oil Sands Mine Wetland Monitoring Program Working Group comprising representatives from AER, AEMERA, AEP, the Canadian Association of Petroleum Producers, and COSIA to interpret the wetland monitoring program *EPEA* approval conditions. Building from the foundational work of Ciborowski et al. (2012) and CH2MHill (2013), the working group developed recommendations for the core of the program on how to define monitoring objectives, monitoring questions, monitoring approaches and design, and specify the key drivers, stressors, and indicators (Cobbaert 2016; Ko 2016).

In a letter from AER to AEMERA on April 1, 2016, the EPEA Oil Sands Mine Wetland Monitoring Program Working Group recommended the following structure for a monitoring program to address the *EPEA* approval conditions (Ko 2016):

**Tiered Effects-based Monitoring Approach.** This approach is recommended by the EPEA Oil Sands Mine Wetland Monitoring Program Working Group to assess the causal relationship between oil sand mine activities and wetland condition. The approach comprises of five types of monitoring approaches to understand wetland change, identify the cause, and develop solutions. The five tiers of recommended monitoring include:

1. *Surveillance monitoring* to track change in wetland condition as a result of oil sands mine development. This would be composed of routine and baseline monitoring at regular intervals.
2. *Confirmation monitoring* to confirm that there is a change in wetland condition. This would focus on comparing results to the reference condition and increasing the sampling frequency.
3. *Focused monitoring* to assess the magnitude and extent of the change. This would increase the number of sampling locations and indicators to delineate the extent and magnitude.
4. *Investigation of cause* would use a research-focused approach determine the cause of the change.
5. *Investigation of solutions* to determine if there are ways to stop the change or mitigate the effects.

**Key Questions.** The EPEA Oil Sands Mine Wetland Monitoring Program Working Group identified two key questions to focus monitoring activities and address the key drivers associated with oil sands mines most likely to cause change. These questions focus on the dominant wetland types (i.e., treed bog, treed poor fen, treed rich fen, and coniferous swamp) adjacent to mine lease boundaries. The key questions are based on current knowledge and could be supplemented with preliminary research studies and expert opinions. To answer each question, the EPEA Oil Sands Mine Wetland Monitoring Program Working Group recommends a combination of regional remote sensing and local, mechanistic field studies.

1. Is hydrologic alteration from oil sands mines causing an effect on the ecological condition of the dominant wetland classes adjacent to the mine lease boundaries compared to the range of natural variability of the reference conditions? (Ko 2016)

2. Is there an effect of aerial deposition from oil sands mines in wetlands located in deposition pathways/plumes on the ecological condition of the dominant wetland classes compared to the natural variability of reference conditions? (Ko 2016)

**Key Drivers.** The recommended drivers are those considered by current knowledge to affect wetland condition through oil sands mine development. In addition to drivers associated with oil sands mine development, natural drivers should be incorporated into the monitoring design. Drivers include:

- Hydrologic alteration including flow, connectivity, and depressurization of surface water and groundwater (oil sands mine development driver);
- Aerial deposition from oil sands operations (oil sands mine development driver);
- Climate variability and change (natural driver);
- Fire (natural driver);
- Landscape attributes such as topography, bedrock permeability, and soil type and depth (natural driver);
- Invasive species ;
- Land disturbance.

**Key Stressors.** These are identified as the key wetland parameters that are impacted chiefly by oil sands mine development:

- Distance below ground to water table and water flow connectivity;
- Salts, cations-anions, and electrical conductivity;
- Nitrogen concentration;
- Contaminants, such as metals and Hg;
- pH and water acidity.

**Key Indicators to Monitor.** These are the recommended key indicators to monitor that could best assess the impacts from oil sand mine development on wetland conditions. The indicators are separated into environmental and biological indicators. In addition to the following recommended indicators, indicator selection should consider ability to diagnose and predict change, cost-effectives, and redundancy.

- Environmental indicators:
    - Surface water quality (e.g., TSS, EC, temperature, alkalinity, salinity, pH);
    - Water quantity (e.g., water table depth, hydrology connectivity, meteorological data);
    - Stable isotopes;
    - N concentration in water.

- Biological indicators:
    - Vegetation community diversity;
    - Amphibians;
    - Yellow Rails;
    - Waterfowl;
    - Species of concern;
    - Biodiversity.

The specific needs and recommendations by the EPEA Oil Sands Mine Wetland Monitoring Program Working Group should be considered in conjunction with developing a new wetland monitoring program for the Oils Sands Region in order to harmonizes the needs and resources of both programs.

### 2.6.5. Guidelines for Wetland Establishment on Reclaimed Oil Sands Leases

To provide guidance and a foundation for oil sands wetland reclamation, CEMA produced several editions of Guidelines for Wetland Establishment on Reclaimed Oil Sands Leases (Wetland Guide), which aims to present an integrated approach to the planning, design, construction, monitoring, adaptive management, and certification of wetlands reclaimed on surface-mined oil sands leases (CEMA 2014b). The Wetland Guide stresses that appropriate operation, monitoring, and adaptive maintenance throughout the reclamation process are critical to keeping wetlands on the trajectory toward reclamation certification (which can take at least 10 years). Effective monitoring of wetland trajectory relies on three key components:

- Performance measures inform reclamation practitioners of an indicator's performance, measured against an established threshold;
- Practitioners investigate the physical, chemical, biological and functional attributes of a wetland site to assess how well the system is performing;
- Monitoring begins as soon as the wetland system starts functioning and continues through to a pre-determined end (CEMA 2014b).

The Wetland Guide recommends a combination of monitoring activities that includes surveying watershed topography, delineating wetland boundaries and water elevation, water quality measurements, groundwater saturation, soil quality and peat thickness, vegetation establishment, coverage, and composition, and wildlife, wildlife habitat, and benthic invertebrate species (CEMA 2014b). Monitoring is recommended to integrate remote sensing techniques, field sampling, and field visual surveys. The Wetland Guide also acknowledges that the timing and level of effort can vary among sites and years as no two projects have the same goals and site characteristics.

## 2.7. Provincial Requirements – In Draft

The GoA is in the process of developing several policies and directives that are implicitly related to Alberta's wetlands and activities in the Oil Sands Region. While still under development, this section reviews the potential future needs of the following:

- Draft Alberta's Biodiversity Policy;
- Draft Directive for the Assessment of Thermally-Mobilized Constituents in Groundwater for Thermal Institute Operation;
- Draft Water Conservation Policy for Upstream Oil and Gas Operations.

