Review of Four Major Environmental Effects Monitoring Programs in the Oil Sands Region

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EO Consulting

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Oil Sands Research and Information Network

OSRIN is a university-based, independent organization that compiles, interprets and analyses available knowledge about returning landscapes and water impacted by oil sands mining to a natural state and gets that knowledge into the hands of those who can use it to drive breakthrough improvements in reclamation regulations and practices. OSRIN is a project of the University of Alberta's School of Energy and the Environment (SEE). OSRIN was launched with a start-up grant of $4.5 million from Alberta Environment and a $250,000 grant from the Canada School of Energy and Environment Ltd.

OSRIN provides:

- **Governments** with the independent, objective, credible information and analysis required to put appropriate regulatory and policy frameworks in place
- **Media, opinion leaders and the general public** with the facts about oil sands development, its environmental and social impacts, and landscape/water reclamation activities – so that public dialogue and policy is informed by solid evidence
- **Industry** with ready access to an integrated view of research that will help them make and execute reclamation plans – a view that crosses disciplines and organizational boundaries

OSRIN recognizes that much research has been done in these areas by a variety of players over 40 years of oil sands development. OSRIN synthesizes this collective knowledge and presents it in a form that allows others to use it to solve pressing problems. Where we identify knowledge gaps, we seek research partners to help fill them.

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Copies of this report may be obtained from OSRIN at osrin@ualberta.ca or through the OSRIN website at http://www.osrin.ualberta.ca or directly from the University of Alberta's Education & Research Archive at http://hdl.handle.net/10402/era.17507.

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There is a general lack of awareness of existing environmental effects monitoring programs for the mineable oil sands region. As a result, there is low public confidence in the nature and extent of the current environment health monitoring and reporting programs for the oil sands with respect to potential impacts of these developments on environmental and human health. The purpose of this study was to engage four main environmental effects monitoring and reporting organizations currently operating in the oil sands area to document their programs. Through an engagement and validation process, program information was tagged, inventoried and characterized.

Each of these organizations is unique; they all play specialized roles in providing information, data and understanding of ecosystem effects. These organizations also provide vital monitoring information based on their media, or domain expertise that is essential to understanding the ecosystem health and human health of the oil sands area.

The resultant information was captured and presented in the form of a one-page visual Summary of Environmental Effects Monitoring in the Oil Sands Area. Additional contextual information adds to the understanding of the current state and is presented as a Chronology of Environmental Effects Monitoring Activities (1990-2010). Detailed Fact Sheets are provided for each of the four monitoring programs:

- Alberta Biodiversity Monitoring Institute (ABMI)
- Cumulative Environmental Management Association (CEMA)
- Regional Aquatic Monitoring Program (RAMP)
- Wood Buffalo Environmental Association (WBEA)

The report concludes by making some observations of the programs studied. The recommendations presented represent possible next steps to build on this body of work. The central observation and recommendation is that stakeholders, including the monitoring program staff themselves, lack a detailed understanding of the full suite of monitoring activities taking place in the oil sands area and in moving forward, a more integrated approach would benefit both the existing environmental effects monitoring programs and the ability to speak authoritatively about oil sands ecosystem effects as a whole.

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- Alberta Biodiversity Monitoring Institute (ABMI) – Kirk Andres, Stan Bouton and Jim Herbers
- Alberta Environment – Monitoring Branch – Tom Dickson and Bob Stone
- Alberta Environment – Integrated Monitoring Evaluation and Reporting Framework (IMERF) – Albert Poulette and Susan Johnston
- Cumulative Environmental Management Association (CEMA) – Glen Semenchuk
- Department of Fisheries and Oceans – Marek Janowicz
- Environment Canada Environmental Effects Monitoring – Paula Siwik
- Oil Sands Developers Group – Fred Kuzmic
- National Forest Inventory – Mark Gillis and David Goodenough
- Fort McKay Industrial Relations Corporation (IRC) – Lisa Schaldemose
- Mikisew Cree Industrial Relations Corporation – Melody Lepine and Matt Whitehead
- Regional Aquatics Monitoring Program (RAMP) – Andrew Tackyi and Wade Gibbons of Hatfield Consulting
- Wood Buffalo Environmental Association (WBEA) – Kevin Percy

Finally we wish to express our appreciation for the feedback received from participants at the OSRIN Challenge Dialogue Workshop entitled *What constitutes an adequate and effective public information and reporting system for ecosystems in the Oil Sands Region?* held in Edmonton, Alberta on June 18, 2010[1].

[1] See the OSRIN report on this project at http://hdl.handle.net/10402/era.19094 (short version) or http://hdl.handle.net/10402/era.19093 (long version).

1 INTRODUCTION

There is a general lack of awareness of existing environmental effects monitoring programs for the mineable oil sands region. As a result, there is low public confidence in the nature and extent of the current environment health monitoring and reporting programs for the oil sands with respect to potential impacts of these developments on environmental and human health. To exacerbate this situation some of the programs have been subject to some negative press, potentially leading the public to wonder about the value and reliability of these data[2]. Below are some examples of recent studies that illustrate these concerns and suggest that the levels of environmental impact are greater than what is being reported:

- Environmental Defense Fund reported large seepage from tailings ponds in a 2008 study (Price 2008).
- Pembina Institute identified several concerns with environmental performance (Grant et al. 2009).
- An expert panel conducted a review of the RAMP program in 2004 and concluded that the scientific validity of data collection and conclusions was questionable. As an aside, questions have also been raised regarding the soundness of the panel's review (Ayles et al. 2004).

There are in fact major provincial, regional and other more specific monitoring initiatives that collect, report on and make available a variety of environmental data for use in decision-making (see Sections 2 and 3 for examples). While these media-focused initiatives are well-established and continue to improve, there may be opportunities to bring them together strategically so a more integrated picture of environmental and human health can be attained. Several of the major programs indicated both the need for and an interest in exploring program and/or design integration options. A more integrated approach to environmental monitoring of the oil sands area would probably broaden and deepen our understanding of environmental effects between the different media and help improve public confidence in the data and its interpretation.

In addition to the four major programs, individual companies measure numerous physical, chemical, and biological parameters within, and adjacent to, their facility sites. These data are reported periodically as part of their regulatory compliance reporting.

This information is important for many parties involved directly or indirectly as stakeholders – locally, regionally, nationally and globally – who need or want to know what environmental features are being monitored to assess the impacts of oil sands development.

1.1 Study Objectives and Scope

As a starting point to improving the public's understanding of environmental effects monitoring work in the oil sands region, OSRIN commissioned a study to characterize the four major regional environmental effects monitoring programs operating in the Regional Municipality of

[2] See for example, http://www.edmontonjournal.com/health/Federal+Liberals+call+more+oilsands+research/3413926/story.html#ixzz0y7TvBDdZ and http://ca.news.yahoo.com/s/capress/100830/business/athabasca_pollution and http://pubs.pembina.org/reports/northern-lifeblood-report.pdf (section 4.4)

Wood Buffalo. To round out the inventory of programs and initiatives, seven other environmental monitoring initiatives were described.

The study had the following three objectives:

1. Engage four environmental effects monitoring and reporting organizations currently operating in the oil sands area to document their programs.
2. Characterize and inventory the current environmental effects monitoring and reporting initiatives within the context of environmental health in the oil sands area.
3. Compare and contrast the results in a formal report and recommend next steps.

The expectation is that this information will help to inform and ultimately improve policy and practices that aim to reduce or mitigate the environmental effects of oil sands development on the ecosystems of the oil sands region.

The four major monitoring program assessed were:

1. Regional Aquatics Monitoring Program (RAMP) which focuses on water quality and is operated by the Oil Sands Developers Group (OSDG) and funded largely by the oil sands industry.
2. Wood Buffalo Environmental Association (WBEA) which focuses on an air monitoring program and is funded largely by the oil sands industry.
3. Alberta Biodiversity Monitoring Institute (ABMI) which provides information on the state of Alberta's biodiversity to facilitate the responsible management of our environment.
4. Cumulative Environmental Management Association (CEMA) which is an NGO located in Fort McMurray that studies the cumulative environmental effects of industrial development in the region. CEMA has produced management frameworks and guidelines. CEMA is funded largely by the oil sands industry.

The seven other environmental initiatives examined are listed below. Some of these initiatives, while not focused on the oil sands development per se, do include this area within their geographical extent. These initiatives are:

1. Alberta Environment programs regarding environmental assurance and regulatory decision-making
2. Integrated Monitoring Evaluation and Reporting Framework (IMERF) initiative, Alberta Environment
3. Community-Based Environmental Monitoring in the Oil Sands Area
4. National Forest Inventory
5. National Pollutant Release Inventory of Environment Canada
6. Environmental Effects Monitoring of Environment Canada
7. OSRIN Challenge Dialogue on 'What Constitutes an Adequate and Effective Public [Environmental] Information and Reporting System for Ecosystems in the Oil Sands'

Three main factors were used to determine what monitoring programs should be included in this study:

1. The type of monitoring program and activities
2. The geographical coverage of the monitoring program in relation to the area of interest – i.e., the oil sands development area
3. The level of detail (resolution) of the monitoring program over the area if interest.

For the purposes of this study we characterized all environmental effects monitoring programs that covered or overlapped the area of interest – namely, the Athabasca oil sands area as defined by the Regional Municipality of Wood Buffalo (Figure 1)[3].

Generally, environmental effects monitoring aims to provide feedback about the actual environmental impacts of a development or project. The results help managers to evaluate the success of different mitigation approaches at protecting various environment values. This use of the monitoring results is often called *effectiveness monitoring*. The monitoring results can also be used to determine compliance with environmental regulations and standards, and to facilitate any needed project design or operational changes. This application of monitoring results is often called *compliance monitoring*.

Environmental monitoring programs collect data for various purposes such as to establish a baseline prior to a development or to establish current conditions; to establish natural variances in undisturbed systems; to make comparisons between pre- and post-development; and to make comparisons against a standard or target level.

Effectiveness or *environmental effects monitoring* is the repetitive and systematic measurement of the characteristics of environmental components or media over a number of years to test specific hypotheses about the effects of human development activity on the environment. Often the hypotheses are posed in the form of questions. The monitoring is undertaken primarily to determine the environmental effects of these activities and to increase understanding of cause-effect relationships between the activities and the environmental change, if it is observed.

This study was mainly interested in characterizing environmental effects monitoring programs like WBEA, RAMP and ABMI. The ABMI program, while concentrating most on measuring and reporting on the state of biodiversity for the province or geographical subsets of the province, is also interested in providing insight into potential relationships between the observed trends and underlying factors such as oil sands development activities, among others. This latter aspect of ABMI's program offers the ability to examine the biodiversity effects of the oil sands development.

The CEMA program claims formally to not be an environmental monitoring program per se, particularly since its focus is less on providing "repetitive and systematic measurements of environmental data over many years." Its focus is more on researching the environmental effects of the oil sands development to produce knowledge-based management guidelines and

[3] Wood Buffalo regional map
http://www.woodbuffalo.ab.ca/residents/maps/pdf/2010_regional_map_with_plant_sites.pdf

frameworks. From a monitoring perspective, part of CEMA's program does falls into the category of *validation monitoring*. This type of monitoring typically refers to research activities that evaluate the strength of the cause and effect relationships and assumptions on which policies, practices and a monitoring program itself are based.

Figure 1. Map of the Regional Municipality of Wood Buffalo

1.2 Study Methods

As described in Figure 2 below, this project was divided into three phases: Initiation, Engagement, and Synthesize and Reporting of Results. This project structure supported the project team in achieving its goal of understanding and articulating the current state of

monitoring initiatives and the monitoring and reporting regime overall as it relates to oil sands areas and their operations. The methodology utilized best practices in stakeholder engagement.

The characterization results of this project were presented at the Monitoring Adequacy Dialogue workshop. The two visual characterizations Appendix 4: Summary of Environmental Monitoring Effects Programs in the Oil Sands Area and Appendix 5: Chronology of Environmental Effects Monitoring Activities (1990 – 20110) were described, presented and discussed during a one hour workshop session. The overall opinion was that both visual characterizations were well received and endorsed for their utility.

Figure 2. Project Structure

2 FOUR REGIONAL ENVIRONMENTAL EFFECTS MONITORING PROGRAMS

For each of the four monitoring programs that were assessed, the research template in Appendix 2 was developed and applied to the information synthesized. The first level information was gathered from websites, annual reports, studies and organization literature. These details were organized shared and discussed in sequence with one face-to-face conversation and often several follow up teleconferences. Within this system the responses to key monitoring and organization questions were explored, captured and integrated. Essentially, the program information for each of the monitoring programs were systematically tagged, classified and organized into a common content structure.

The following information follows the text and headings of the common content structure in Appendix 2. An overview of the four key monitoring programs is provided in Appendix 3 and a detailed version is provided in Appendix 4.

2.1 ABMI – Alberta Biodiversity Monitoring Institute

Below is a summary of the environmental monitoring programs undertaken by ABMI. A visual summary of all the programs is included in Appendix 4 and a more detailed look at the ABMI program is included in Appendix 6.

Organization

a. Purpose: The purpose of ABMI is to support natural resource decision making by providing relevant, timely and credible scientific knowledge on the state of provincial biodiversity.

b. Intent: To provide consistent, scientifically credible means to evaluate the status and trends in biodiversity, and provide insight into potential relationships between trends and underlying factors.

Organization Structure

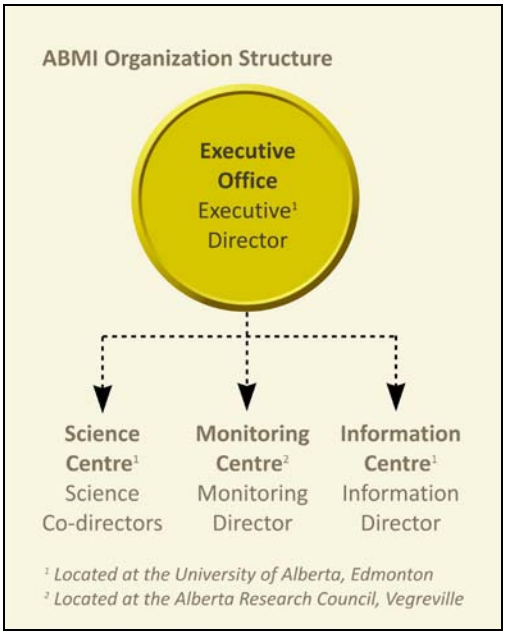

Figure 3. ABMI Organizational Structure

Media Scope: Biodiversity (with reference to land use - human footprint)

a. Coverage Province of Alberta

b. Client Government of Alberta, energy industry, forestry industry, Government of Canada, and Alberta's public

Media: Status, Understanding and Effects on

- Wildlife
- Wildlife habitat
- Ecological health
- Healthy aquatic ecosystems
- Natural capital
- Sustainability

Monitoring Questions

a. Status What is the health of the species in a given area, region, or an ascribed are?

What is the health of the habitat in a given area, region or an ascribed area?

How intact is the ecosystem in a given area, region or an ascribed area?

What is the human impact on the land, in a given area, region or an ascribed area?

b. Understanding

c. Effects

Monitoring Program(s)

Biodiversity — ABMI monitors biodiversity by sampling 1,656 permanent sites established on a 20 km systematic grid across Alberta. Each survey site consists of a permanent terrestrial and wetland plot that is surveyed once every five years.