### 2.7.1. Draft Alberta's Biodiversity Policy

The GoA is drafting the Alberta's Biodiversity Policy with the intention of setting provincial direction and aligning of the biodiversity management frameworks. The draft Alberta's Biodiversity Policy may also provide "context and high-level guidance for other activities that could affect biodiversity, such as species management, forest management, and energy and mineral sector planning and development" (GoA 2014a).

The draft Alberta's Biodiversity Policy aims to foster the continuation of a cumulative effects monitoring approach to support biodiversity management. While the draft Alberta's Biodiversity Policy does not specify wetland monitoring requirements, monitoring the state of wetland biodiversity with existing or new biodiversity monitoring initiatives maybe important to ensuring that the goals of the policy are achieved.

### 2.7.2. Draft Directive for the Assessment of Thermally-mobilized Constituents in Groundwater for Thermal Institute Operation

The GoA is developing a Directive for the Assessment of Thermally-mobilized Constituents in Groundwater for Thermal In Situ Operations (Thermal Directive) in accordance with requirements of the *EPEA* and the Lower Athabasca Region Groundwater Management Framework. The Thermal Directive aims to focus monitoring of non-saline aquifers within aquifer management units that are at higher risk. Under the directive, a high-risk non-saline aquifer could be defined as an aquifer that is "known to or has the potential to discharge to a wetland or wetland complex (i.e., marsh, fen, swamp, or shallow open water wetland)" (GOA 2016.). Monitoring the state of wetland water quantity, quality, extent and connectivity to non-saline aquifers is a need for this Thermal Directive.

### 2.7.3. Draft Water Conservation Policy for Upstream Oil and Gas Operations

The GoA is developing a Water Conservation Policy for Upstream Oil and Gas Operations in response to projected increases in non-saline water demands for the upstream oil and gas industry. Non-saline water demands have the potential to drive change for wetlands through changes in water availability and hydrologic connectivity. This policy aims to provide an update to the Water Conservation and Allocation Policy for Oilfield Injection. The intention is that the policy will emphasize the continued reduction of non-saline water and preference the use of alternatives to non-saline sources such as municipal/industrial wastewater and impaired quality groundwater (Wallace 2015).

While the draft policy does not specify wetland monitoring requirements, monitoring the state of wetland quality and quantity in relation to saturation and hydrologic connectivity maybe important to ensuring that the goals of the policy are achieved.

## 2.8. Wetland Expert and Stakeholder Needs Assessment Interviews

It is vital that the Wetland Monitoring Program be relevant to stakeholder needs and that it asks the questions that will address those needs. The ABMI engaged 50 wetland experts and stakeholders through a needs assessment interview process. The wetland experts and stakeholders represented a range of sectors, including federal and provincial government, industry (i.e., oil, gas, and forestry), academia, environmental monitoring, environmental consulting, and environmental non-governmental organizations. To understand the specific wetland management and monitoring needs, we asked each wetland expert and stakeholder the following two questions[9]:

1. *What are the wetland management and monitoring needs of your sector?*

[9] For a detailed description of the needs assessment Interviews as part of Developing a Wetland Monitoring Program for the Oil Sands Region, see Supporting Document 1: Identifying the Scope and Objectives of the Wetland Monitoring Program – A Three-phased Stakeholder Engagement Process.

2. *What key legislations, policies, frameworks, and regulatory requirements should a wetland monitoring program support?*

We received recommendations that the Wetland Monitoring Program should support the following and the bolded ones will be discussed in further detail[10]:

- **Alberta Wetland Policy;**
- ***Environmental Protection and Enhancement Act;***
- **Land-use Framework;**
- Ramsar Convention;
- Water for Life strategy;
- *Alberta Water Act;*
- *Public Lands Act;*
- *Wildlife Act;*
- Draft Alberta's Biodiversity Policy;
- Climate change policies;
- Wetland reclamation guidance.

### *Alberta Wetland Policy*

The majority of wetland experts and stakeholders recommended that the Wetland Monitoring Program should support the needs of the Wetland Policy. Collectively, they suggested that to support the Wetland Policy the Wetland Monitoring Program should:

- Monitor all types and hydroperiods of natural wetlands in the Alberta and in the Oil Sands Region. The classification of wetlands should be aligned with the AWCS;
- Develop a wetland inventory that maps and tracks changes over time in wetlands; e.g., the location, extent, abundance and classification of wetlands in the Oil Sands Region and throughout Alberta;
- Collect information in the field and by remotely sensed means on the condition of wetlands including information on their hydrology, water quality, and biodiversity;
- Track the condition of wetlands over time to detect change and understand the drivers of the observed change(s), which may include direct anthropogenic activities, land use changes, and/or climate change.

### *Environmental Protection and Enhancement Act*

To support the *EPEA's* aim of protection, enhancement, and sustainable use of environmental resources in the Oil Sands Region and comply with *EPEA* approval conditions, a majority of wetland experts and stakeholders recommended that the Wetland Monitoring Program should:

- Understand the connection between the implementation of the Alberta Wetland Policy and the *EPEA*. Some participants mentioned that the link between the mandate of the *EPEA* and that of the Alberta Wetland Policy must be clearly defined as it is currently only implicitly stated;

[10] The Alberta Wetland Policy, *EPEA*, and Land-use Framework were most frequently mentioned in the interviews and the recommends are further discussed in the section.

- Understand the natural range of variability of wetlands within or adjacent to areas with oil sands activities and within the in situ area. At present, this lack of information prevents determination of whether observed changes in wetland condition should be attributed to industrial activities or to natural factors such as climate change;
- Track the condition of reclaimed, restored, and created wetlands over time to assess how those ecosystems compare to natural wetlands. Some participants highlighted the need for the program to monitor the long-term trajectory of reclaimed/restored/created wetlands. In contrast, other participants argued that this type of monitoring is industry's responsibility and that public funds should not be used to monitor these wetlands.

### *Land-use Framework*

To support the Land-use Framework's goals of managing the cumulative effects of development on land, water, and air, wetland experts and stakeholders recommended that the Wetland Monitoring Program should:

- Develop a wetland inventory that maps and tracks changes over time in wetlands, including information on the location, extent, abundance and classification of wetlands in the Oil Sands Region and throughout Alberta. For example, under the BMF's Aquatic habitat pyramid, Aquatic and wetland native cover is a proposed Tier 1 indicator and Fen cover is a proposed Tier 2 indicator;
- Use wetland monitoring to support the development of environmental limits and targets for the regional plans;
- Use wetland monitoring to assess the efficacy of the Lower Athabasca Regional Plan and to support adaptive management decisions.

## 3. Summary of Wetland Management and Monitoring Needs

A monitoring program should provide the data to inform decision-making. It is important to understand and provide a direct connection to support the needs of the Wetland Management Framework. One of the goals in developing the Wetland Monitoring Program for the Oil Sands Region is to understand how such a program can complement, support, and be harmonized with existing water and wetland legislations, policies, and frameworks. To further examine the monitoring needs, we tabulated and assessed the specific monitoring needs within the Wetland Management Framework, as well as those expressed by the interviewed wetland experts and stakeholders. This section describes the process and outcomes of this analysis. After grouping and assessing the explicit and implicit wetland management and monitoring needs of the Wetland Management Framework and interviews with wetland experts and stakeholders, it was evident that those needs could be organized into five broad categories.

The five broad monitoring needs are:

1. **Collect baseline data to characterize the natural variability of wetlands.**

   Collecting baseline data was the primary need for both the Wetland Management Framework and wetland experts and stakeholders. Establishing baseline data is a first step for any monitoring program, whether field- or remote sensing-based. In order to track change, it is necessary to develop a dataset of current wetland conditions in the region. A long-term monitoring program will then be able to compare measurements to the baseline data or reference condition and detect change. For the Wetland Monitoring Program, this monitoring need translates to questions such as "*What are the depth, duration, frequency, and seasonality of wetland saturation?*"

2. **Detect change in wetlands over time (through status and trend monitoring) and identify the cause(s) of change.**

   The central purpose of a monitoring program is to track change that may occur over time and, ideally, identify the cause of negative change in order to find solutions. Based on our review of management frameworks and recommendations from wetland experts and stakeholders, it is clear that detecting wetland change is critical. To this end, it is vital to understand both what is changing and what is causing the change. For the Wetland Monitoring Program, this monitoring need translates to questions such as "*Do the depth, duration, frequency, and seasonality of wetland saturation change over time?*"

3. **Identify and measure the effects of climate change on wetlands.**

   As northern high-latitude regions, such as the Oil Sands Region, are expected to experience some of the greatest temperature increases in the near future (IPCC 2014), establishing a monitoring program that tracks the impacts of climate change on wetlands was a commonly expressed need among wetland experts and stakeholders. For the Wetland Monitoring Program, this monitoring need translates to questions such as "*What are the effects of climate change on the depth, duration, frequency, and seasonality of wetland saturation*?"

4. **Track the long-term trajectory of reclaimed wetlands.**

   In the Oil Sands Region, the Wetland Management Framework establishes the need, process, and guidelines for reclamation. A majority of wetland experts and stakeholders brought up the need to

track the long-term trajectory of reclaimed wetlands in order to determine if reclaimed wetlands are indeed comparable to natural wetlands. There was disagreement on whether it is the responsibility of a regional monitoring program or of industry to monitor reclaimed wetlands. However, monitoring reclaimed wetlands does rely on baseline data from reference natural wetlands. For this reason, this broad monitoring need should be considered and evaluated. For the Wetland Monitoring Program, this monitoring need translates to questions such as *"Are the depth, duration, frequency, and seasonality of saturation in reclaimed wetlands equivalent to those under reference conditions?"*

5. **Assess the efficacy of the Wetland Management Framework and support adaptive management decisions.**

   This monitoring need is less focused on specific types of monitoring data and more on using monitoring data holistically to evaluate the success of the management framework. For example, there is a need for wetland monitoring data to be used to assess whether the Wetland Policy is achieving its goal to "conserve, restore, protect and manage Alberta's wetlands to sustain the benefits they provide to the environment, society and economy" (GoA 2013a).

Under these broad monitoring needs and wetland characteristics, we compiled the specific data needs of the Wetland Policy, *EPEA*, Land-use Framework, other components of the management framework, and key sectors in the Oil Sands Region (Table 2). These data needs were generated by evaluating the Wetland Management Framework, as well as through review by the respective policy experts at the GoA and AER. The policy experts evaluated the table and provided comments on the accuracy of captured data needs. Both explicit and implicit data needs are detailed. Each document used and personal communication with a wetland expert or stakeholder is referenced. While the table may not capture every monitoring data need, we compiled as extensive a list as possible. The main goal of the Table 2 is to characterize common and unique monitoring data needs.