Monitoring Approach

ABMI monitors biodiversity by sampling 1656 permanent sites distributed every 20 km across Alberta. The precise geographic location of ABMI monitoring sites is confidential. Public coordinates identify the location of terrestrial and aquatic survey sites to within 5.5 km of the precise geographic coordinate (or 95 km^2). Each site is surveyed once every five years, within a two-week window, based on a Julian date to reduce seasonal variation. In 2008 the ABMI collected data at 80 terrestrial sites, 70 wetlands, 10 streams, 41 winter sites, six lakes and six rivers. Thirty-seven of the terrestrial and wetland sites required helicopter access as did two river, two lake, and nine winter sites. Data collection successfully occurred across the province from High Level to Lethbridge and included surveys in private land, mountainous terrain and bogs.

Outputs

a. Products

The *Raw Data Download* program provides biodiversity data, a description of collection methods and relevant metadata.

The *Biodiversity Browser* allows users to explore existing data, make species selections, select custom areas and produce reports on selected indices.

Information Products provides an overview of ABMI information products and the Access to Information Policy.

Business Advantage information provides a summary of how the ABMI benefits government, industry and all the general public.

Information Pyramids and Intactness Manuals

The *Intactness Index* describes the expected intact state of biodiversity (species and habitats) in natural regions using only ABMI data. These reference conditions are often considered as "controls" or "benchmarks" against which change in biodiversity can be determined.

The *Human Footprint Index* reports on the extent of the human footprint by determining the area of land directly altered by human activities. It is based on a scale of 0% to 100%, where 0% means

there is no human footprint and 100% means the landscape has been completely modified by human footprint.

b. Accessibility — Products and data accessible through the ABMI website, www.abmi.ca

Outcomes

- The status and trends of ecosystems and species in the oil sands region are better known.
- The relationship between biodiversity and the human footprint in the oil sands region is better understood.
- Natural resource decision-making is better informed through the provision of credible, scientific, relevant, and timely knowledge on the state of biodiversity in the oil sands region.
- The natural biodiversity of the oil sands area is maintained.
- Ecological goods and services that support strong and healthy economies and communities in the oil sands area are maintained.

2.2 RAMP – Regional Aquatics Monitoring Program

Below is a summary of the environmental monitoring programs RAMP undertakes. A visual summary of all the programs is included in Appendix 4 and a more detailed look at the RAMP program is included in Appendix 7.

Organization

a. Purpose: — To determine, evaluate and communicate the state of the aquatic environment and any changes that may result from cumulative resource development within the Regional Municipality of Wood Buffalo.

b. Intent — The program strives to achieve a holistic understanding of potential effects of oil sands development on aquatic systems, as well as address specific issues important to communities of the region.

Organization Structure

Figure 4. RAMP Organizational Structure

Media Scope: Water

a. Coverage: The RAMP Regional Study Area (RSA) is defined by the northeastern Regional Municipality of Wood Buffalo.

The RAMP RSA is bounded by the Alberta-Saskatchewan border on the east, the Alberta-Northwest Territories border to the northeast, the Wood Buffalo National Park to the northwest and various demarcations including the Athabasca River and Cold Lake Air Weapons Range to the south.

b. Client: Industry, government, regional stakeholders and Aboriginal communities

Media: Status, Understanding and Effects on

- Water Quantity
- Water Quality
- Sediment Quality
- Fish Habitat
- Fish Population

Monitoring Questions

Below is a sample of the RAMP monitoring questions. For a complete list refer to Appendix 7.

a. Status: What are the baseline conditions and range of natural variation?

	What are the baseline conditions and range of natural variability of water quality in the RAMP study area?
	Is water quality at monitored locations outside the range of natural, or baseline, variability?
	What are the baseline conditions and range of natural variability of indices of benthic invertebrate community composition in the RAMP study area?
	What are the baseline conditions and range of natural variability of fish measurement endpoints in the RAMP study area?
b. Understanding	What changes in hydrological variable are predicted in oil sands Environmental Impact Assessments (EIAs)?
	What changes in water quality are predicted in oil sands EIAs?
	What changes in benthic invertebrate composition are predicted from the EIAs?
	What sediment quality data are required by other RAMP components to assist in interpretation of monitoring results?
	Is sediment quality in the RAMP study area suitable to support aquatic life?
	What changes in fish populations and fish health are predicted in oil sands EIAs?
	Do fish measurement endpoints vary significantly between areas or water bodies exposed (test) and unexposed (baseline) to oil sands development?
	What is the natural or normal range of variability of measurement endpoints used to detect acidification in these lakes?
	Are there trends in lake chemistry that would indicate incipient acidification?
c. Effects	Do fish measurement endpoints from test areas exhibit time trends reflective of effects associated with increasing oil sands development?

Monitoring Program(s)

Climate and Hydrology	RAMP monitors changes in the quantity of water flowing through rivers and creeks in the RAMP study area.
Water Quality	RAMP monitors water chemistry to identify human and natural factors affecting the quality of streams and lakes in the oil sands region.
Benthic Invertebrates	RAMP monitors benthic invertebrate communities.
Sediment Quality	RAMP monitors sediment to provide supporting data for benthic invertebrate and fish monitoring results.

Fish Populations	The RAMP fish population component was established to monitor the health and sustainability of fish populations within the oil sands region.
Acid Sensitive Lakes	The RAMP ASL component was designed to monitor lake water chemistry in regional lakes "as an early-warning indicator of excessive acid deposition".
Monitoring Approach	
Climate and Hydrology	Several monitoring stations have been established throughout the RAMP study area. Data collected include air temperature; rainfall and snowfall; relative humidity; wind speed and direction; solar radiation; snow on the ground; snow depth and mass; water level; and discharge.
Water Quality	Water samples are collected at stations on rivers, streams, and lakes throughout the RAMP study area. Water quality sampling occurs in each season. Water quality samples are submitted to analytical laboratories for measurement of conventional variables such as major ions, nutrients, biological oxygen demand, organics and total and dissolved metals.
Benthic invertebrates	Benthic invertebrate communities are monitored in rivers, streams, and lakes throughout the Athabasca oil sands region. Sampling is conducted in the fall of each year. Supporting environmental data, including flow velocity, water depth, substrate grain size, sediment organic matter content, and substrate chlorophyll-a content are collected. Benthic invertebrate organisms are separated from these samples, identified to the lowest practical taxonomic level, and counted.
Sediment Quality	Since 2006, sediments are sampled concurrently with benthic invertebrate sampling at the most downstream benthic invertebrate replicate sampling station in depositional reaches, and at one randomly selected benthic invertebrate sampling station in regional lakes. RAMP analyzes numerous physical, chemical and toxicological variables in sediment samples. This list of variables was first developed by the initial implementing consultant for RAMP from previous sampling designs for baseline studies and EIAs in the region, with input from Alberta Environment and other RAMP stakeholders.
Fish Populations	RAMP implements four different sampling programs on the Athabasca River and its tributaries: fish inventories, sentinel species monitoring, fish fence monitoring and fish tissue monitoring. Each monitoring program has its own objectives, questions and measurement endpoints, etc.
Acid Sensitive Lakes	On behalf of Alberta Environment (AENV) and Environment Canada (EC), RAMP samples approximately fifty regional lakes each year in late summer-fall. Water samples are collected from the euphotic zone (upper water layer exposed to sunlight) and sent to an analytical laboratory for analysis. Data collected include: conventional variables,

ions, nutrients and total dissolved phosphorus; Chlorophyll-a; total and dissolved fractions of 27 metals; and phytoplankton and zooplankton.

Outputs

a.	Products	Annual Technical Report to members, AENV approvals office and stakeholders
		Data incorporated into the long-term RAMP database for use by members
		Community Report of past year's monitoring program (often in collaboration with WBEA and CEMA)
		Presentations to local communities, scientific community, Elder's Advisory Group of Fort McKay
		Publishing of RAMP data in scientific journals (ongoing in 2010)
		Fish tissue data to Alberta Health and Wellness and Health Canada
		Upload technical and community reports to website and development of environmental report card (in progress)
b.	Accessibility	Reports accessible through the RAMP website
		Data available through an approved request to the RAMP program

Outcomes

- Monitoring of different components of the aquatic environment and in different geographic locations is more integrated.
- The state of the aquatic environment within the Regional Municipality of Wood Buffalo is better known, evaluated and communicated.
- Cumulative resource development effects on the aquatic environment within the Regional Municipality of Wood Buffalo are better known, evaluated and communicated.
- Long-term trends, regional issues and potential cumulative effects are identified better and addressed.
- The aquatic monitoring needs of all RAMP stakeholders are fulfilled.
- The potential effects of oil sands development on aquatic systems are better understood holistically.
- Specific aquatic issues important to the communities of the region are better understood.

2.3 WBEA – Wood Buffalo Environmental Association

Below is a summary of the environmental monitoring programs WBEA undertakes. A visual summary of all the programs is included in Appendix 4 and a more detailed look at the WBEA program is included in Appendix 8.

Organization

a. Purpose: WBEA monitors air quality and air quality related environmental impacts to generate accurate and transparent information which enables stakeholders to make informed decisions.

b. Intent: State of the art air monitoring system that meets the needs of residents and stakeholders in the Regional Municipality of Wood Buffalo.

Organizational Structure

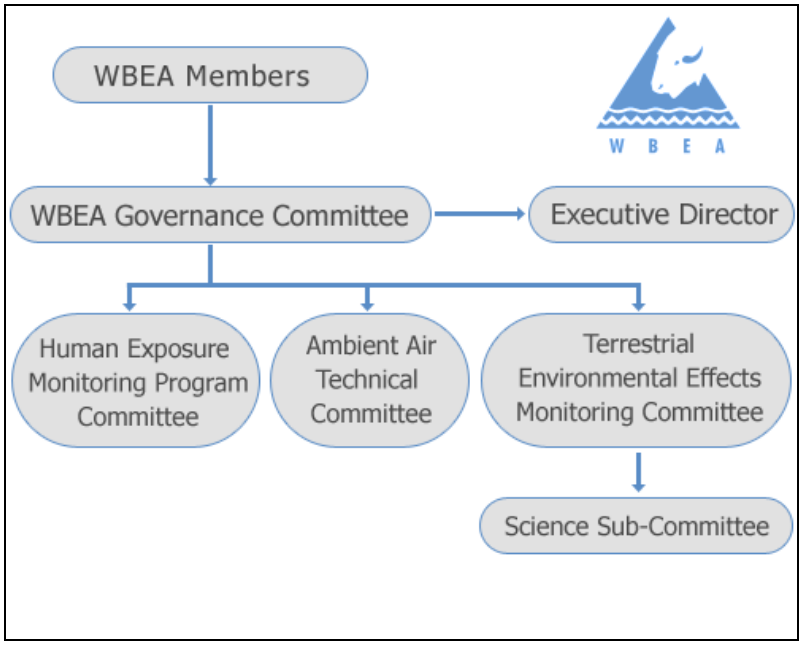

Figure 5. WBEA Organizational Structure

Media Scope

a. Coverage: Regional Municipality of Wood Buffalo (70,000 km^2)

b. Client: The citizens of the Regional Municipality of Wood Buffalo and other WBEA Stakeholders

Media: Status, Understanding and Effects on

- Air Quality
- Human Health
- Terrestrial Ecosystems: (Soil-Vegetation)

Monitoring Questions

a. Status What is the air quality in the WBEA?

b. Understanding What are air emissions comprised of?

		How are air emissions dispersed and deposited?
		To what level are ecosystems exposed to air emissions?
		How can we improve overall predictability of the passive regional monitoring network?
		How can we provide early indication of air-related impacts on vegetation occurring in the region?
c.	Effects	What are the long-term impacts of air quality (indoor or outdoor or both), if any, on human health in the WBEA area?
		What are the air quality impacts on the terrestrial environment in the WBEA area?

Monitoring Program(s)

AATC — The Ambient Air Technical Committee directs the air monitoring component of WBEA, which is the cornerstone of the organization.

TEEM — Terrestrial Environmental Effects Monitoring is focused on the effects of air emissions on the environment.

HEMP — The Human Exposure Monitoring Program monitors the effects and exposure of select air contaminants on individuals in their everyday environments.

Monitoring Approach

AATC — The AATC air quality monitoring program operates 24 hours a day, 365 days a year and provides scientifically-credible data that focuses on air quality with respect to human and ecosystem health. AATC has four air monitoring components as described below:

Continuous air monitoring occurs at fifteen stations. The stations transfer raw, real-time data to AENV and CASA that are used in calculating an air quality index.

Semi-continuous air monitoring is collected once monthly at four stations for 10-day time periods. Precipitation chemistry, VOCs and PAH information is collected.

Passive air monitoring occurs at over 30 sites and collects information related to monthly exposure to SO_2, NO_2, O_3, HNO_3, and NH_3.

Advanced air monitoring is conducted through an ambient ion monitor dual detector GC that monitor ambient air concentrations of inorganic/organic sulphur compounds.

TEEM — TEEM operates ten passive monitoring sites that measure concentrations of sulphur dioxide, nitrogen dioxide and ozone at remote forest locations. There are also four passive monitoring sites surrounding the Petro-Canada MacKay River Project. These four sites monitor concentrations of sulphur dioxide, hydrogen sulphide, nitrogen dioxide and ozone.

HEMP — HEMP undertakes community-based, personal monitoring of indoor and outdoor air quality. Scientific peer review was completed in 2009 and the program is being redesigned with community input.

Outputs

a. Products
- Real time 24-7 Air Quality Index information
- Historically corrected and validated air quality data
- Program annual reports
- Archived air quality data within the Clean Air Strategic Alliance (CASA) data warehouse
- The Air Quality Index (AQI), which is a system developed to provide the public with a meaningful measure of outdoor air quality. The AQI converts concentrations of five major air pollutants (CO, $PM_{2.5}$, NO_2, O_3, SO_2) to a single numerical value and matching air quality description that ranges from Good to Poor. A minimum of four of the above listed pollutants is required to calculate the AQI, one of which must be $PM_{2.5}$.

b. Accessibility
- Products and data accessible through the WBEA website
- AQI data accessible through CASA

Outcomes

WBEA works towards accomplishing the following:

- Meeting the air monitoring needs of residents and stakeholders in the Wood Buffalo Region through utilization of a state-of-the-art air monitoring system.
- Making more accurate and transparent air quality monitoring information available 24 hours a day, 365 days a year and openly sharing it with stakeholders and the public.
- Supporting stakeholders in making better informed decisions about air quality and air quality related environmental impacts.

2.4 CEMA – Cumulative Environmental Management Association

Below is a summary of the environmental monitoring programs CEMA undertakes. A visual summary of all the programs is included in Appendix 4 and a more detailed look at the ABMI program is included in Appendix 9.

Organization

a. Purpose — To study the cumulative environmental effects of industrial development in the region and produce guidelines and management frameworks.

b. Intent — The environment of the region, including the land, forest, air, water, wildlife and biodiversity, will be protected, sustained, and

restored over the long term and that the collective activity of industrial activity in the region will not cause any lasting harm to the environment or adverse effects to the health of humans. Should these impacts be evident, the Association and its Members will recommend, promote and implement mitigation action to reverse their effects.

Organization Structure

Five working groups have been established within CEMA. Working groups have "primary responsibility" for developing management recommendations. Subcommittees called task groups undertake specific technical components of the work (Figure 6).