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| **Collect baseline data to characterize the natural variability of wetlands** | Wetland location, area, extent, and classification | • Location and abundance of wetlands of each class. [a]<br>• Location of reference, restored, replacement, and impacted wetlands in the landscape to support the Alberta Wetland Inventory, as a Knowledge and Information System support by the Wetland Policy. [a] | • Location of wetland habitat in relation to land use activities. [c, d]<br>• Data on Aquatic and wetland native cover, a proposed Tier 1 indicator, and Fen cover, a proposed Tier 2 indicator, to support the draft Lower Athabasca Region Biodiversity Management Framework. [e] | • Extent, location, class and distribution of wetlands in the Oil Sands Region and their variation due to surficial geology, soils, and topography. [g, h, w] | • Forestry – Location of wetlands for harvesting plans, road development, and best management practices. [i, j]<br>• Wildland Fire – Location of wetlands to track soil moisture over the fire season. [j]<br>• Waterfowl and Migratory Bird Management – Wetland location to track species distribution and habitat. [j, k, l]<br>• Academia – Functional baseline wetland inventory with accessible data on a wall-to-wall scale. Focus on swamps and intermittent wetlands. [j]<br>• Environmental Monitoring – Baseline wetland inventory of wetland area. [j]<br>• General Public – Inform Albertans about wetland locations to encourage wetland stewardship. [a, j, m] |
| | Physicochemical conditions of water (water quality) | • Water quality improvement is a central function contributing to relative wetland value. [a, b]<br>• Water quality data to support a wetland value assessment tool, such as a Green Area ABREWT-A Tool. [b]<br>• Provide water quality data to support a publicly accessible database and reporting tool. [a] | | • Wetland water quality indicators to monitor natural variability (e.g., TSS, EC, temperature, alkalinity, salinity, cations and anions, and pH, stable isotopes, N concentration). [g, h, p, w] | • Water for Life – Data on wetland water quality for effective decision making. [m]<br>• Water Management Frameworks – Data on wetland water quality as part of the larger watershed. [n, q, r]<br>• Industrial – Normal range of water quality to assess the trends and causes. [j]<br>• Environmental Monitoring – Establish a wetland water quality baseline. [j] |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Physicochemical conditions of sediment (sediment quality) | • Data on sediment retention and stabilization to support a wetland value assessment tool, such as a Green Area ABREWT-A Tool. [b]<br>• Provide sediment quality data to support a publically accessible database and reporting tool. [a] | | | Academia – Better baseline soil data and information. [j] |
| | Distribution, abundance, productivity, and health of wetland fauna and flora | • Biodiversity is a central function contributing to relative wetland value. [a]<br>• Data on fish habitat, invertebrate habitat, amphibian habitat, waterbird habitat, bird and mammal habitat, and native plant and pollinator habitat to support a wetland value assessment tool, such as a Green Area ABREWT-A Tool. [b]<br>• Provide biodiversity data to support a publically accessible database and reporting tool. [a] | Data on Aquatic and wetland biodiversity intactness, a proposed Tier 1 indicator, to support the draft BMFs. [e] | • Biological response indicators to monitor wetland natural variability (e.g., vegetation community, amphibian health, lichens and mosses, biodiversity, Yellow Rail, and waterfowl). [g, h, p] | • Water Management Frameworks – Biodiversity. [n, q, r]<br>• Wildlife Management – Need a baseline of wetland biodiversity to make management decisions, especially on key species such as caribou, waterfowl, amphibians, and migratory birds. [j, l]<br>• Environmental Monitoring – Baseline vegetation composition and wetland inventory to assess biodiversity. [j]<br>• General Public – Albertans want to know about biodiversity and the variety of wetland species. [a, j, m] |
| | Depth, duration, frequency, and seasonality of wetland saturation | • Data on wetland saturation to support a Green Area ABREWT-A Tool. [b]<br>• Provide wetland saturation data to support a publically accessible database and reporting tool. [a] | | • Wetland saturation indicators to monitor wetland natural variability (e.g., water table depth, flow). [g, h, p, w] | • Wildland Fire – Yearly information on soil moisture and fuel availability over the fire season. [j]<br>• Waterfowl and Migratory Birds – Habitat availability, which relates to wetland saturation. [k, l] |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Wetland interaction with groundwater and surface water (e.g., recharge, discharge, and connectivity) | • Data on hydrologic function for relative wetland value assessment. [a]<br>• Data on water storage and delay and stream flow to support a wetland value assessment tool such as a Green Area ABREWT-A Tool. [b]<br>• Provide hydrologic connectivity data to support a publically accessible database and reporting tool. [a] | Groundwater quantity and connectivity to wetlands to support Secondary Groundwater Quantity Indicators for the Lower Athabasca Groundwater Management Framework. [f] | • Hydrologic connectivity indicators (e.g., stable isotopes to identify primary water sources and residence times) to monitor wetland natural variability and assess influence of oil sands mining on surface water and ground water alteration gradient. [g, h, p, w] | • Water for Life – Need baseline information on how wetlands contribute to water storage within the landscape. [m]<br>• Water Management Framework – Need to know how wetlands contribute to the water budget within the landscape. [m, n, q]<br>• Environmental NGO Sector – Need baseline information to understand how impacts like dewatering change wetland hydrology. [j]<br>• Academia – Need for hydrologic connectivity understanding in the boreal. Challenging but closely tied to wetland location, extent, and resiliency. [j] |
| | Carbon, phosphorus, nitrogen, etc., produced, retained, and exported by wetlands (biogeochemical cycling) | • Data on phosphorous retention, nitrate removal and retention, and organic nutrient export to support a wetland value assessment tool, such as a Green Area ABREWT-A Tool. [b]<br>• Provide biogeochemical data to support a publicly accessible database and reporting tool. [a] | | | • ENGO – Baseline conditions of wetland (peatlands) carbon sequestration contribution potential. [j]<br>• Academia – Baseline understanding of nitrogen cycling. [j]<br>• Environmental Monitoring – Continue baseline from RAMP and AEMERA on acid deposition to water bodies and extend it to wetlands. [j] |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| **Detect wetlands change over time and identify the cause (s) of change.** | Wetland location, area, extent, and classification | • Track the gains and losses of wetland extent to evaluate the efficacy of the Wetland Policy. [a]<br>• Track wetland restoration and mitigation in the landscape to ensure that functions are not being lost. If they are being lost, need to attribute loss to environmental factors, anthropogenic factors, or cumulative effects. [a, o] | • Track wetland area to understand if wetland loss is occurring due to land use changes. [c, e]<br>• Track changes to Aquatic and wetland cover, a proposed Tier 1 indicator, and Fen cover, a proposed Tier 2 indicator, for cumulative effects to biodiversity in the draft LAR BMF. [e] | Track wetland delineation and classification to assess whether change/loss can be attributed to oil sands mine development effects of hydrologic alteration and aerial deposition on wetlands near oil sands mine leases. [g, h, p, w] | • Forestry – Track wetland loss to assess whether loss is due to forestry practices. [c, i, j]<br>• Waterfowl and Migratory Bird Management – Need to track wetland loss to understand changes to bird populations. [j, k, l]<br>• Environmental Monitoring – Need routine updates in wetland inventory to track land use change over time. [j]<br>• General Public – Inform Albertans about how much and where wetlands are gained and lost, and understand the drivers of change. [a, j, m] |
| | Physicochemical conditions of water (water quality) | • Track degradation of wetland water quality to inform decisions to restore those functions through mitigation and modify the driver(s) of change. [a]<br>• Assess the efficacy of the Wetland Policy to "avoid and minimize" impacts on wetland water quality. [a]<br>• Identify cause-effect relationships of anthropogenic activities to wetland water quality to inform wetland best management practices. [j] | Track wetland water quality as a supporting indicator for the BMFs to assess whether land use changes are a driver of change. [e] | Track wetland water quality indicators (e.g., TSS, EC, temperature, alkalinity, salinity, cations and anions, and pH, stable isotopes, N concentration, passive air sampling) to assess whether effects can be attributed to oil sands mine development effects of hydrologic alteration and aerial deposition on wetlands near oil sands mine leases. [g, h, p, w] | • Water for Life – Understand changes to wetland water quality for decision-making. [m]<br>• Water Management Frameworks – Need to know whether there are changes to wetland water quality that might be indicators for larger changes in the watershed. [n, q, r]<br>• Environmental Monitoring – Need to track wetland water quality to inform biodiversity intactness calculations. [j]<br>• General Public – Inform Albertans about the trend of wetland water quality and identify the cause(s) of change. [m] |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Physicochemical conditions of sediment (sediment quality) | • Track degradation of wetland soil quality to inform decisions to restore those functions through mitigation and modify the driver(s) of change. [a]<br>• Assess the efficacy of the Wetland Policy to "avoid and minimize" impacts on wetland soil quality. [a]<br>• Identify cause-effect relationships of anthropogenic activities to wetland soil quality to inform wetland best management practices. [j] | | | Environmental Monitoring – Need spatially-explicit soil quality information for ecosite mapping. [j] |
| | Distribution, abundance, productivity, and health of wetland fauna and flora | • Track changes in wetland biodiversity to inform decisions to restore those functions through mitigation and modify the driver(s) of change. [a]<br>• Assess the efficacy of the Wetland Policy to "avoid and minimize" impacts on wetland biodiversity. [a]<br>• Identify cause-effect relationships of anthropogenic activities to inform wetland best management practices. [j] | Track changes to Aquatic and wetland biodiversity intactness, a proposed Tier 1 indicator in the draft BMFs, for cumulative effects to biodiversity from land use changes. [e] | Track impacts to wetland biodiversity indicators (e.g., vegetation community, amphibian health, lichens and mosses, biodiversity, yellow rail, and waterfowl) to assess whether effects can be attributed to oil sands mine development effects of hydrologic alteration and aerial deposition on wetlands near oil sands mine leases. [g, h, p, w] | • Wildlife Management – Track wetland flora and fauna to make management decisions if species decline, especially on key species such as caribou, waterfowl, amphibians, and migratory birds. [j, l]<br>• Fish and Wildlife – Track wetland fish and wildlife species and assess population changes. [j]<br>• General Public – Albertans want to know if there are declines in biodiversity, specific species, and what is driving them. |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Depth, duration, frequency, and seasonality of wetland saturation | • Track changes in wetland saturation to inform decisions to restore those functions through mitigation and modify the driver(s) of change. [a]<br>• Assess the efficacy of the Wetland Policy to "avoid and minimize" impacts on wetland saturation. [a]<br>• Identify cause-effect relationships of anthropogenic activities to wetland saturation to inform wetland best management practices. [j] | | Track wetland saturation indicators (e.g., water table depth, flow) to assess whether effects can be attributed to oil sands mine development effects of hydrologic alteration and aerial deposition on wetlands near oil sands mine leases. [g, h, p, w] | • Wildland Fire – Track changes to soil moisture and fuel availability over the fire season. [j]<br>• Waterfowl and Migratory Bird Management – Track changes to habitat availability, which relates to wetland saturation. [k, l]<br>• Environmental Monitoring – Need to track wetland saturation to inform biodiversity intactness calculations. [j] |
| | Wetland interaction with groundwater and surface water (e.g., recharge, discharge, and connectivity) | • Track changes in wetland hydrologic connectivity to inform decisions to restore those functions through mitigation and modify the driver(s) of change. [a]<br>• Assess the efficacy of the Wetland Policy to "avoid and minimize" impacts on wetland hydrologic connectivity. [a]<br>• Identify cause-effect relationships of anthropogenic activities to wetland hydrology to inform wetland best management practices. [j] | Track groundwater quantity and connectivity to wetlands to support Secondary Groundwater Quantity Indicators for the Lower Athabasca Groundwater Management Framework. [f] | Track wetland hydrologic connectivity indicators (e.g., stable isotopes to identify primary water sources and residence times) to assess whether effects can be attributed to oil sands mine development effects of hydrologic alteration and aerial deposition on wetlands near oil sand mine leases. [g, h, p, w] | • Water for Life - Track changes to water storage within the landscape. [m]<br>• Water Management Framework – Track how wetland hydrologic connectivity changes and where the drivers of changes are in the landscape. [m, n, q, r] |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Carbon, phosphorus, nitrogen, etc. produced, retained, and exported by wetlands (biogeochemical cycling) | • Track changes in wetland biogeochemical cycling to inform decisions to restore those functions through mitigation and modify the driver(s) of change. [a]<br>• Assess the efficacy of the Wetland Policy to "avoid and minimize" impacts on wetland biogeochemical cycling. [a]<br>• Identify cause-effect relationships of anthropogenic activities to wetland biogeochemical cycling to inform wetland best management practices. [j] | | | • ENGO and Climate Change Policy – Track changes in wetland (peatland) carbon sequestration contribution potential. [j]<br>• Academia – Track change in nitrogen cycling with anthropogenic inputs and climate. [j] |
| **Identify and measure the effects of climate change on wetlands** | Wetland location, area, extent, and classification | While not explicitly mentioned in the Wetland Policy, there is a management need to assess the effect of climate on wetland extent separately from other drivers' effects in order to determine the relative effect of each driver. [a] | • There is an implicit need to track the gains and losses of wetland habitat to assess the relative contribution of climate change. [c]<br>• There is an implicit need to track changes to Fen cover, a proposed Tier 2 indicator in the draft LAR BMF, to assess climate change impacts. [e] | | • Waterfowl and Migratory Birds – Need to track wetland loss to understand changes to bird populations. [j, k, l]<br>• General Public – Inform Albertans about where wetlands are gained and lost, and understand the drivers of change. [a, j, m] |
| | Physicochemical conditions of water (water quality) | While not explicitly mentioned in the Wetland Policy, there is a management need to assess the effect of climate on wetland water quality separately from other drivers' effects in order to determine the relative effect of each driver. [a] | | | Water for Life – Understand changes to wetland water quality for decision-making. [m] |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Physicochemical conditions of sediment (sediment quality) | While not explicitly mentioned in the Wetland Policy, there is a management need to assess the effect of climate on wetland sediment quality separately from other drivers' effects in order to determine the relative effect of each driver. [a] | | | |
| | Distribution, abundance, productivity, and health of wetland fauna and flora | While not explicitly mentioned in the Wetland Policy, there is a management need to assess the effect of climate on wetland biodiversity separately from other drivers' effects in order to determine the relative effect of each driver. [a] | There is an implicit need to track changes to Aquatic and wetland biodiversity intactness, a proposed Tier 1 draft BMF indicator, to assess impact of climate change. [e] | | • Wildlife Management – Track wetland flora and fauna to make management decisions if species decline, especially for key species such as caribou, waterfowl, amphibians, and migratory birds. [j, l]<br>• Fish and Wildlife – Track wetland fish and wildlife species and assess population changes. [j] |
| | Depth, duration, frequency, and seasonality of wetland saturation | While not explicitly mentioned in the Wetland Policy, there is a management need to assess the effect of climate on wetland saturation separately from other drivers' effects in order to determine the relative effect of each driver. [a] | | | |
| | Wetland interaction with groundwater and surface water (e.g., recharge, discharge, and connectivity) | While not explicitly mentioned in the Wetland Policy, there is a management need to assess the effect of climate on hydrologic connectivity separately from other drivers' effects in order to determine the relative effect of each driver. [a] | There is an implicit need to track groundwater quantity and connectivity to wetlands to support Secondary Groundwater Quantity Indicators for the Lower Athabasca Groundwater Management Framework to assess impact of climate change. [f] | | Water for Life – Track changes to water supply due to climate change for decision-making. [m] |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Carbon, phosphorus, nitrogen, etc., produced, retained, and exported by wetlands (Biogeochemical cycling) | While not explicitly mentioned in the Wetland Policy, there is a management need to assess the effect of climate on wetland biogeochemical cycling separately from other drivers' effects in order to determine the relative effect of each driver and the contribution of wetlands to greenhouse gas sequestration, storage, and emissions (forest fire, mining). [a] | | | |
| **Track the long-term trajectory of reclaimed wetlands** | Wetland location, area, extent, and classification | Track the number and extent of reclaimed wetlands in the Oil Sands Region to support wetland mitigation and policy evaluation. [a, r] | Track changes to Fen cover, a proposed Tier 2 indicator in the draft LAR BMF, to assess the efficacy of management actions on wetland mitigation. [e] | Track delineation of wetland boundary/standing water and water elevation from construction to certification of a reclaimed wetland. [v] | Waterfowl and Migratory Bird Management – Need to track wetland reclamation to understand changes to species populations. [j, k, l] |
| | Physicochemical conditions of water (water quality) | • Long-term data to track the water quality of reclaimed wetland over time to determine if it is equivalent to that of reference wetlands. [a, r]<br>• Track the long-term water quality improvement of reclaimed wetlands to assess the effectiveness of the Wetland Policy at protecting and maintaining wetland functions. [a] | | • Use baseline wetland water quality data to assess the trajectory of reclaimed wetland prior to and through certification. [p]<br>• Track fen water quality in reclaimed fens; specifically measure pH, $HCO_2$, specific conductivity, and $Ca^{2+}$. [u] | Water for Life – Understand how wetland reclamation changes water quality. [m] |
| | Physicochemical conditions of sediment (sediment quality) | Long-term data to track the soil quality of reclaimed wetland over time to determine if it is equivalent to that of reference wetlands. [a, r] | | • Use baseline wetland soil quality data to assess the trajectory of reclaimed wetland prior to and through certification. [p]<br>• Track soil salinity and peat thickness from construction to certification of a reclaimed wetland. [v] | |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Distribution, abundance, productivity, and health of wetland fauna and flora | • Long-term data to track the biodiversity of reclaimed wetland over time to determine if it is equivalent to that of reference wetlands. [a, r]<br>• Track the long-term biodiversity function of the reclaimed wetlands to assess the effectiveness of the Wetland Policy at protecting and maintaining wetland functions. [a] | Track changes to Aquatic and wetland biodiversity intactness, a proposed Tier 1 draft BMF indicator, to assess the efficacy of management actions on wetland reclamation. [e] | • Use baseline wetland biodiversity data to assess the trajectory of reclaimed wetland prior to and through certification. [p]<br>• Track marsh open-water zone plant Index of biotic integrity for reclaimed wetlands. [u]<br>• Track marsh wet meadow plant Index of biotic integrity for reclaimed wetlands. [u]<br>• Track vegetation establishment, plant productivity, coverage, composition, invasive plants, traditional use species, wildlife habitat, wildlife use, and benthic invertebrate species abundance from construction to certification of a reclaimed wetland. [v] | • Wildlife Management – Track wetland biodiversity change with respect to wetland reclamation. [j, l]<br>• Fish and Wildlife – Track wetland fish and wildlife species and assess population changes with respect to reclaimed wetlands. [j] |
| | Depth, duration, frequency, and seasonality of wetland saturation | Long-term data to track the water saturation of reclaimed wetland over time to determine if it is equivalent to that of reference wetlands. [a, r] | | • Use baseline wetland water saturation data to assess the trajectory of reclaimed wetland prior to and through certification. [p]<br>• Track the hydroperiod of reclaimed wetlands. [u] | Academia – Track wetland saturation to understand reclaimed wetland trajectory and resiliency to future natural and anthropogenic disturbances. [j] |