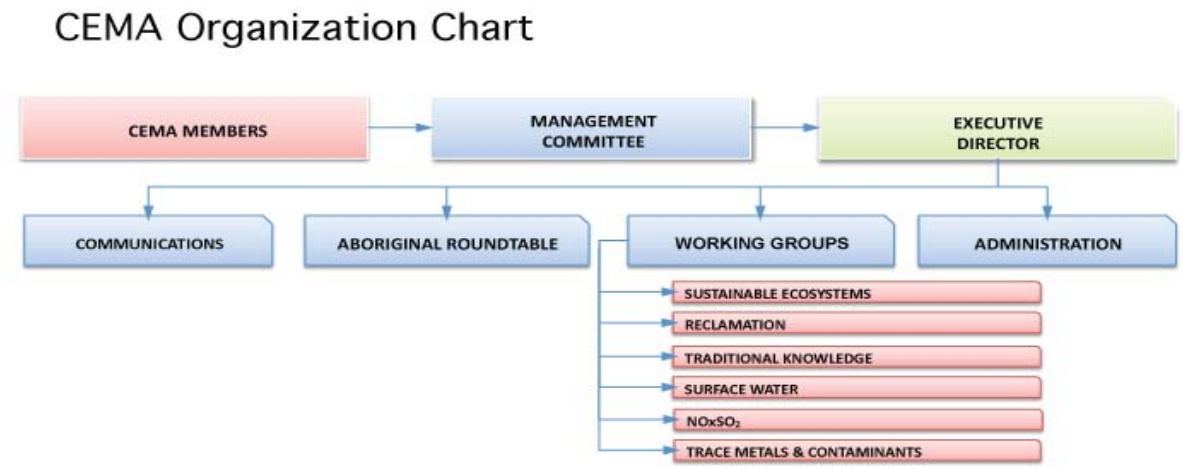

Figure 6. CEMA Organizational Structure

Media Scope: Environment, Ecosystems and Landscapes

a. Coverage: Oil sands area or the Regional Municipality of Wood Buffalo or as defined by the issue / study.

b. Client CEMA members (48 in total), including all levels of government, industry, regulating bodies, environmental and aboriginal groups, local health authorities and other stakeholders.

Media: Status, Understanding and Effects on

- Land
- Forest
- Biodiversity
- Water
- Air
- Wildlife

- Aquatic Ecosystems
- Human Health

Monitoring Questions

a. Status

b. Understanding — What are the best management tools, frameworks and guidelines available to protect, sustain, and restore the health of the landscape, vegetation, soil, and watersheds, while balancing industrial development and environmental considerations?

What are the best measures and methods available to protect the environment in areas where reclamation activities need to occur?

How can we increase the understanding of potentially harmful emissions?

c. Effects — How is the health of aquatic ecosystems (rivers, lakes, streams, etc.) and the natural environment likely to respond to increasing oil sands development?

How can we increase our understanding of that response?

How can we develop a system that minimizes the long-term environmental impacts on surface water quantity and quality so that the water systems will remain healthy?

Monitoring Program(s)

CEMA has no Cumulative Effects Monitoring Programs per se, but engages in cause-and-effect studies (validation monitoring) to fulfill their mandate. In doing so, they have collected a large amount of monitoring data and information.

Monitoring Approach

SEWG — The mandate of the Sustainable Ecosystems Working Group is to address seventeen Regional Sustainable Development Strategy (RSDS) issues on sustainable ecosystems, wildlife and biodiversity. The Working Group is developing recommendations for a management system to address cumulative effects of oil sands development on ecosystems and landscapes in the Regional Municipality of Wood Buffalo.

RWG — The Reclamation Working Group, which previously existed separately from CEMA as the Reclamation Advisory Committee (RAC), joined CEMA in May 2001. RWG work includes not only surface mineable oil sands areas, but all surface disturbances within the region.

NSMWG — The NO_X/SO_2 Management Working Group is charged with "reviewing the relevant science and developing a management plan (system) for NO_x and SO_2 emissions as they relate to acidification," as well as establishing environmental capacity guidelines, environmental management objectives and a management system and plan for ground-level ozone.

SWWG	The Surface Water Working Group is tasked with: (i) developing a recommendation for the lower Athabasca River Phase 2 Water Management Framework; (ii) establishing the in-stream flow needs of the lower Athabasca River; (iii) defining indicator criteria and thresholds; and (iv) communicating information on surface water quantity to the public.
TMAC WG	The Trace Metals and Air Contaminant Working Group has been charged with assessing the risks posed by trace metals and air contaminants to human health and ecosystems under existing environmental management programs.
TEK WG	Traditional Environmental Knowledge is a body of local environmental knowledge and beliefs transmitted through oral tradition and first hand observation based on living in close contact with nature. It includes a system of classification, a set of empirical observations about the local environment, a system of self-management that governs sustainable resource base, and an understanding of the relationships of living beings (including humans) with one another and their environment. Environmental aspects are closely tied to social and spiritual aspects of the knowledge system.
GWG	Groundwater Working Group - A newly formed group; details to be determined.

Outputs

a.	Products	Frameworks, guides, tools
		Regional Environmental Management System (EMS) that is stakeholder driven
		Issue priorities, work plans
		EMS standards and practices for resource developers
		Standards and practices to support regulators in their environmental approvals
		Research products and databases
		Indicators and thresholds
		Management triggers and responses
		Reports of various types
b.	Accessibility	Reports, frameworks and guidelines are available through the CEMA website.

Outcomes

- The cumulative environmental effects of industrial development are better understood.
- Cumulative environmental effects guidelines and management frameworks help to reduce the impacts of industrial development in the region.
- Adverse effects of industrial activity are mitigated as soon as possible when they become evident.

- The collective industrial activity in the region does not cause any lasting harm to the environment or adverse effects to human health.
- The land, forests, air, water, wildlife and biodiversity of the region is protected, sustained and restored for the long-term.

3 OTHER MONITORING PROGRAMS AND INITIATIVES

The following monitoring programs are effects-based programs or inform environmental effects-based programs. They have some aspect of coverage in the Oil Sands Area. The resolution of information and purpose of the program make them worth mentioning in the inventory but a full characterization and description was not completed.

3.1 Alberta Environment

Alberta Environment (AENV) plays several key roles in oil sands environmental effects monitoring:

1. The Ministry compels monitoring and reporting of air quality, surface and groundwater quality and quantity, wetlands, reclamation and waste through operating approvals under the *Environmental Protection and Enhancement Act* (EPEA) and approvals and licenses under the *Water Act*. Greenhouse gas emissions are reported in accordance with the *Climate Change and Emissions Management Act*. Approval and license holders are often required to participate in regional monitoring and reporting programs that have been developed through organizations such as RAMP and WBEA.
   Specific research on issues such as tailings management or acid deposition is also conducted as a part of operating approval conditions. In addition, the Ministry requires applicants to provide baseline environmental data as a part of environmental impact assessments.
   Ministry staff work directly with authorized parties to ensure accuracy and completeness in data collection and reporting activities.
2. AENV is an active member of several regional monitoring organizations. AENV staff and executive play a leadership role on boards, steering committees, and technical working groups. AENV collaborates closely with monitoring partners such as RAMP and WBEA. The Ministry also provides in-kind monitoring and financial support to these monitoring organizations. AENV collaborates with stakeholders and other levels of government, including federal and provincial ministries to ensure monitoring activities are aligned and coordinated.
   AENV considers groups such as WBEA and RAMP to be an integral part of the monitoring system in the region. By participating in monitoring and reporting initiatives through regional organizations, approval and license holders are able to effectively fulfill some of the requirements under EPEA and the *Water Act* while contributing to a regional-scale program. Significant funding for regional monitoring initiatives is provided by industry as part of approval and license conditions. Data and information that is produced through monitoring and reporting initiatives from the regional groups is used in AENV decision-making. Specific information on these organizations can be found in other sections of this report.

3. Alberta Environment-owned and -operated monitoring networks contribute to environmental effects monitoring in the oil sands area. These include provincial-scale monitoring programs that provide long-term trend and condition monitoring, as well as more targeted and specific monitoring programs related directly to oil sands activities and impact. Examples are the Contaminant Loading Study of surface water tributaries in the mineable oil sands area and the recent acid deposition study.

Data provided from the above support the Ministry mandates of environmental assurance and regulatory decision-making:

- Monitoring programs contribute to the understanding of the impact of oil sands activity. Monitoring results inform management options, including regulatory decision-making and compliance activities. Data are used to evaluate the effectiveness of management activities and to ensure appropriate actions are taken to mitigate environmental risk.
- Monitoring data and information also support the development, delivery and assurance of environmental outcomes and policy, as well as issues identification, priority setting, and resource allocation decisions.

Alberta Environment has played a leadership role in the development of the *Lower Athabasca Regional Plan* through the Government of Alberta's Land Use Framework. The Ministry has led the development of frameworks for the management of water and air and contributed to land use planning initiatives. These frameworks include monitoring, evaluation and reporting components that will enhance and improve environmental data and information with respect to oil sands effects monitoring.

The Oil Sands Information Portal (OSIP) is an AENV initiative that will work with partners to provide a "one-window" interface for oil sands data and reports, including geospatial information.

Specific AENV activities related to oil sands environmental effects monitoring are summarized below in four tables (Tables 1 to 4) for each media and in relation to the regulatory monitoring requirement, work with partners and the Alberta Environment's monitoring programs.

Table 1. Alberta Environment: Groundwater (GW) Monitoring and Reporting

Groundwater (GW) Monitoring and Reporting	
Regulatory Monitoring Requirement	• AENV requires monitoring of priority GW quality and quantity parameters as a part of individual EPEA approvals and *Water Act* licenses. • Monitoring is generally site specific (designed to ensure no impact leaves the site) however approval or license holders may be required to participate in regional groundwater initiatives, including planning and operation of regional groundwater monitoring networks. Water use is reported monthly and summarized through an annual or biannual report.

Work with Partners	• AENV provided a grant of $1.2 million to CEMA to develop a groundwater monitoring program for the mineable oil sands area, including drilling several groundwater monitoring wells. • AENV staff provide technical support to the CEMA working group. It is anticipated that a formal regional GW working group will be developed in the very near future as a part of the GW management frameworks. • AENV recently collaborated with the Alberta Geological Survey to map buried valley channels and conduct aquifer vulnerability assessments.
AENV Monitoring	• AENV currently monitors water levels at 5 wells through the provincial-scale Groundwater Observation Well Network. • AENV also holds historical datasets for GW, the bulk of which date to the 1970s. • GW Management Frameworks for the North Athabasca Oil Sands and South Athabasca Oil Sands areas are currently in development. These include significant groundwater monitoring initiatives. Drilling of new wells or incorporation of existing wells (primarily owned by industry) is also a part of the Frameworks' design.

Table 2. Alberta Environment: Surface Water Quality (SWQ) Monitoring and Reporting

Surface Water Quality (SWQ) Monitoring and Reporting	
Regulatory Monitoring Requirement	• AENV requires monitoring of SWQ parameters as a part of individual EPEA approvals and *Water Act* licenses – companies are required to report on sites up and downstream of all potential seepage and release points along a water body. Companies also monitor and report river crossings. • AENV requires monitoring and reporting of industrial wastewater run-off and release, domestic wastewater production, and effluent. These are reported monthly, with a summary report annually. • Approval holders conduct monitoring research on specific surface water quality issues as part of their approval conditions. They may be required to participate in RAMP, contributing to their water quality monitoring research and programs. • Three companies (Shell, Imperial, and Syncrude) are conducting ongoing monitoring in the Muskeg River basin as part of the implementation of the Muskeg River Interim Management Framework (see: http://www.environment.alberta.ca/01245.html)
Work with Partners	• AENV collaborates on a number of surface water quality working groups with partner organizations. • AENV works with RAMP to ensure impact monitoring of lakes/rivers is carried out as per EPEA requirements. • AENV is a partner with RAMP on the Acid Sensitive Lakes Program. • AENV partners with Environment Canada and Parks Canada on several SWQ monitoring sites (e.g., 27th baseline/Slave River sites).

AENV Monitoring	• AENV operates two Long Term River Network (LTRN) sites established with monthly monitoring extending back 40 years plus a third established in 2010. These sites are part of the provincial LTRN and measure the broad range of water quality parameters of interest plus those specific to oil sands. • In addition there are 6 Athabasca River and 6 tributary sites, all in the mineable oil sands area, with continuous (24-7) monitoring for organic and metal compounds. • AENV is conducting a Contaminant Loading Study of tributaries within the mineable oil sands area. • AENV conducts an Acid Lakes Program. • AENV conducts a lake sediment coring program for specific lakes in the region (including Lake Athabasca).

Table 3. Alberta Environment: Surface Water Quantity Monitoring and Reporting

Surface Water Quantity Monitoring and Reporting	
Regulatory Monitoring Requirement	• Surface water quantity monitoring is required under individual *Water Act* licenses. This includes water use, extraction, and diversion activities. • AENV requires license holders to produce an annual Water Use Report under the Water Management Framework, including diversions and water use in accordance with approval conditions.
Work with Partners	• AENV employees collaborate with RAMP as part of the Hydrology and Climate technical team. • AENV works in partnership with the Water Survey of Canada, Alberta Sustainable Resource Development and Environment Canada to ensure that hydrometric monitoring in the oil sands area is comprehensive.
AENV Monitoring	• AENV monitors water quantity at a number of hydrometric stations in the municipality as part of the provincial hydrometric network. These are monitored by the Water Survey of Canada through a memorandum of understanding. • AENV holds historic data-sets for stations that are no longer monitored. • AENV monitors lake levels at 3 to 4 lakes/year in the region. • AENV operates 2 meteorological stations in the area that measure precipitation parameters.
Land Monitoring and Reporting	
Regulatory Monitoring Requirement	• AENV requires monitoring and reporting of acid deposition impacts to land, bio-monitoring (including aquatic and terrestrial monitoring), as well as monitoring and reporting on progress of reclamation activities as a part of individual EPEA approval conditions. Data and information are reported monthly and summarized in an annual report.

	• In some authorizations, AENV requires research to be conducted related to specific issues such as wetlands management and reclamation, reforestation and vegetation, tailings management and end pit lakes. • Approval holders may be required to contribute to joint monitoring initiatives as part of the TEEM program. • AENV requires monitoring and reporting on waste management activities including identification and measurement of liquid hazardous waste. • AENV collaborates with Sustainable Resource Development and the Energy Resource Conservation Board to ensure alignment with regulatory requirements with respect to reclamation activities.
Work with Partners	• AENV participates in TEEM to provide technical/scientific support to monitoring initiatives, including acid deposition monitoring program development.
AENV Monitoring	• AENV operates a long-term (since 1981) soil acidification monitoring plot measuring effects of acid deposition on soil as part of an overall provincial program.

Table 4. Alberta Environment: Air Monitoring and Reporting

Air Monitoring and Reporting	
Regulatory Monitoring Requirement	• AENV requires air monitoring through operating approvals. This includes the monitoring of stack emissions for priority pollutants with some special requirements depending on the approval. Data are reported monthly and summarized in an annual report. • All oil sands mine companies are required under their EPEA approval to monitor air emissions. Emission requirements vary among companies based on the specific technologies used at each site. • Industries fulfill their requirement to conduct ambient air monitoring and reporting through membership in WBEA, which collects data from industry stations operating within the airshed zone. The data are submitted monthly, with an annual summary report. • Industries monitor fugitive volatile organic compounds in accordance with the approved Fugitive VOC Emissions and Leak Detection and Repair Program and the *Environmental Code of Practice for the Measurement and Control of Fugitive VOC Emissions from Equipment Leaks* (CCME 1993). • Monitoring of mobile emissions (including particulate matter) from facility sites is also required under EPEA. • Industries are required to report greenhouse gas emissions through the Specified Gas Regulation and reporting requirement.
Work with Partners	• AENV provides technical and scientific support to the WBEA Ambient Air Technical Committee and a several air-related sub-committees. • AENV supports WBEA to ensure that impact monitoring of compliance (industrial) sites is completed to fulfill EPEA requirements.

	• AENV has collaborated with WBEA, University of Alberta and Suncor on polycyclic aromatic hydrocarbons (PAHs) monitoring, and is planning a partnership with Environment Canada and WBEA to monitor PAHs and metals in ambient air and snow. • AENV participates in TEEM to provide technical/scientific support to acid deposition monitoring program development. • AENV is involved in capital planning for new stations and equipment and funds some station maintenance. • AENV participates as a member of CEMA's program committees and funds CEMA framework and planning activities. • AENV is an active participant in the Clean Air Strategic Alliance (CASA), including collaboration on the CASA data warehouse. Data that are submitted to the CASA Data Warehouse have been subjected to a data quality assessment by an external consultant and are used by many stakeholders, including AENV.
AENV Monitoring	• AENV owns one station and provides annual funding to WBEA to operate the station on behalf of the department. • Data and information collected from stations operated by WBEA is reported to the CASA Data Warehouse and AENV Current Air Quality Website. • AENV also audits station instrumentation. AENV intends to conduct a data quality assessment for CASA air data on a regular basis. • AENV established a series of precipitation monitoring sites (wet deposition) that represent the oil sands region from three sites. After three years of monitoring, AENV partnered with WBEA to integrate this monitoring with their program. • AENV operates a Mobile Air Monitoring Laboratory (MAML) that conducts special monitoring projects throughout Alberta. These projects are designed to address specific local issues including odours, hotspots, and pre-planning for long-term monitoring site location. Monitoring reports from the MAML projects are posted on Alberta Environment's website[4]. • AENV is planning to monitor GHG emissions from oil sands tailings ponds in collaboration with the University of Alberta. An application for funding is with EcoTrust. • AENV operates 2 meteorological stations in the area that measure meteorological parameters (e.g., air temperature, wind speed, and humidity).

3.2 Integrated Monitoring Evaluation and Reporting Framework (IMERF) Project

The Alberta Minister of Environment is mandated with transitioning environmental management from a project-by-project mitigation approach to one that encompasses cumulative effects management with a view to managing towards broad based environmental outcomes. As a result the monitoring, evaluation and reporting processes and functions of the Government of Alberta and Alberta Environment must respond accordingly. Recognizing this Alberta Environment has

[4] Recent MAML reports are at http://environment.alberta.ca/0978.html; older reports are at http://environment.gov.ab.ca/info/home.asp (enter MAML in the Search box).

initiated development of an Integrated Monitoring Evaluation and Reporting Framework (IMERF) [5]. The IMERF project, which began in March 2009, will set out the strategic approach to environmental monitoring, evaluation and reporting activities in Alberta.

The main goal of IMERF is to provide a vision and a path forward that defines principles, terms, processes and activities, controls and practices that support and enable a sound environmental monitoring, evaluation and reporting system. Implementation of IMERF enables a strategic approach to environmental monitoring and reporting activities in the province. The principle outcome in implementing IMERF is to support a broader performance management system within Alberta Environment and the Government of Alberta. In initiating the IMERF project, an evaluation of the current environmental management program was undertaken. Three key areas were identified where improvements or changes could be considered:

- Environmental data and information processes require a more systematic cross-media approach to be efficient and effective across time and places. Process improvements are required from the planning stage to reporting accessibility.
- Monitoring and reporting programs, investment, and infrastructure must be better coordinated among Alberta Environment and its partners. In some cases, accountability and roles associated with monitoring, evaluation and reporting activities need to be clarified.
- Increased demand and public expectation for environmental monitoring and information requires a robust monitoring and reporting system to meet Albertans' needs. Scientific and water-related data must be more integrated and readily accessible to the public and stakeholders, in order to meet the demand.

Transitioning to a cumulative effects approach will also require an improved monitoring, evaluation and reporting system that includes:

- Improved coordination and planning across Ministry and partner activities to increase the efficiency and effectiveness of monitoring and reporting activities and processes.
- A broad enterprise approach to data management and infrastructure to improve data accessibility, integrity, and appropriateness across media, time and place.
- A systematic approach to monitoring, evaluation and reporting activities that improves the ability to connect monitoring data and information to environmental management decisions and policy.
- Integrated monitoring and reporting activities that assist the department and the government in understanding the implications of management actions and assessing the performance of policy and management decisions.

3.3 Community-Based Environmental Monitoring in the Oil Sands Area

Community or Community-Based Environmental Monitoring (CBEM), in the oil sands region represents another aspect of the overall effort to assess the effects of oil sands development on

[5] http://www.calgaryherald.com/pdf/AuditorGeneralReport.pdf (April 2010)

the various components of the environment[6]. This monitoring sometimes includes the consideration of, and linkages with, socioeconomic factors at play in these communities. In the oil sands area CBEM is also closely associated with the monitoring interests of the Aboriginal peoples whose rights and interests are an important consideration in many of the oil sands communities. As such, these environmental monitoring initiatives often include aspects of TEK as well as science-based approaches.

At its core, CBEM is about engaging local people within their particular community settings, first in the assessment of their environmental concerns and then in the design, development, implementation and long-term operation of appropriate monitoring programs. The more technical work associated with environmental monitoring means that capacity must be built within the affected communities. When community members are able to meaningfully participate in these monitoring initiatives they obtain a deeper understanding of the monitoring objectives and methods, and as a result are able to relate the program information more effectively to community members. Furthermore, CBEM can also be used to augment provincial monitoring efforts such as those that support wildlife management. There is also movement towards integrating community monitoring objectives and activities with those of the main regional monitoring programs (ABMI, CEMA, RAMP, and WBEA) and with the *Environmental Protection and Enhancement Act* (EPEA) approval-related monitoring requirements for industry.

First Nations communities in the oil sands region have also undertaken CBEM programs. This effort stemmed from community concerns about the environmental effects of oil sands development and the lack of information communities were being provided by companies as they related to the environmental effects of their developments. Environmental concerns included those related to land, water, fish, human health, and the effect on traditional uses of the land by Aboriginals. Long and expensive court hearings underscored the need for the key parties to find a better way to address these concerns. It was also recognized that there was a need to build stronger, more mutually beneficial relationships that can lead to better results in terms of the environment, cultural and social systems and the economy of these communities.

As a result of these concerns, industry formed an organization called the Industrial Relations Corporation (IRC). The IRC was designed to operate at arm's-length from First Nation's Chief and the Council and the Métis Board, and receives funding from industry and governments. The IRC has developed chapters throughout the province in affected communities and employs staff and technical consultants to help build environmental monitoring capacity, facilitate consultation with government and companies and evaluate and respond to impacts of industrial development. Each IRC differs somewhat in that they each reflect:

- their local, bio-geographical setting;
- the nature of the development around these communities and hence, the priority environmental concerns;
- the local environmental monitoring capacity within the community; and

[6] We wish to acknowledge information provided by Lisa Schaldemose, Fort McKay Industrial Relations Corporation and Melody Lepine and Matt Whitehead of the Mikisew Cree Government & Industry Relations that supported these research efforts.

- the nature and extent of the existing regional and other monitoring programs within and around the community.

For example, Fort Chipewyan in the northern part of the province is more concerned about the long distance transport of air pollutants whereas, in the Fort McKay area, groundwater transport concerns are more prevalent. First Nations further south are surrounded by SAGD developments where groundwater issues would again be a priority.

The Fort McKay IRC has been used as a model for the other First Nation bands in the region. This effort has been guided by the Athabasca Tribal Council and an All Parties Core Agreement. This agreement reflects a multi-stakeholder approach involving government (provincial and federal), all of the resource developers (mining, forestry other industries) and all five of the affected First Nations.

CBEM is driven primarily by the immediate, local, environmental concerns of the community. Often these environmental concerns are not addressed in the regional environmental monitoring programs nor are they easily accessible through the environmental monitoring work done by the companies as part of their EPEA approvals. The community monitoring efforts, in this regard, help to ensure that these gaps in environmental monitoring are addressed to the satisfaction of the community, including in some cases having more direct input to the design of the companies' environmental monitoring programs and the interpretation of the results. An example of this in the Fort McKay IRC is their “Air Canister" program which monitors and analyzes offensive odour events. This analysis helps the community to better understand the cause and effects of their occurrence and can influence future approaches used in regional environmental monitoring programs.

As noted above, traditional knowledge of the local environment can, play a significant role in CBEM. This knowledge can be helpful in identifying indicators and interpreting environmental effects because they are often based on observations that cross multiple generations. When combined with science-based knowledge, TEK can help to create a more comprehensive and holistic sense and understanding of development impacts.

3.4 National Forest Inventory (NFI)

As a major forest nation, Canada must have reliable, current and consistent information on the extent and nature of its forests to enable the sustainable management of these resources. Authoritative information on forest change is also required to support the development of policy to address immediate needs as well as new and emerging issues, such as climate change impacts and possible adaptive strategies. The National Forest Inventory (NFI) [7] is a national level vegetation inventory and monitoring program designed to supply information at the provincial/national level.

NFI was established over the period 2000 to 2006, and monitors a network of sampling points covering one percent of Canada's land mass on an ongoing basis to provide accurate, timely and consistent information on the state and sustainable development of Canada's forests. This information is shared with collaborators and the public and is used to provide credible

[7] Information taken from: https://nfi.nfis.org

information to inform domestic forest policies and positions, and to support scientific initiatives, and regional, national and international reporting commitments.

The NFI is a product of a successful collaboration of provincial and territorial jurisdictions and the federal government. The program is coordinated by Natural Resources Canada (Canadian Forest Service), under the guidance of the Canadian Council of Forest Ministers (National Forest Inventory Task Force). Through the interagency arrangement, the provincial and territorial collaborators collect and provide data using jointly developed standards and procedures. The federal government provides the infrastructure to manage the data, and leads in the analysis of data and generation of reports.

To track changes in the state of the forests, an ongoing measurement program is required. The original design of the NFI was based on a 10-year measurement and reporting cycle. However, new initiatives require more frequent, timely, and up-to-date information. In response, various design options have been developed by considering different time scales and sampling designs (annual, biannual, and 5-year periods with a fixed proportion of plots measured in each year). These options were evaluated against business needs, cost, reliability, operational feasibility, and the degree to which each option could address emerging issues.

A five-year measurement and reporting strategy has been adopted to provide credible information to address strategic objectives and key initiatives of the Canadian Council of Forest Ministers as well as information required to inform national and international positions. This strategy will also lead to cost savings as some of the measurements will align with provincial/territorial inventory schedules. Deviations from the original design will be addressed over the course of the first re-measurement cycle.

3.5 National Pollutant Release Inventory (NPRI)

The National Pollutant Release Inventory (NPRI)[8] is Canada's legislated, publicly accessible inventory of pollutant releases and transfers. It includes a variety of types of information including:

- information reported by facilities to Environment Canada as per requirements within the *Canadian Environmental Protection Act*, 1999 (CEPA 1999);
- voluntarily reported air pollutant emission estimates compiled by facilities; and
- non-industrial emission estimates from sources such as motor vehicles, residential heating, forest fires and agriculture.

The NPRI is a key resource for:

- identifying pollution prevention priorities;
- supporting the assessment and risk management of chemicals, and air quality modeling;
- supporting the development of targeted regulations for reducing releases of toxic substances and air pollutants;

[8] Information taken from: http://www.ec.gc.ca/inrp-npri

- encouraging actions to reduce the release of pollutants into the environment; and
- improving public understanding of sources and levels of emissions.

Owners or operators of facilities that meet published reporting requirements are required to report releases, disposals and transfers of substances (including those in tailings and other mine wastes) that are tracked by the NPRI. Information on pollution prevention activities and facility information, such as location, industry classification and the number of employees, is also reported to the NPRI. For each facility and substance, data users can find out where and to what media (air, water or land) the substance was released. The information also includes how and where the substance was disposed of, treated or recycled. The NPRI is not a survey or voluntary program and failure to comply with any provision, including requirements for submission of the data or reports by the stipulated deadline is an offence under the Act.

The NPRI is at the centre of the Government of Canada's efforts to track toxic substances and other substances of concern. It is a major starting point for identifying and monitoring sources of pollution in Canada, as well as for developing indicators for air, water and land quality. Information collected through the NPRI is used by Environment Canada in its chemicals management programs and it is made publicly available to Canadians each year. Public access to the NPRI motivates industry to prevent and reduce pollutant releases. NPRI data support the Government of Canada in:

- tracking progress in pollution prevention,
- evaluating releases and transfers of substances of concern,
- identifying and taking action on environmental priorities,
- conducting air quality modeling, and
- implementing policy initiatives and risk management measures.

The NPRI is one of many Pollutant Release and Transfer Registers (PRTRs) that exist throughout the world.

3.5.1 Capture of NPRI Data

Facilities report their pollutant release and transfer data through Environment Canada 's One Window to National Environmental Reporting System (OWNERS) website. The OWNERS website is an online reporting tool used by Environment Canada, some provincial governments and industry associations to collect environmental data from industry. The tool was developed in response to stakeholder requests to streamline and simplify reporting requirements. Environment Canada implements data quality measures to ensure that NPRI data maintain a high standard of accuracy, consistency and comprehensiveness, and meets the needs of data users.

3.5.2 Users of NPRI Data

Data from the NPRI can be used in many ways by many different organizations and groups. For example:

- **Data analysts** (e.g., scientists, policy analysts, and academic researchers) use NPRI data to conduct research on environmental issues such as the impacts of pollutant releases on the environment and human health.

- **Companies** use NPRI data to report on corporate environmental performance and to compare their pollutant releases with others in their sector.
- **Industry associations** use NPRI data to research sectoral environmental issues and to evaluate the performance of member facilities.
- **Non-governmental organizations** use NPRI data to promote understanding of pollution issues and to influence public policy and corporate environmental management.
- **Aboriginal groups** use NPRI data to understand and report on the impact of pollutant releases and transfers on their communities.
- Governments:
    - *Federal* officials use NPRI data to track the progress of pollution prevention efforts, identify sectoral concerns, and to support air quality modeling and chemical risk assessment and management initiatives.
    - *Provincial* governments use the data to develop provincial emissions inventories and environmental indicators and to track progress of facilities within their jurisdictions.
    - *Municipal* officials use pollution data to conduct environmental sustainability planning and to research local air and water quality concerns.
- **Individuals and community groups** use NPRI data to obtain information on pollutant releases and transfers from facilities near their homes, workplaces and schools and to engage the facilities in pollution prevention.
- **Finance sector firms** use pollution data to assess the growth potential for environmental services and technologies (e.g., waste management and emission control), to research companies for environmentally friendly mutual funds and to report on environmental performance to investors.
- **Academics and students** use NPRI data to research pollution issues and to develop project or course content.
- **The media** use NPRI data to report on local, regional and national pollution issues and trends.

The NPRI program makes a significant amount of information available, including facility-reported data on pollutant releases and transfers, latitude and longitude and other location data for reporting facilities, air pollutant emission summaries and trends for all Canadian sources of key air pollutants.

3.5.3 Compilation of the Air Pollutant Emission Summaries and Trends

Environment Canada uses the information contained within the NPRI to compile, annually, air pollutant emission summaries and trends that support the provision of information to Canadians that:

- Identify pollutants that affect their health and the environment;

- Identify priorities for action;
- Allow tracking of progress in pollution prevention;
- Support the development of regulations and air quality modeling; and
- Meet domestic and international reporting requirements such as Canada-Wide Standards (CWS), Canada US-Air Quality Agreement, and the United Nations Economic Commission for Europe Convention on Long-range Trans-boundary Air Pollution (UNECE LRTAP).