| | | Monitoring Data Needs | | | |
|---|---|---|---|---|---|
| **Monitoring Need** | **Wetland Characteristics** | **Alberta Wetland Policy** | **Land-use Framework** | **Environment Protection and Enhancement Act** | **Other** |

**Table 2.** Summary of the monitoring data needs of the Wetland Management Framework.

| | | | | | |
|---|---|---|---|---|---|
| | Wetland interaction with groundwater and surface water (e.g., recharge, discharge, and connectivity) | • Long-term data to track the hydrologic connectivity of reclaimed wetland over time to determine if it is equivalent to that of reference wetlands. [a, r]<br>• Track the long-term hydrologic connectivity function of the reclaimed wetlands to assess the effectiveness of the Wetland Policy at protecting and maintaining wetland functions. [a] | Track groundwater quantity and connectivity to wetlands to support Secondary Groundwater Quantity Indicators for the Lower Athabasca Groundwater Management Framework.[f] | Use baseline wetland hydrologic connectivity data to assess the trajectory of reclaimed wetland prior to and through certification. [p] | |
| | Carbon, phosphorus, nitrogen, etc. produced, retained, and exported by wetlands (biogeochemical cycling) | Long-term data to track the biogeochemical cycling of reclaimed wetland over time to determine if it is equivalent to that of reference wetlands. [a, r] | | Use baseline wetland biogeochemical cycling data to assess the trajectory of reclaimed wetland prior to and through certification. [p] | • Academia – Track biogeochemical cycling to understand reclaimed wetland resiliency. [j] |

a. GoA 2013a.
b. GoA2015d
c. GoA2008b.
d. GoA2012b.
e. GoA2014b.
f. GoA2012c.
g. Ciborowski et al. 2012.
h. Ko 2016 .
i. GoA 2012a.
j. Personal communication as part of Stakeholder and Wetland Expert Interviews.
k. Government of Canada 1994a.
l. Alberta North American Waterfowl Management Plan Partnership 2008.
m. GoA 2008d.
n. GoA 1999.
o. Government of Canada 1991.
p. CEMA 2014.
q. GoA 2006.
r. GoA 2008c.
s. GoA 2015c.
t. GoA 2008a.
u. GoA 2013b.
v. CEMA 2014b.
w. Cobbaert 2016.

# 4. Summary, Synthesis, and Conclusion

## 4.1 Summary

The Wetland Monitoring Program has the potential to provide field and remote-sensing data of use both within the Wetland Management Framework and to stakeholders. By understanding the Wetland Management Framework's monitoring data needs, the Wetland Monitoring Program can be developed to provide data and guidance that will both inform management decisions and determine the efficacy of individual management framework components.