The air pollutant emission summaries and trends are compiled in collaboration with provincial, territorial, and regional environmental agencies. The summaries include emissions reported by facilities to the NPRI, as well as emissions estimated by Environment Canada using the latest published statistics or other sources of information such as surveys and reports.

The methodologies used to estimate emissions are reviewed, updated and improved on a periodic basis. Collaborative work with sector experts from within or outside Environment Canada is undertaken to incorporate available expertise and the latest advancements in scientific knowledge.

Geographic Information Systems (GIS) play an important role in the estimation and geographical distribution of the information for air pollutant emissions. Over the years, spatial dissemination techniques as well as GIS-based models have been developed and enhanced to estimate and geographically distribute emissions from point, area, open, mobile and natural sources. Various geographic data sets are used within these numerous modeling techniques to obtain more accurate and detailed emission estimates geographically distributed at the national, provincial and regional levels. A large number of socio-economic statistics including population, dwelling and labor force at very fine geographic resolution are used to distribute the majority of emissions from industrial and non-industrial sources. National road network data are also used to help estimate and distribute emissions from road dust and road transportation. In addition, other internally generated geographic parameters are used to spatially distribute emissions from various sources (aircraft, marine, railroad activities, etc.) within specific corridors, buffers and areas.

The results of an example database inquiry on Suncor Energy Inc.'s Oil Sands 2008 Facility Information are included in Appendix 10.

3.6 Environmental Effects Monitoring – Environment Canada

In general, Environmental Effects Monitoring (EEM) is a science-based tool that helps protect ecosystem health by determining the impact of human activities. The EEM program within Environment Canada, more specifically, detects and measures changes in **aquatic ecosystems** (the receiving environments) potentially affected by the **effluent discharges** caused by the human activities of regulated mills and mines. Environment Canada determines an environmental effect through the calculation of a statistically significant difference in fish or benthic invertebrate community indicators taken in an exposure area and compared against results from a reference area (or along a gradient of effluent exposure). Environmental effects can also be determined through an exceedence of the Health Canada tissue guidelines in the fish that have been exposed to the effluent.

EEM is an iterative system of monitoring and interpretation phases that can be used to help assess the effectiveness of environmental regulations, policy and practices. These assessments help determine the sustainability of human activities on ecosystem health.

EEM is currently a requirement for regulated mills and mines under the *Pulp and Paper Effluent Regulations* (PPER) and the *Metal Mining Effluent Regulations* (MMER), both under the authority of the *Fisheries Act*. These regulations exclude oil sands mining. The objective of these regulations is to evaluate the effects of effluents on fish and fish habitat and the use of fisheries resources by humans. EEM information assesses the adequacy of these regulations in protecting aquatic resources. The Canadian EEM programs are unprecedented in the world for their magnitude and mandatory requirements.

EEM provides a nationally consistent approach to determine if effluents are causing effects on ecosystems. Long term effects are assessed using regular cyclical monitoring and interpretation phases. In this regard, impacts on the same endpoints and locations are recorded periodically every two to six years, depending on the program, thereby providing both a spatial characterization of potential effects and a record through time to assess changes in receiving environments.

The EEM program in Canada is tiered to allow for more extensive monitoring where there are effects and less monitoring where there are not, building upon the information obtained from successive studies. Initial studies look for biological effects in an area near the point of discharge (near-field environments). If there are effects in near-field environments, and successive studies confirm the presence of those effects, then mills determine their magnitude and extent, and identify effluent-related causes. This tiered approach to monitoring is efficient because the results of previous studies are used to focus successive studies. EEM Reports can be found on the Environment Canada website[9].

3.6.1 Investigation of Cause Studies

Investigation of Cause Studies (IOC) were introduced in the May 2004 PPER amendments for those mills that had detected and confirmed environmental effects and had determined their extent and magnitude. The purpose of the IOC study is to gain a better understanding of the cause of the observed effects. An example thought-process related to an IOC study is shown in Figure 7.

[9] Pulp & Paper: http://www.ec.gc.ca/esee-eem/default.asp?lang=En&n=3552C583-1

Metal Mining: http://www.ec.gc.ca/esee-eem/default.asp?lang=En&n=2DAFFC56-1

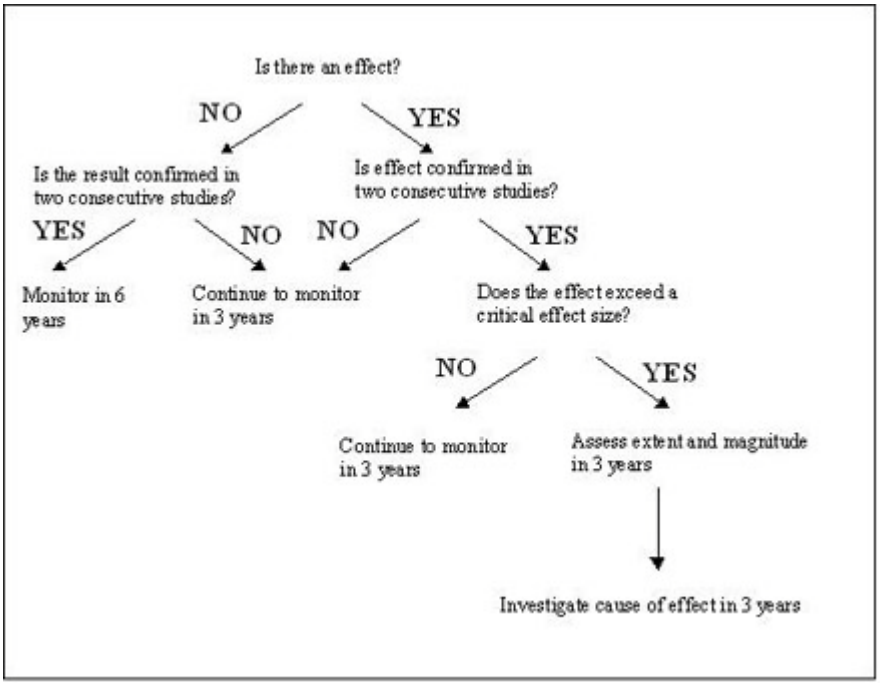

Figure 7. Sequence of Events in IOC Studies

Investigation of solutions (IOS) is a new component of the EEM Program included in the most recent PPER amendments (August 2008).

3.6.2 Relevance of EEM to OSRIN

Environment Canada's EEM program is focused on effluents produced by pulp and paper and metal mining facilities. Oil sands operations are excluded from the regulations. However the ALPAC pulp mill participates in this program and is therefore capturing these environmental effects data for the Athabasca River. These data, with due consideration to their purpose and sampling design, might provide additional data points for assessing the overall environmental effects of oil sands development in the Athabasca area. In considering these data it is important to recognize that the EEM is primarily designed to assess in aggregate, nationally, the effectiveness of mainly federal regulations that are aimed at reducing the impact of effluents from pulp and paper and metal mining on aquatic ecosystem health.

It should be noted that Environment Canada's EEM website contains information and accessible reports that offer a considerable resource for understanding more thoroughly the practices and tools that support environmental monitoring.

3.7 OSRIN Challenge Dialogue

In February 2010 OSRIN sponsored a Challenge Dialogue project focused on the question: *What constitutes an adequate and effective public information and reporting system for ecosystems in the Oil Sands Region?* This parallel project will help inform some of the other important aspects of the Monitoring challenge and OSRIN Program of work. This summary is intended to provide a glimpse into that body of work and emphasize the key linkage with the outcomes of the Challenge Dialogue and recommendations of this project.

To prepare for the Dialogue a Challenge Paper was prepared and distributed to over 70 individuals with a wide range of affiliations including government, industry, First Nations and non-government organizations. Feedback was received from 31 individuals, representing 44% of those contacted. Resulting from the feedback a Progress Report that assessed and synthesized the feedback was produced. The refined key challenge that resulted from this process was:

> *To describe key principles and elements of an adequate and effective information and reporting system that would provide Albertan's (and the World) with assurance that ecosystem effects due to development in the oil sands region are known and reported and, along with socio-economic information, support meaningful decision-making and responsible management of the resource during its entire life cycle.*

The outcomes for the Dialogue were:

- Improve understanding and appreciation of the diverse perspectives regarding effective public information and reporting system for environmental impacts.
- Improve understanding of existing information and reporting systems currently in place in the oil sands region.
- Develop a clear understanding and alignment about the key principles and elements required for an adequate public information and reporting system for the oil sands region.
- Develop a draft model of an adequate, effective and credible environmental and ecosystem information and reporting system consistent with the principles and elements accepted at the workshop.
- Identify information and reporting gaps that need to be addressed and warrant additional focus.

The results for the June workshop and the Dialogue overall should be available from OSRIN in October, 2010.

4 VISUAL INFORMATION SUMMARIES

4.1 Summary of Environmental Effects Monitoring Programs

The visual summary of Environmental Effects Monitoring Programs in the Oil Sands Area is presented in Appendix 4. The summary is intended to depict a way of viewing different monitoring programs in a comparative light, while maintaining the specific nature and features of each program. The summary is comprised of three sections, described below in Figure 8.

<table>
<tr><td colspan="4">1. The Header: The header at the top of the chart provides an overview of this OSRIN Scoping study and the guiding principles that were found to be common amongst the monitoring organizations.</td></tr>
<tr><td rowspan="2">2. The Left Menu: On the left side of the chart word clouds were added both as a visual stimulating distraction and to help the user cue on the key words that represent that organization. The word clouds are generated through www.wordle.net and are a visual depiction of the word content of each monitoring organization's website. The project wordle at the top left is derived from the individual program Fact Sheets in Appendices 6 to 9.</td><td colspan="3">3. The Main Table: The main table has three sections.</td></tr>
<tr><td>The first three columns speak to the nature of the organization and view in to the environmental system:
Organization: Purpose and Intent
Organization Structure
Media: Coverage and Client.</td><td>The next four columns speak directly to the core monitoring program and the activities each organization is focused on to meet the needs of the programs
Status, Understanding and Effects on Monitoring Questions: Status, Understanding and Effects on,
Monitoring Program(s)
Monitoring Approach.</td><td>The last two columns of the chart inform the reader how the organization is broadcasting their work and what the intended end points look like
Outputs: Products and Accessibility
Outcomes.</td></tr>
</table>

Figure 8. Components of the Summary of Environmental Effects Monitoring Programs in the Oil Sands Area.

This summary was designed and created to provide the reader a comparative view of all four monitoring programs on a single page. It is not intended to provide a comprehensive picture but rather a synoptic overview of the main and key features for each program.

4.2 Chronology of Environmental Effects Monitoring Activities (1990 – 2010)

The EEM Chronology shown in Appendix 5 depicts a visual summary of the key events and milestones of the four major environmental monitoring programs over the last 20 years in relation to key events and milestones of oil sands development since the 1970s. The chronology illustrates how the environmental programs have matured over time.

The chronology can be read in a number of different ways. Each monitoring program is represented by a different colour. Different development stages can be compared by looking at the chart between different vertical timeframes. Events and points-in-time are approximate.

5 OBSERVATIONS

5.1 General Observations

There is a substantial amount of environmental monitoring going on in the oil sands area producing vast quantities of time series data. As these data accrue the scientists and practitioners are examining cause-effect relationships. These relationships help to test initial assumptions, evaluate the effectiveness of policies and guidelines, and inform and continuously improve the effectiveness of the monitoring.

Some of the methods being used are state-of-the-art and among the top in the world in terms of the calibre of their: design and advisory guidance, the teams doing the work, and the technology and methodologies that are being employed. These organizations are hiring top flight scientists, technologists and practitioners in this field.

The monitoring programs are continuing to expand in terms of the nature and extent of the questions they are examining including increasingly the study of cross-media and larger landscape-scale effects**.**

However, it seems that few people outside those working in the oil sands area are aware of, or appreciate the extent of this effort. Communication of these programs appears not to be a priority despite its increasing importance globally.

In aggregate, data related to a significant number of environmental components and parameters for air, land, water, and biota are being collected and analyzed for each media and in terms of ecosystem and landscape interactions.

Despite all this activity, to our knowledge there has not been a cross-program effort that has examined all of these initiatives systematically to see if all key questions are being addressed and if important cause-effect relationships are emerging with respect to oil sands development impacts. This sort of effort would be a lot of work but the benefits would be well worth it given the investment risks. We expect a cross-program effort such as this could be accomplished by utilizing existing expertise within the various programs in conjunction with additional resources to address capacity.

The one consistent message we heard from all the organizations was that they knew generally what the other programs were doing, but had very little understanding of the specifics. They also did not know to what extent their program may overlap the others. Clearly one the most important actions looking ahead should be for these organizations to communicate and collaborate with one another more regularly and effectively – sharing data and results, best practices and expertise. Everyone we spoke with felt that there was a significant opportunity for everyone involved in environmental monitoring in the oil sands area to develop a more integrated approach.

Furthermore, to our knowledge no one is pulling all of this data and information together to create an integrated, higher level monitoring report – an environmental effects report card for the oil sands development area. To come anywhere near that today, you would need to painstakingly assemble the information program-by-program, media-by-media, area-by-area and stream/river segment-by-stream/river segment. It would require an enormous one-off effort not unlike the effort some provinces have invested in for state of the environment reporting. This state of the environment reporting opportunity is important and getting more important every

day. There is a lot at stake for Alberta and Canada. Appendix 10 outlines additional Technical Forms of Integrated Environmental Monitoring.

5.2 Monitoring Highlights

As discussions with each monitoring group progressed and the monitoring program Fact Sheets developed and evolved, we found that a number key insights and characteristics of the nature of each monitoring organization needed to be highlighted and shared.

5.2.1 ABMI – Separation of Church and State

ABMI created a hard division between the stakeholders and funders of the monitoring program and the monitoring design and approach. This separation ensures that stakeholders cannot in any formative way shape the manner in which the program is designed and rolled out. The monitoring organization, in consultation with stakeholders and funders, articulates the needs, requirements of the issues and intent of the challenge, and then designs and implements the monitoring program based on that agreement. They seek out and establish an advisory body to ensure scientific integrity and quality, evolving the program of work based on feedback from this group of peers. They also maintain a strong client-stakeholder relationship to validate the needs and requirements upon which the program was built.

5.2.2 ABMI – Service Delivery Focus

ABMI has worked skillfully and artfully at addressing the challenge of how you communicate the essence of the difficult subject of monitoring to your stakeholders and client. The attention and focus they have placed on this key factor has resulted in a well-articulated and visual depiction of the monitoring approach and program. It has also allowed them to specifically address the key clients and products that their monitoring program supports. This focus on understanding your stakeholder's needs, the key questions they are asking and how they are answering them (through products) is key to their future success.

5.2.3 RAMP – Technical Design and Rationale Document

The *RAMP: Technical Design and Rationale* document (Hatfield Consultants 2009a) is one part How to manual, one part design blueprints and one part field guide. This all-in-one document articulates a cohesive, detailed monitoring understanding and approach. It lays out explicitly its design and assumptions and provides an historical overview of the evolution of the various monitoring components. This document represents a complete codification of the monitoring program and provides the governing body the ability to contract this service to the best available service provider.