The legislation, policies, and frameworks reviewed in this report, along with their respective wetland management manadates, monitoring needs, and explicit wetland metrics or indicators, are summarized in Table 1. Each of the pieces of the Wetland Management Framework has a management mandate for wetlands, in varying degrees of specificity and scale. While not all of the reviewed the piece of the Wetland Management Framework have explicit monitoring needs, most rely on monitoring to support and inform management action. The monitoring needs generally involve establishing a baseline and tracking change over time, at both the regional and site-specific scales. Approximately half of the reviewed the pieces of the Wetland Management Framework explicitly define variables or indicators to monitor. The most common include: a) wetland location, extent, and classification, b) wetland water quality and quantity indicators, and c) vegetation communities. The Wetland Policy, Land-use Framework and Environmental Management Frameworks, *EPEA* approval conditions for oil sands mine operators, and wetland reclamation requirements have the most specific indicators, such as Fen cover and marsh wet meadow plant index of biotic integrity. Understanding and categorizing management mandates, monitoring needs, and specific metrics and indicators provides a basis from which the Wetland Monitoring Program can select indicators that align most closely with wetland legislations, policies, and frameworks, and effectively inform management decisions.

## 4.2 Synthesis and Conclusion

Wetlands serve as common threads among environmental policies with varying mandates. By understanding the Wetland Management Framework's monitoring data needs, the Wetland Monitoring Program can be developed to provide data and guidance that will both inform management decisions and determine the efficacy of individual management framework components. Our review of the Wetland Management Framework and interviews with wetland experts and stakeholders highlighted the following key messages.

### *Overarching Support*

- **Support the Wetland Management Framework**
  Ideally, a monitoring program should support all of the needs within the Wetland Management Framework. To that end, it is necessary to understand the fundamental needs and interconnectedness of the Wetland Management Framework. However, the Wetland Monitoring Program, in practice, cannot monitor everything. It is critical to review the extensive breadth of international, federal, and provincial legislations, policies, and framework necessary to understand the fundamental needs and interconnectedness.

- **Monitor Policy Relevant Variables**

You manage what you measure. To support management decisions, which are guided by policy, is it critical to collect the variables relevant to and used by the key policies.

- **Be Adaptive and Responsive**
  A monitoring program should be adaptive and responsive to the existing and emerging needs of legislations, policies, and frameworks. At the same time, a monitoring program should provide relevant data that allow for adaptive management action to respond to monitored change.

- **Publically Available Data**

  Protecting, conserving, and managing wetlands in Alberta and specifically the Oil Sands Region is a collaborative effort among many stakeholders – different sectors, organizations, and administrations. When feasible[11], publicly available data collected with standardized protocols ensure that all wetland experts and stakeholders have equal access, regardless of affiliation. Freely accessible, standardized data and protocols can contribute to improved wetland management and help fulfill the mandates of legislations, policies, and frameworks.

### *Potential for Alignment*

As recognized by the wetland experts and stakeholders, the Wetland Policy, Land-use Framework, and *EPEA* are the principal legislations, policies, and frameworks that the Wetland Monitoring Program could support. They work in concert to support other mandates within Alberta's Wetland Management Framework. In supporting the *EPEA*, the Wetland Policy, and the Land-use Framework, the other legislations, policies, and frameworks at the federal and provincial level would also be supported. In the section below, we discuss the Alberta Wetland Policy, Land-use Framework, and *EPEA* and provide examples of how the monitoring program can support their needs.

- **Alberta Wetland Policy**
  The Wetland Policy works in concert to support the needs of many international, federal, and provincial environmental policies, and the Federal Policy on Wetland Conservation, *Water Act*, and Water for Life Strategy in particular. As the Wetland Policy is central to wetland management in Alberta, the Wetland Policy implementation and decisions could benefit from a monitoring program that is aligned with its management and monitoring needs.

  - *Monitor the location, extent, and classification of wetlands in the Green Area*
    There is a monitoring need for Wetland Policy to create a baseline of the location, extent, and classification of wetlands in the Green Area to determine whether there is a loss or gain of wetland area over time. The Wetland Monitoring Program aims to include a remote sensing component that could be tailored to tracking the location, extent, and classification of wetlands in the region.

  - *Baseline to establish relative wetland values in the Oil Sands Region*
    As the Wetland Policy is implemented in the Green Area, the ABREWT-A tool can be used to establish relative wetland value. However, it will need to be calibrated. To do so, information on the natural variability of the different wetland classes and types is necessary.

[11] Publically available data caveat for industry partner compliance where prohibited by privacy laws and business considerations.

The Wetland Monitoring Program has the potential to collect information on the natural range of variability.

- *Monitor wetland function*
  As the Wetland Policy is function based, the monitoring needs center on tracking wetland function over time. The key wetland function metrics to track include: water storage, water cooling, sediment retention and stabilization, phosphorous retention, nitrate removal and retention, organic nutrient export, fish habitat, invertebrate habitat, amphibian habitat, waterfowl habitat, mammal habitat, and human use. The Wetland Monitoring Program could be developed to monitor variables that are indicators for wetland function.

- **Land-use Framework's Regional Plans and Management Frameworks**

  The Land-use Framework aims to manage the long-term cumulative effects of development on the environment at a regional level by developing regional plans and management frameworks. These management frameworks, such as the BMFs, build on Alberta's policies and regulations. With respect to wetlands, the Land-use Framework supports the *Water Act*, *Public Lands Act*, *EPEA*, and Wetland Policy and other federal and provincial polices. The Land-use Framework, and planning in the LAR in particular, could benefit from a wetland monitoring program that tracks wetland-related variables and indicators in the management frameworks.

  - *Wetland and land use location and extent*
    Knowing the location of wetlands and their geographic relationship to anthropogenic activities in an ever-changing landscape is critical. As the Wetland Monitoring Program aims to link remote sensing measurements with field collected data, the Wetland Monitoring Program can continue to improve the tracking of wetland locations in relation to land use activity in the Oil Sands Region.

  - *Environmental Management Framework indicators*
    In the LAR, the Environmental Management Frameworks contain a suite of indicators that have been selected to reflect regional conditions and trigger management action, if warranted. Some of those indicators are related to wetlands. To support the established decision-making process, the Wetland Monitoring Program could monitor indicators such as Aquatic and wetland native cover, Fen cover, and Aquatic and wetland biodiversity intactness.

- ***EPEA* Approval Conditions**

  The *EPEA* is the primary environmental statute in Alberta that supports and promotes the protection, enhancement, and wise use of the environment and ensures its preservation. In addition, the *EPEA* supports the mandates of other policies, such as the *CEAA*, *Wildlife Act*, and Land-use Framework. Further, there is an *EPEA* approval condition for oil sands mine operators to develop and implement a regional wetland monitoring program. The *EPEA* implementation and compliance by oil sands mine operators could benefit from a monitoring program that is aligned with its management and monitoring needs.