5.2.4 RAMP – Monitoring Program Out Sourced

RAMP's unique nature as a program that is implemented and operated by a third party as a service has a number of advantages and challenges. One of the challenges embedded in this relationship has seen the development of the Design and Rational document discussed in the previous section. Other observations shared through interviews and discussion include the simplicity of establishing the cost of the implementation and running of the program, by using the Request for Proposal (RFP) process to bring the best available resources to deliver and

implement the monitoring program for a contracted term. Once the term is up the contract is renewed through the marketplace.

5.2.5 WBEA – Real Time Data and Cutting Edge Hardware and Reporting

WBEA has worked diligently in responding to the needs of the local community and as a result has harnessed technology to provide near-real-time information to the local communities about the state of the air quality in the region. This early adoption of technology and web-interface is only one example of applying state-of-the-art information systems to push the data and information being collected and delve deeper into the questions being asked around the effects of air emissions on the health of human and of the ecosystem. They have surrounded themselves with air and monitoring experts and have embarked into a number of key areas adopting and trialing new monitoring equipment to develop the understanding necessary to comprehensively answer the questions being asked.

5.2.6 WBEA – Connection to the Community

This observation was not one that anyone spoke directly to or pointed out to the study coordinators but it became clear nonetheless. WBEA has been a member of the Wood Buffalo community for over fifteen years. The people who work at the organization are part of the community and the WBEA mandate and intent of delivering state-of-the-art air monitoring system that meets the needs of residents and stakeholders in the Regional Municipality of Wood Buffalo shows a clear commitment to the community. HEMP demonstrates a clear response to a new or priority community need. This clear connection to the community (client) and the service that WBEA is delivering is an important factor to the historical and long term success of the organization.

5.2.7 CEMA – Stakeholder Engagement and Relationships

CEMA, as one of its core operating principles, has embraced the concept of multi-stakeholder engagement and relationships. The organization has positioned itself more on the management side of the monitoring equation which is key to understanding needs and providing feedback in a context when action needs to be taken. This core operating principle has not made life easy and CEMA members admit openly to the struggles of establishing a governance model under which they can successfully operate. Following an external review, CEMA has overhauled its governance structures and has a list of strategic objectives it is committed to working through. CEMA offers a real example of the work and focus needed to ensure a proper stakeholder engagement model and governance structure is in place within the context of the complex environmental work associate with oil sands operations.

5.2.8 CEMA – Recommendations Through Frameworks, Guidelines, Checklists and Tools

CEMA has specialized in understanding complex issues in a multi-stakeholder forum and addressing them through information products and work. They have in the last decade created over a dozen of these products which are summarized in the 2008 document from AENV and Alberta Sustainable Resource Development called *Implementation of CEMA*

Recommendations[10]. These information products have been adopted and implemented by Government and have helped to achieve meaningful change. The importance of this work cannot be understated. An effective monitoring program without an effective management program running parallel, is similar to driving with a destination in mind and a good map but no way to alter your course.

5.3 Emergent Questions

This study described four main organizations with environmental effects-related monitoring programs in the oil sands area. Each organization is unique and all play specialized roles in providing data, information and a better understanding of ecosystem effects. These organizations provide critical monitoring information for their specific media that is needed to understand the environmental and human health of the system as a whole and to inform practitioners on appropriate mitigation options.

Considering the depth of experience and expertise embodied within each of the programs and reviewing their products, some important questions emerge. The questions reflect the ultimate need for us to understand all of the monitoring elements, not in isolation but in aggregate, and from a holistic ecosystem and landscape perspective.

- How do these different aspects of environmental monitoring and reporting fit together; how should they fit together?
- If we were to integrate aspects of the four monitoring systems, what would the result be? What do we mean when we say 'integrate'? What kind of integration should be explored (see Appendix 10 for some examples)?
- From a monitoring perspective, what would be enough resources, data and information to respond to the questions being posed?
- How do the individual monitoring program questions add-up to provide an overall understanding of the health of the ecosystems and landscapes of the oil sands area?
- What higher level questions would help focus, drive and guide the need for taking a more integrated approach to the monitoring of the oil sands area?

6 RECOMMENDATIONS

The following recommendations are based on the review of the four monitoring programs and discussions with the program personnel.

1. **Validate this report.** Publish this report along with the charts and use them as a basis to have a series of discussions with key stakeholders to determine options for moving forward.
2. **In collaboration with Alberta Environment's IMERF initiative, explore options for taking a more integrated environmental monitoring approach.** Use this inventory and characterization report and the IMERF design discussions a starting

10 *Implementation of CEMA Recommendations*, Document prepared by Alberta Environment and Sustainable Resource Development Provided to CEMA October 8, 2008 Contact: Amanda Spyce

point for exploring options for taking a more integrated approach to environmental effects monitoring for the oil sands area". Discussion points should include:

- If a more integrated approach were taken, what would be the benefits?
- What would be the key barriers that would need to be overcome?
- Do we have the required expertise to accomplish such a task?
- Who would you involve?
- How would you accomplish it?

3. **Annually update the inventory – explore how this might be done most efficiently.** Updating this inventory annually or every 2 years is important for understanding changing priorities over the previous year, sharing monitoring results and how they intend to adapt and evolve the programs moving forward. Through this dialogue the inventory could be refreshed and made broadly accessible. Part of this effort should be to examine how this update might be done most efficiently.

4. **Develop a regular Environmental Monitoring Report for the Oil Sands Area.** One option that was proposed in a few of the discussions was the idea of designing and creating an environmental monitoring report for the oil sands area on a regular basis (annually or very 2 years, etc.). Such an initiative would help sort out how the different organizations and programs would collaborate for the purpose bring the data sets together for higher level shared reporting. The process would also identify gaps between the existing monitoring programs and cause the articulation of higher level set of reporting questions. This concept is consistent with the Monitoring, Evaluation and Reporting approach described in the Landuse Framework (Landuse Secretariat 2008).

In conclusion the overarching recommendation moving forward is to bring all the organizations together and begin a facilitated conversation about next steps and pose the questions of integration. Present the results of this work and the Challenge Dialogue work, use the options listed above as a backdrop to develop and commit to a plan.

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APPENDIX 1: Acronyms Used in this Report

AAAQO	Alberta Ambient Air Quality Objective
AATC	Ambient Air Technical Committee
ABMI	Alberta Biodiversity Monitoring Institute
AENV	Alberta Environment
AGM	Annual General Meeting
AMS	Air Monitoring Station
AQI	Air Quality Index
ASL	Acid Sensitive Lake
ASRD	Alberta Sustainable Resource Development
AWMA	Air and Waste Management Association
BP	Barometric Pressure
BTEX	Benzene, Toluene, Ethylene and Xylene
Ca	Calcium
CASA	Clean Air Strategic Alliance
CBEM	Community-Based Environmental Monitoring
CCME	Canadian Council of Ministers of the Environment
CE	Cumulative Effects
CEMA	Cumulative Environmental Effects Management Association
CEPA	*Canadian Environmental Protection Act*
Cl	Chlorine
CNRL	Canadian Natural Resources Limited
CWS	Canada-Wide Standards
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CONRAD	Canadian Oil Sands Network for Research and Development
DOC	Dissolved Organic Carbon
EC	Environment Canada
EEM	Environmental Effects Monitoring
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EPA	Environmental Protection Agency (US)
EPEA	*Environmental Protection and Enhancement Act*

Fl	Fluorescein
GIS	Geographic Information Systems
GLC	Ground Level Concentration
GM	General Meeting
GoA	Government of Alberta
GW	Groundwater
GWG	Groundwater Working Group
H_2S	Hydrogen Sulfide
HCl	Hydrogen Chloride
HEMP	Human Exposure Monitoring Program
HNO_3	Nitric Acid
Ho	Null Hypothesis
IAFE	Institute for Agriculture, Forestry and the Environment
IMERF	Integrated Monitoring Evaluation and Reporting Framework
IOC	Investigation of Cause
IOS	Investigation of Solutions
IRC	Industrial Relations Corporation
K	Potassium
LTRN	Long Term River Network
m^3	Cubic Metres
MAML	Mobile Air Monitoring Laboratory
MMER	*Metal Mining Effluent Regulations*
Mg	Magnesium
N	Nitrogen
Na	Sodium
NFI	National Forest Inventory
NGO	Non-governmental Organization
NH_3	Ammonia
NH_4	Ammonium
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_3	Nitrate
NO_x	Nitrogen oxide

NPRI	National Pollutant Release Inventory
NSMWG	NO_x SO_2 Management Working Group
O_3	Ozone
OSDG	Oil Sands Developers Group
OSIP	Oil Sands Information Portal
OSRIN	Oil Sands Research and Information Network
OWNERS	One Window to National Environmental Reporting System
PAH	Polycyclic Aromatic Hydrocarbon
$PM_{2.5}$	Particulate Matter less than 2.5 micrometres
PM_{10}	Particulate Matter less than or equal to 10 micrometres
PPER	*Pulp and Paper Effluent Regulations*
ppm	Parts Per Million
PRTR	Pollutant Release and Transfer Registers
RAC	Reclamation Advisory Committee
RAMP	Regional Aquatics Monitoring Program
RAQCC	Regional Air Quality Coordinating Committee
RH	Relative Humidity
RSA	Regional Study Area
RSDS	Regional Sustainable Development Strategy (AENV)
RWG	Reclamation Working Group
S	Sulphur
SAGD	Steam Assisted Gravity Drainage
SEWG	Sustainable Ecosystems Working Group
SO_2	Sulphur Dioxide
SO_4	Sulphate
SWQ	Surface Water Quality
SWWG	Surface Water Working Group
T	Temperature
THC	Total Hydrocarbon
TEEM	Terrestrial Environmental Effects Monitoring
TEK	Traditional Environmental Knowledge
TEK WG	Traditional Environmental Knowledge Working Group
TDS	Total Dissolved Solids

TKN	Total Kjeldahl Nitrogen
TMAC WG	Trace Metals and Air Contaminant Working Group
TOC	Total Organic Carbon
TRS	Total Reduced Sulphur
TSS	Total Suspended Solids
UNECE LRTAP	United Nations Economic Commission for Europe Convention on Long-range Trans-boundary Air Pollution
VOC’s	Volatile Organic Compounds
WBEA	Wood Buffalo Environmental Association
WD	Wind Direction
WS	Wind Speed

APPENDIX 2: Common Information Template Used in this Study

Organization

a. Purpose – the result or goal of the action undertaken
b. Intent – is the planning and desire to perform an act and achieve a result

Organization Structure

The hierarchical concept of entities that collaborate and contribute to serve one common aim

Media Scope

a. Coverage – The area and resolution of the program
b. Client – Who is the client of the program

Media – A term used to describe the collections of biophysical and physical components of the environment with which the organisms interact, such as air, soil, and water.

a. Status – state or condition of the media
b. Understanding – to have conceptualized it to a given measure
c. Effects – A result or change to the media

Monitoring Questions

a. Status – state or condition of the media
b. Understanding – to have conceptualized it to a given measure
c. Effects – A result or change to the media

Monitoring Program(s)

Monitoring Approach

Outputs

a. Products
b. Accessibility

Outcomes – The intended end point

APPENDIX 3: An Overview of the Four Key Monitoring Programs

Organization Purpose - Intent	Organization Structure	Media Scope: Coverage and Client
WBEA **Purpose**: The Wood Buffalo Environmental Association monitors air quality and air quality related environmental impacts to generate accurate and transparent information which enables stakeholders to make informed decisions. **Intent:** State of the art air monitoring system that meets the needs of residents and stakeholders in the Regional Municipality of Wood Buffalo		**Air** **Coverage:** Regional Municipality of Wood Buffalo 70 000 km2 **Client:** The citizens of the Regional Municipality of Wood Buffalo and other WBEA Stakeholders
RAMP **Purpose:** Regional Aquatics Monitoring Program (RAMP) is to determine, evaluate and communicate the state of the aquatic environment and any changes that may result from cumulative resource development within the Regional Municipality of Wood Buffalo. **Intent:** The program strives to achieve a holistic understanding of potential effects of oil sands development on aquatic systems, as well as address specific issues important to communities of the region		**Water** **Coverage:** The RAMP Regional Study Area (RSA) is defined by the northeastern Regional Municipality of Wood Buffalo. The RAMP RSA is bounded by the Alberta-Saskatchewan border on the east, the Alberta-Northwest Territories to the northeast, the Wood Buffalo National Park to the northwest and various demarcations including the Athabasca River and Cold Lake Air Weapons Range to the south **Client:** Industry, Government, regional stakeholders and Aboriginal communities
ABMI **Purpose:** The Alberta Biodiversity Monitoring Institute's purpose is to support natural resource decision making by providing relevant, timely, and credible scientific knowledge on the state of provincial biodiversity. **Intent:** To provide consistent, scientifically credible means to evaluate the status and trends in biodiversity, and provide insight into potential relationships between trends and underlying factors.		**Biodiversity** **(With reference to Land Use - Human Footprint)** **Coverage:** Province of Alberta **Client:** The Government of Alberta, Energy Industry, Forest Industry, the Government of Canada, Alberta's Public
CEMA **Purpose:** To study the cumulative environmental effects of industrial development in the region and produce guidelines and management frameworks. **Intent:** The environment of the region, including the land, forest, air, water, wildlife and biodiversity, will be protected, sustained, and restored over the long term and that the collective activity of industrial activity in the region will not cause any lasting harm to the environment or adverse effects to the health of humans. Should these impacts be evident, the Association and its Members will recommend, promote and implement mitigation action to reverse their effects.		**Environment, Ecosystems and Landscapes** **Coverage:** Oil Sands Area or the Regional Municipality of Wood Buffalo or as defined by the issue / study **Client:** CEMA Members (45 in totoal) including all levels of government, industry, regulating bodies, environmental and aboriginal groups,local health authorities and other stakeholders

APPENDIX 4: Summary of the Four Key Monitoring Programs

Review of Four Major Environmental Effects Monitoring Programs in the Oil Sands Area

Oil Sands Research and Information Network

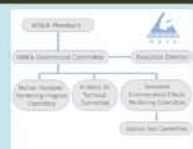
A **Word Cloud** is a visual depiction of user-generated tags, or simply the word content of a site, typically used to describe the content of web sites. The size of the word is an indication of the number of times it is used in the text and the colour is random. For this study we have depicted a Word Cloud for the aggregate of the Monitoring program fact sheets and one for each of the four main organization websites, ABMI, CEMA RAMP and WBEA.

Objectives:

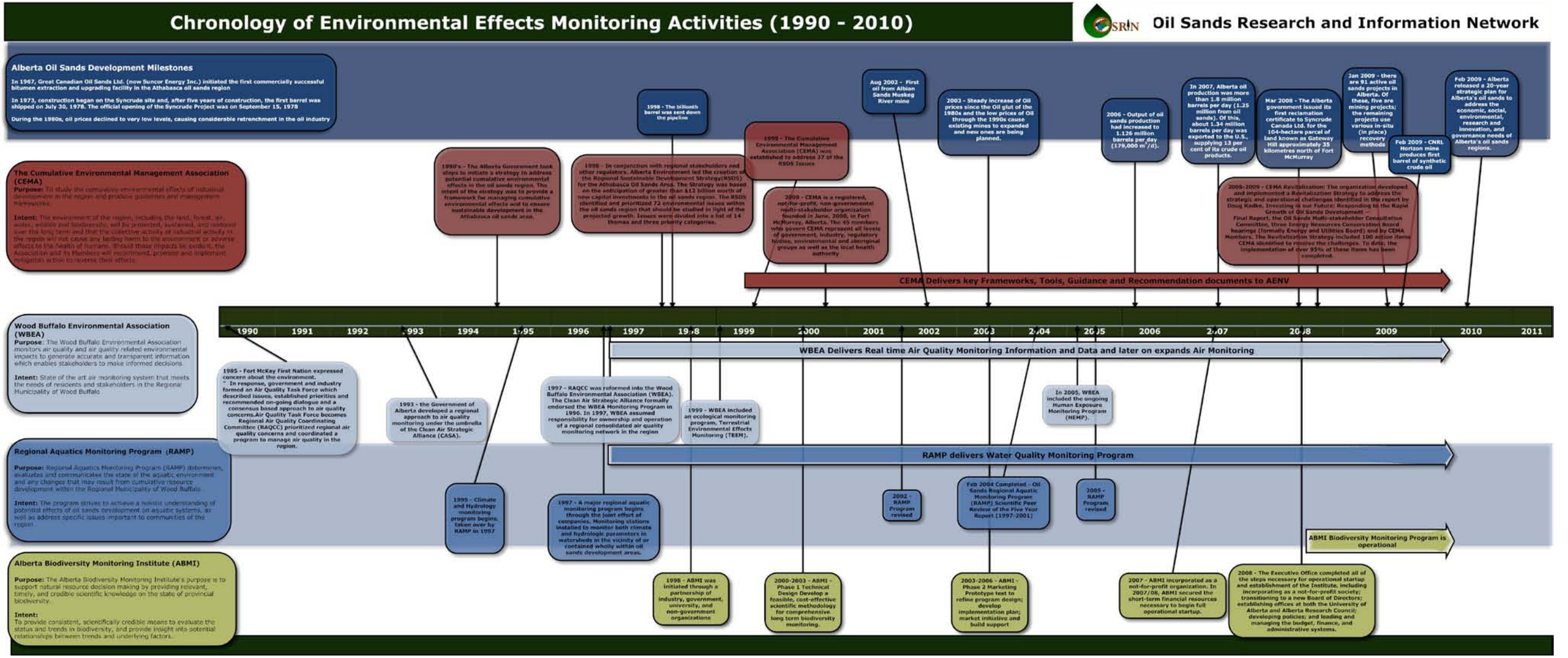
- Engage and document the various monitoring and reporting organizations and programs currently in place in the Oil Sands area.
- To characterize and inventory the current monitoring and reporting initiatives and regime within the context of the oil sands environmental health.
- Compare and contrast the results and report and recommend next steps

Guiding Principles

- Accurate, accessible and timely data
- Mechanisms and commitment to respond to adverse effects
- Proactive
- Consensus-based decision-making
- Recognize, respect and apply Traditional Environmental Knowledge
- Transparent, meaningful communication
- Credible scientific knowledge
- Better information = better decisions
- Purposeful information
- Interpretation and effective knowledge transfer and exchange
- Continuous improvement
- Clear context
- Environmental systems perspective
- Robust and comprehensive

	Organization Purpose - Intent	Organization Structure	Media Scope: Coverage and Client	Status, Understanding and Effects on	Monitoring Questions Status - Understanding - Effects on	Monitoring Program(s)	Monitoring Approach	Outputs: Products - Accessibility	Outcomes (approximately in order from the lowest order outcome to the highest order outcome)
 www.wbea.org	**WBEA** - Wood Buffalo Environmental Association **Purpose:** to monitor air quality and air quality related environmental impacts to generate accurate and transparent information which enables stakeholders to make informed decisions. **Intent:** State-of-the art air monitoring system that meets the needs of residents and stakeholders in the Regional Municipality of Wood Buffalo		**Air** **Coverage:** Regional Municipality of Wood Buffalo 70 000 km **Client:** The citizens of the Regional Municipality of Wood Buffalo and other WBEA Stakeholders	Air Quality; Human Health; Terrestrial Ecosystems: (Soil- Vegetation)	**Status:** •What is the Air Quality in the WBEA area? **Understanding:** •What are air emissions comprised of? •How are air emissions dispersed and deposited? To what level are ecosystems exposed to air emissions? How can we improve overall predictability of the passive regional monitoring network? How can we provide early indication of air-related impacts on vegetation occurring in the region? **Effects on:** •What are the long-term impacts of air quality (indoor or outdoor or both), if any on human health in the WBEA area? What are the air quality impacts on the terrestrial environment in the WBEA area?	**AATC (Ambient Air Technical Committee)** The air monitoring component of WBEA is the cornerstone of the organization and is directed by the AATC. **TEEM (Terrestrial Environmental Effects Monitoring)** TEEM is focused on the effects of air emissions on the environment. **HEMP (Human Exposure Monitoring Program)** HEMP monitors the effects and exposure of select air contaminants on individuals in their everyday environments.	**AATC** Air quality monitoring program operates 24 hours a day, 365 days a year and provides scientifically credible data, focusing on air quality with respect to human and ecosystem health. Continuous air monitoring: 15 stations that continuously monitor. Transfers raw, real-time data to calculate an air quality index. Semi-continuous air monitoring: Precipitation chemistry, VOCs ,PAH's: once monthly at 4 stations for 10 days Passive air monitoring: monthly exposure to SO_2, NO_2, O_3, HNO_3, NH_3 at over 30 sites Advanced air monitoring: ambient ion monitor dual detector GC to monitor ambient air concentrations of inorganic/organic sulphur compounds. **TEEM** operates ten passive monitoring sites to measure concentrations of sulphur dioxide, nitrogen dioxide and ozone at remote forest locations and there are four passive monitoring sites surrounding the Petro-Canada MacKay River Project that monitor concentrations of sulphur dioxide, hydrogen sulphide, nitrogen dioxide and ozone. **HEMP** Community-based personal monitoring of air quality indoors and outdoors. All communities monitored using volunteers at least once since 2005 Scientific peer review completed in 2009 and program being re-designed with community input.	Products ▫Real time 24-7 Air Quality Index information ▫Historically corrected and validated Air Quality data ▫Program Annual Reports ▫Archived air quality data within the Clean Air Strategic Alliance (CASA) data warehouse ▫Air Quality Index (AQI) [illegible] Accessibility: Products and data accessible through the WBEA website www.wbea.org, historical AQI data accessible through CASA	WBEA OUTCOMES ▫The air monitoring needs of residents and stakeholders in the Wood Buffalo region are better met with a state-of-the-art air monitoring system. ▫More accurate and transparent air-quality monitoring information is available 24 hours a day, 365 days a year and openly shared with stakeholders and the public. ▫Stakeholders make better informed decisions about air-quality and air quality related environmental impacts.
 www.ramp-alberta.org	**RAMP** Regional Aquatics Monitoring Program **Purpose:** to determine, evaluate and communicate the state of the aquatic environment and any changes that may result from cumulative resource development within the Regional Municipality of Wood Buffalo. **Intent:** The program strives to achieve a holistic understanding of potential effects of oil sands development on aquatic systems, as well as address specific issues important to communities of the region		**Water** **Coverage:** The RAMP Regional Study Area (RSA) is defined by the northeastern Regional Municipality of Wood Buffalo. The RAMP RSA is bounded by the Alberta-Saskatchewan border on the east, the Alberta-Northwest Territories to the northeast, the Wood Buffalo National Park to the northwest and various demarcations including the Athabasca River and Cold Lake Air Weapons Range to the south **Client:** Industry, Government, regional stakeholders and Aboriginal communities	Water Quantity; Water Quality; Sediment Quality; Fish Habitat; Fish Population	*Sample of RAMP questions - for complete list refer to the RAMP Program fact sheet* **Status:** •What are the baseline conditions and range of natural variation? •What are the baseline conditions and range of natural variability of water quality in the RAMP study area? •Is water quality at monitored locations outside the range of natural or baseline variability? •What are the baseline conditions and range of natural variability of indices of benthic invertebrate community composition in the RAMP study area? •What are the baseline conditions and range of natural variability of fish measurement endpoints in the RAMP study area? **Understanding:** [illegible] **Effects on:** •Do fish measurement endpoints from test areas exhibit time trends reflective of effects associated with increasing oil sands development?	**Climate and Hydrology** RAMP monitors changes in the quantity of water flowing through rivers and creeks in the RAMP study area. **Water Quality** [illegible] **Benthic Invertebrates** [illegible] **Sediment Quality** [illegible] **Fish Populations** [illegible] **Acid Sensitive Lakes** [illegible]	**Climate and Hydrology** [illegible] **Water Quality** [illegible] **Benthic Invertebrates** [illegible] **Fish Populations** [illegible] **Acid Sensitive Lakes** [illegible]	Products [illegible] Accessibility: Reports accessible through the RAMP website www.ramp-alberta.org, data available through an approved request to the RAMP program.	RAMP OUTCOMES ▫Monitoring of different components of the aquatic environment and in different geographic locations is more integrated. ▫The state of the aquatic environment within the Regional Municipality of Wood Buffalo is better known, evaluated and communicated. ▫Cumulative resource development effects on the aquatic environment within the Regional Municipality of Wood Buffalo are better known, evaluated and communicated. ▫Long-term trends, regional issues and potential cumulative effects are identified better and addressed. ▫The aquatic monitoring needs of all RAMP stakeholders are fulfilled. ▫The potential effects of oil sands development on aquatic systems are better understood holistically. ▫Specific aquatic issues important to the communities of the region are better understood.
 www.abmi.ca	**ABMI** Alberta Biodiversity Monitoring Institute **Purpose:** to support natural resource decision-making by providing relevant, timely, and credible scientific knowledge on the state of provincial biodiversity. **Intent:** To provide consistent, scientifically credible means to evaluate the status and trends in biodiversity, and provide insight into potential relationships between trends and underlying factors.		**Biodiversity** (With reference to Land Use - Human Footprint) **Coverage:** Province of Alberta **Client:** Government of Alberta, Energy Industry, Forest Industry, Government of Canada, Alberta's Public	Wildlife; Wildlife Habitat; Ecological Health; Healthy Aquatic Ecosystems; Natural Capital; Sustainability	**Status** • What is the health of the species, in a given area, region or an ascribed area? • What is the health of the habitat, in a given area, region or an ascribed area? • How intact is the ecosystem in a given area, region or an ascribed area? • What is the human impact on the land, in a given area, region or an ascribed area? **Understanding:** **Effects on:**	**Biodiversity** ABMI monitors biodiversity by sampling 1656 permanent sites established on a 20 km systematic grid across Alberta. [illegible]	**ABMI monitors biodiversity** by sampling 1656 permanent sites distributed every 20 km across Alberta. [illegible]	Products ▫Raw Data Download- biodiversity data, description of collection methods and relevant metadata. ▫Biodiversity Browser- explore, species selection, select custom area and report on indices. ▫Information Products-about ABMI information products and Access to Information Policy. ▫Business Advantage- learn how the ABMI benefits government, industry and all Albertans. ▫Information Pyramids and Intactness Manuals ▫Intactness Index [illegible] ▫Human Footprint Index [illegible] Accessibility: Products and data accessible through the ABMI website www.abmi.ca	ABMI OUTCOMES ▫The status and trends of ecosystems and species in the oil sands region are better known. ▫The relationship between biodiversity and the human footprint in the oil sands region is better understood ▫Natural resource decision-making is better informed through the provision of credible, scientific, relevant, and timely knowledge on the state of biodiversity in the oil sands region. ▫The natural biodiversity of the oil sands area is maintained. ▫Ecological goods and services that support strong and healthy economies and communities in the oil sands area are maintained
 www.cemaonline.ca	**CEMA** Cumulative Environmental Monitoring Association **Purpose:** To study the cumulative environmental effects of industrial development in the region and produce guidelines and management frameworks. **Intent:** The environment of the region, including the land, forest, air, water, wildlife and biodiversity, will be protected, sustained, and restored over the long term and that the collective activity of industrial activity in the region will not cause any lasting harm to the environment or adverse effects to the health of humans. Should these impacts be evident, the Association and its Members will recommend, promote and implement mitigation action to reverse their effects.		**Environment, Ecosystems and Landscapes** **Coverage:** Oil Sands Area or the Regional Municipality of Wood Buffalo or as defined by the issue / study **Client:** CEMA Members (45 in total) including all levels of government, industry, regulating bodies, environmental and aboriginal groups, local health authorities and other stakeholders	Land; Forest; Biodiversity; Water; Air; Wildlife; Aquatic Ecosystems; Human Health	**Status:** **Understanding:** •What are the best management tools, frameworks and guidelines available to protect, sustain, and restore the health of the landscape, vegetation, soil, and watersheds, while balancing industrial development and environmental considerations? •What are the best measures and methods available to protect the environment in areas where reclamation activities need to occur? How can we increase the understanding of potentially harmful emissions? **Effects on:** •How is the health of aquatic ecosystems (rivers, lakes, streams, etc) and the natural environment likely to respond to increasing oil sands development? •How can we increase our understanding of that response? •How can we develop a system that minimizes the long-term environmental impacts on surface water quantity and quality so that the water systems will remain healthy? •How can we assess the potential impacts of oil sands air emissions (i.e., discharges from stacks) on the environment and recommend actions to keep the air clean and minimize the effects of emissions?	**CEMA has no Cumulative Effects Monitoring Programs per se but engages in cause-and-effect studies (validation monitoring) in fulfilling their mandate.**	**Sustainable Ecosystems Working Group (SEWG)** [illegible] **Reclamation Working Group (RWG)** [illegible] **NOx SO₂ Management Working Group (NSMWG)** [illegible] **Surface Water Working Group (SWWG)** [illegible] **Trace Metals and Air Contaminant Working Group (TMAC WG)** [illegible] **Traditional Environmental Knowledge (TEK)** [illegible] **Groundwater Working Group (GWG)** [illegible]	Products ▫Frameworks, Guides and Tools ▫Regional Environmental Management System that is stakeholder driven ▫Issue priorities, work plans ▫EMS standards and practices for resource developers ▫Standards and practices to support regulators in their environmental approvals ▫Research products and databases ▫Indicators and thresholds ▫Management triggers and responses ▫Reports of various types Accessibility: Reports, Frameworks and Guidelines are available through the CEMA website: www.cemaonline.ca	CEMA OUTCOMES ▫The cumulative environmental effects of industrial development are better understood. ▫Cumulative environmental effects guidelines and management frameworks help to reduce the impacts of industrial development in the region. ▫Adverse effects of industrial activity are mitigated as soon as possible when they become evident. ▫The collective industrial activity in the region does not cause any lasting harm to the environment or adverse effects to human health. ▫The land, forests, air, water, wildlife and biodiversity of the region is protected, sustained and restored for the long-term.

APPENDIX 5: Chronology of Environmental Effects Monitoring Activities (1990 – 2010)



APPENDIX 6: ABMI Fact Sheet

Organization and Program Profile [Who?]

Name	Alberta Biodiversity Monitoring Institute (ABMI)
Start Date	The ABMI was initiated in 1998 through a partnership of industry, government, university, and non-government organizations. The ABMI incorporated as a not-for-profit organization in 2007.
What questions is the organization trying to answer?	*Mission:* To support natural resource decision-making by providing relevant, timely, and credible scientific knowledge on the state of provincial biodiversity. Biodiversity encompasses Alberta's living resources and is the foundation of healthy ecosystems. The ecological goods and services provided by biodiversity include products such as lumber and cereal crops and the creation, maintenance, and restoration of Alberta's ecosystems. Among other things, biodiversity is responsible for purifying air and water, ensuring the productivity of agriculture and forest lands, and regulating climate. Strong economies and communities depend on healthy environments. ABMI is a scientifically rigorous program designed to monitor and report on the health of species, habitats, and human footprint at many different ecological or spatial scales in many different administrative or environmentally defined regions. For example, ABMI can report on the status and trends related to hundreds of species in the Oil Sands Region of Alberta including fur bearing mammals, old forest birds, soil quality, wetland health, and forest habitat.