  - *Use a tiered effects-based monitoring approach*
    To assess the effect of oil sands mine development on wetlands, the AER recommends a tiered approach to monitoring: surveillance, confirmation, focused monitoring of extent and magnitude, research-oriented investigation of cause, and investigation of solutions. To align

with this recommendation, the Wetland Monitoring Program could be structured with a tiered effects-based monitoring approach.

- *Monitor the natural variability of wetlands and establish a baseline of wetland condition*
  A key component of the *EPEA* approval conditions is to monitor natural wetlands for natural variability. This is an important step toward understanding whether effects are meaningful and teasing out whether change can be attributed to mine development or other confounding factors such as climate.

- *Monitor and assess the potential effects of hydrologic alteration from oil sands mines on wetlands.*
  To comply with the *EPEA* approval conditions, the AER recommends oil sands mine operators focus monitoring to track the effects of hydrologic alteration on wetlands. Key indicators the Wetland Monitoring Program could measure include water level, vegetation community, stable isotopes to identify water sources, water quality, and wetland extent and boundaries.

- *Monitor and assess the potential effects of aerial deposition from oil sands mines on wetlands.*
  To comply with the *EPEA* approval conditions, the AER recommends oil sands mine operators additionally focus monitoring to track the effects of aerial deposition on wetlands. Key indicators the Wetland Monitoring Program could measure include wetland extent and boundaries, vegetation community, and air chemistry data.

The Wetland Monitoring Program aims to link field measurements with remote sensing data to provide a multi-scale assessment of wetland conditions to support and inform management decisions in the Oil Sands Region. Reviewing the extensive breadth of international, federal, and provincial legislation, policies, and frameworks highlights the fundamental needs and interconnectedness of the Wetland Management Framework in the Oils Sands region and Alberta. In developing the Wetland Monitoring Program, the needs of the Wetland Policy, *EPEA*, and Land-use Framework, as well as those of other federal and provincial policies, such as the Convention on Biodiversity Treaty, *Migratory Birds Convention Act*, *Species at Risk Act*, and wetland reclamation requirements, should be considered. A monitoring program that tracks policy-relevant variables, responds and adapts to change, and enhances collaboration and partnership will fundamentally help achieve the mandates of the management framework, inform management decisions, and assess the efficacy of each pieces of the Wetland Management Framework.

## 5. Glossary and Acronyms

| | |
|---|---|
| ABMI | Alberta Biodiversity Monitoring Institute |
| ABWRET-A | Alberta Wetland Rapid Evaluation Tool – Actual |
| AEMERA | Alberta Environmental Monitoring, Evaluation, and Reporting Agency |
| AEP | Alberta Environment and Parks |
| Wetland Policy | Alberta Wetland Policy |
| ALSA | Alberta Land Stewardship Act |
| AWCS | Alberta Wetland Classification System |
| BMF | Biodiversity Management Framework |
| CAC | Component Advisory Committees |
| CBD | Convention on Biological Diversity |
| CEAA | Canadian Environmental Assessment Agency |
| CEMA | Cumulative Environmental Management Association |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| COSIA | Canada's Oil Sands Innovation Alliance |
| Cumulative Effects | The combined effects of past, present and reasonably foreseeable land use activities, over time, on the environment. |
| DUC | Ducks Unlimited Canada |
| Energy Resources | Oil, natural gas, oil sands, coal, and electrical energy; and the pipelines and transmission lines to move the resources to market. |
| EPEA | Environmental Protection and Enhancement Act |
| ESRD | Environment and Sustainable Resource Development |
| EMCLA | Ecological Monitoring Committee for the Lower Athabasca |
| FMA | Forest Management Agreement |
| FMP | Forest Management Plan |
| GoA | Government of Alberta |

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|---|---|
| Ground Rules Framework | Alberta Timber Harvest Planning and Operating Ground Rules Framework |
| Groundwater Framework | Lower Athabasca Region Groundwater Management Framework |
| Indicator | A measurable characteristic of the environment from which one can infer the magnitude of stress, degree of exposure to the stressor, or degree of environmental response to the stressor exposure that an ecosystem has experienced. Indicators may be biological (e.g., biological indicators/bioindicators/biological metric), or chemical/physical in nature (e.g., environmental indicators). They are often, but not always, linearly related to ecosystem condition. Ideal indicators should be biologically or socially relevant; diagnostic; anticipatory; consistent; interpretable; verifiable; explicable; integrative; broadly applicable; quantifiable; able to be measured in a way that is cost-effective, timely, and non-destructive to the environment; and parsimonious/non-redundant with other measures. Definition adapted from Hunsaker and Carpenter (1990) and Cairns et al. (1993). |
| IRMS | Integrated Resource Management System |
| JOSM | Joint Oil Sands Monitoring |
| LAR | Lower Athabasca Region |
| LARP | Lower Athabasca Regional Plan |
| LICA | Lakeland Industry & Community Association |
| Wetland Management Framework | In this document “Wetland Management Framework” refers collectively to the legislation, regulations, policies, frameworks, strategies, plans, and guidance documents that influence the management of wetlands in Alberta. |
| Natural Resources | The subsurface, land surface, water, fauna and flora resources of Alberta, not including energy resources as defined in the Energy Resources Conservation Act. |
| Natural Variability | The range of variation observed in environmental and biological variables sampled in a large number of natural wetlands that are minimally subjected to human influences (Ciborowski et al. 2012). |
| PRAMP | Peace River Area Monitoring Program |
| RAMP | Regional Aquatic Monitoring Program |

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| Reclamation | The process of converting disturbed land to its former uses and productivity. Similar to restoration, which is a more general term defining the process of returning any site to a prior condition. (GOA 2014) |
| REDA | Responsible Energy Development Act |
| SARA | Species at Risk Act |
| Tailings Framework | Tailings Management Framework for the Mineable Athabasca Oil Sands |
| Thermal Directive | Directive for the Assessment of Thermally-mobilized Constituents in Groundwater for Thermal In Situ Operations |
| Trigger | 'Warning system' that signals that a change in condition has occurred and that a management response process needs to be initiated |
| UN | United Nations |
| Water Act | Alberta Water Act |
| WBEA | Wood Buffalo Environmental Association |
| Wetland | Land saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation, and various kinds of biological activity that are adapted to a wet environment (GoA 2013a). |
| WPAC | Watershed Planning and Advisory Councils |

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