What is the nature of the Organization (governance structure)?	*Financial Resources:* The Executive Office is instrumental in ensuring sustainable funding is in place for the ongoing growth and maintenance of the program. In 2007/08, ABMI secured the short-term financial resources necessary to begin full operational startup. Although progress has been made in establishing long-term funding, the finalization of a formula for long-term sustainable funding remains a significant, ongoing priority. *Institute Establishment:* The Executive Office has completed all of the steps necessary for operational startup and establishment of the Institute. This includes incorporating as a not-for-profit society; transitioning to a new Board of Directors; establishing offices at both the University of Alberta and Alberta Research Council; developing policies; and leading and managing the budget, finance, and administrative systems. *Business Agreements:* ABMI has established master agreements with both the University of Alberta and the Alberta Research Council, including space, human resources, commitments, services, terms and conditions, commitment of financial resources, and renewals. In addition, the Executive Office has overseen the execution of sub-agreements with the Royal Alberta Museum and Alberta Conservation Association, as well as a Memorandum of Understanding with Alberta Sustainable Resource Development.

Organizing structure (how do they do what they do)?	ABMI is a not-for-profit society that is arms-length from government, industry, and environmental groups. The society is member based. An eight person Management Board oversees the operations. The Board includes senior management representatives from the agriculture, forestry, energy, academia, research, environmental, and government sectors. ABMI is jointly delivered through the University of Alberta, Alberta Innovates, the Royal Alberta Museum, and the Alberta Conservation Association. Functionally, there is an Executive Office which oversees the ABMIs' Science Centre, Monitoring Centre, and Information Centre.
Constituency (who is the client)?	• Government of Alberta • Energy Industry • Forest Industry • Government of Canada • Alberta's Public
Funding (where and how does the funding break down - industry / government / others)?	**ABMI 2008 Annual Report** **2008 Annual budget** **$ 5,040,781.00** % of Total Income *Income* Government of Alberta Contributions $ 4,200,000.00 83% Private Sector Contributions $ 765,000.00 15% *Expenses* Staffing $ 1,143,004.00 Other Expenditures $ 3,054,127.00

What are the organizational objectives?	• Engaging, on a regular basis, local, national, and international scientific experts during all aspects of science development. All data collection and analysis protocols receive extensive peer review by the greater scientific community; • Developing scientific protocols; • Developing scientific monitoring procedures; • Maintaining a high level of scientific credibility and objectivity; • Delivering relevant core products and services that meet the needs of major stakeholders; • Maintaining a focus on the core business of biodiversity monitoring; • Staying flexible and responsive to emerging needs in the fields of biodiversity monitoring and sustainable resource management; • Ensuring financial sustainability, by securing long-term funding; and • Ensuring managerial effectiveness and accountability. These factors are the key business drivers in the design and operations of ABMI. ABMI has been successful in addressing all but one of these factors. Long-term funding has not been secured and remains the primary business challenge.

Purpose [Why?]

What is the reason for the organizations existence?	The purpose of ABMI is to support natural resource decision-making by providing credible scientific knowledge on the state of provincial biodiversity.
What has the organization been charged with?	• Monitoring the status and trends of ecosystems and species. • Monitoring the human footprint to correlate with biodiversity information. • Monitoring the status and trends of approximately 2,000 species, 200 habitat elements, and 40 human footprint variables.

Monitoring Overview [Where, What, How and Why?]

Monitoring program overview and how it links to organizational authority.	ABMI measures and reports on the state of land, water, and wildlife across the province using scientifically credible indicators of environmental health. ABMI measures and reports on more than 2,000 species and habitats at 1,656 sites across the province. This includes the collection and management of knowledge on mammals, birds, plants, moss, lichen, soil mites, wetlands, fish, and the human footprint. Data and knowledge generated by ABMI are value-neutral, independent, and publicly accessible. Adding value to the data collection activities is core to the ABMI mission. Raw information is converted into knowledge and applied to resource management. ABMI is built on a foundation of high-quality science. More than 30 Alberta-based scientists worked on its program design. To ensure continued excellence in science, ABMI has established an independent Scientific Committee composed of world-class experts in the field of biodiversity monitoring and conservation. The purpose of the Science Committee is to provide external, third-party review and recommendations on strategic science decisions as they relate to the operations of the ABMI. Reporting directly to the ABMI Management Board, the independent Science Committee consists of: • Dr. Reed Noss, University of Central Florida, USA. Expertise in biodiversity conservation and planning. • Dr. Jeremy Kerr, University of Ottawa, Canada. Expertise in remote sensing and biodiversity conservation. • Dr. John Reynolds, Simon Fraser University, Canada. Expertise in aquatic ecosystems and salmon conservation. • Dr. Jari Kouki, University of Joensuu, Finland. Expertise in arthropod and fungi ecology.

Subject Matter Extent / Focus	*State of Provincial Biodiversity* Biodiversity is a broad phrase that encompasses: • Wildlife • Wildlife Habitat • Ecological Health • Healthy Aquatic Ecosystems • Natural Capital • Sustainability
Rationale / Casual Logic *What is the nature of their casual logic?*	ABMI employs a cumulative-effects monitoring approach that is targeted at detecting the ecological effects of a diverse set of environmental stresses on broad suites of indicators. Cumulative effects monitoring exposes correlative relationships between stressors in a system and the many indicators that are monitored. As such, ABMI assesses the performance toward management objectives such as "regional sustainability" or "ecological integrity". This monitoring approach remains relevant over long timeframes as new human activities and environmental stresses are introduced to landscapes.
Geographic Extent	Across Alberta

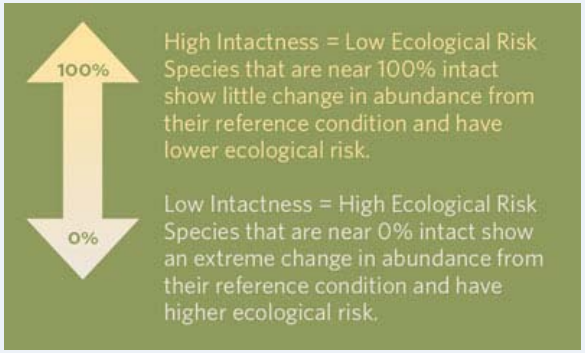
Sampling Approach • How are they stratified? • What is the geographic layout? • What is the periodicity? • What is being measured?	ABMI monitors biodiversity by sampling 1,656 permanent sites distributed every 20 km across Alberta. The precise geographic location of ABMI monitoring sites is confidential. Public coordinates identify the location of terrestrial and aquatic survey sites to within 5.5 km of the precise geographic coordinates (or 95 km^2). Each site is surveyed once every five years, within a two-week window based on a Julian date to reduce seasonal variation. In 2008 ABMI collected data at 80 terrestrial sites, 70 wetlands, 10 streams, 41 winter sites, six lakes and six rivers. Thirty-seven of the terrestrial and wetland sites required helicopter access as did two river, two lake, and nine winter sites. Data collection successfully occurred across the province from High Level to Lethbridge and included surveys in private land, mountainous terrain and bogs. ABMI measures and reports on provincial habitat and human footprint using both a sampling and an inventory approach.

Monitoring [The Means and the How?]

Monitor *What are the effects of Oil Sands operations on ecosystem health and human health?*	ABMI employs a cumulative-effects monitoring approach that is targeted at detecting the ecological effects of a diverse set of environmental stresses on broad suites of indicators (Manley et al. 2004). Cumulative-effects monitoring exposes correlative relationships between stressors in a system and the many indicators that are monitored (Noon et al. 1999, Thornton et al. 1994). As such, ABMI assesses the performance toward management objectives such as "regional sustainability" or "ecological integrity" (Mulder et al. 1999). This monitoring approach remains relevant over long timeframes as new human activities and environmental stresses are introduced to landscapes (Watson and Novelly 2004).

The Intactness Index

ABMI determines intact reference conditions for individual species and habitat elements. They describe the expected intact state of biodiversity (species and habitats) in natural regions using only ABMI data. These reference conditions are often considered as "controls" or "benchmarks" against which change in biodiversity can be determined.



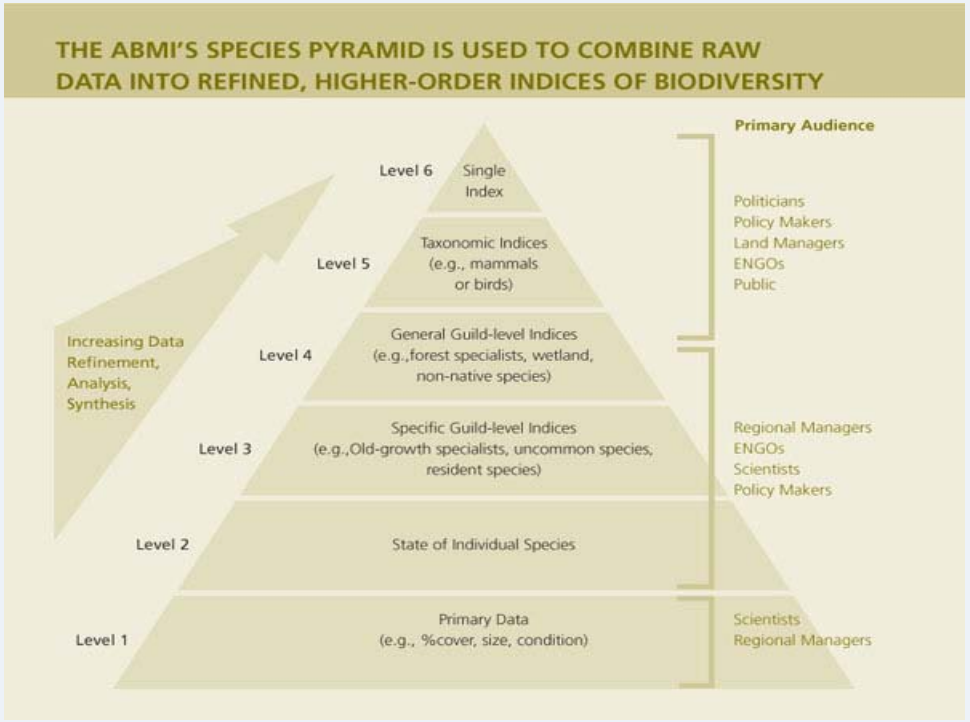
ABMI uses tools called the *Species Index* and the *Habitat Index* to report on how intact our species and habitats are. A general overview of how these tools work is provided below:

- The indices range from 100% intact to 0% intact.
  - An area with no evidence of human impact is 100% intact.
  - An urban parking lot surrounded by big box stores is 0% intact.
- If the abundance of a species is equal to the number we expect to find in a pristine area, that species is considered to be 100% intact.
- If the amount of habitat is the amount we expect to find in a pristine area, that habitat is considered to be 100% intact.
- The index declines from 100% toward 0% when:
  - Common species or habitats become rare or disappear.
  - Weeds or invasive species become very common.

	The Human Footprint Index ABMI reports on the extent of our human footprint by determining the area of land directly altered by human activities. In general, this tool works as follows: • A score of 0% means there is no human footprint. • A score of 100% means the landscape has been completely modified by human footprint. ABMI uses aerial photographs and satellite images to sample human footprint.

Evaluation, Analysis and Reporting

What is the communications framework?	The use of science to inform sustainable resource and environmental management policy requires that ecological knowledge be effectively communicated to decision-makers. It is, therefore, necessary that ABMI be able to summarize raw data into products that Alberta's decision-makers find timely and relevant. ABMI has chosen *Information Pyramids* as a framework for aggregating and simplifying ecological knowledge to meet the needs of resource managers and policy makers. Information Pyramids are appealing because they support the integration of diverse forms of biotic and abiotic data into synthesized, transparent and easily understood messages. The pyramid framework is designed to communicate the state of species and habitats to politicians, policy makers, managers, and the public and has the following characteristics: • Data used in Information Pyramids are scientifically sound. • Data analyses methods are transparent, scientifically rigorous, and peer reviewed. • Information products are flexible and responsive to the diversity of stakeholder needs. • Products are easy to interpret, timely, and relevant. Information products give insight into the underlying reasons for change in biodiversity. ABMI's Species Pyramid, an example of which is below, enables managers to access detailed information on the condition of species or to view highly aggregated information describing the state of all species.



Outputs from the Species Pyramid

- *Raw Data Download* – Download biodiversity data, description of collection methods and relevant metadata.
- *Biodiversity Browser* – Explore species detected by ABMI throughout the province since 2003, the initial prototype data collection year, as well as human footprint features from 2007 remote sensing information for the province.
- *Create Custom Area* – Explore species detected and human footprint features for custom management area, or by Natural Regions and Subregions, Government of Alberta Land-use Framework regions, Watersheds, Sustainable Resource Development Areas, Forest

	Management Agreements, National Parks, or Provincial Protected Areas. • *Data Collection Protocols* – Full detailed reports of data collection methods and biotic and abiotic laboratory protocols. • *Sites Sampled to Date* – Details of sites surveyed and protocols implemented to date. • *Information Products* – About ABMI information products and Access to Information Policy. • *Business Advantage* – Learn how ABMI benefits government, industry and all Albertans. • *Sites Surveyed to Date* – Details of sites surveyed and protocols implemented to date. • Information Pyramids and Intactness Manuals

Adjustment Mechanism (Actions that respond to the "So What"?)

How do you now take this information and, reflecting on your mandate and authority, what do you then do with it?	Prior to the development of ABMI, Alberta did not have a system in place to track and report on biotic performance. Consequently, resource managers had little credible information available to assist provincial and regional scale decision making. This was a serious weakness in Alberta's sustainable resource and environmental management system. As a first step, ABMI plays a major role in several natural resource planning and management systems across Alberta. *Land-use Framework* ABMI has worked closely with the Secretariat of the Land-use Framework to ensure the two initiatives are well integrated. For both the Lower Athabasca and South Saskatchewan Regional Plans, ABMI information is used extensively to select sustainability indicators and establish targets and thresholds for these indicators. In addition ABMI is a critical source of data for approximately 75% of the land, water, wildlife, and biodiversity indicators identified in the land-use plans.

Sustainable Forest Management – Regional Health

On December 1, 2009, ABMI released its first report specific to sustainable forest management in Alberta: *The Status of Biodiversity in Alberta-Pacific Forest Industries' Forest Management Agreement Area – Preliminary Assessment* (ABMI 2009). The findings in this report serve as a benchmark for the environmental health of an area that comprises nine percent of Alberta's land base. The report, which details the status of mammals, birds, vascular plants and habitats throughout the Al-Pac FMA area, states that the region's species are 96 percent intact and the region's habitats are 97 percent intact. Approximately seven percent of the landscape in the area has been altered by human activities, primarily forestry and energy operations. This ABMI report was successfully used by Alberta Pacific to support their Forest Stewardship Council of Canada certification review in 2009. The Forest Stewardship Council is an international certification and labeling system that guarantees that their certified forest products come from responsibly managed forests and verified recycled sources.

Market Based Instruments for Conservation and Stewardship – Measuring Ecological Goods and Services

ABMI has been working with the Institute for Agriculture, Forestry and the Environment (IAFE) to help them fulfill their mandate of developing a market-based framework that will contribute to "greening Alberta's growth". IAFE is recommending a framework that focuses on a market approach to environmental stewardship, fosters innovation and describes changes in environmental integrity. Under this framework, ABMI is developing an integrated approach to assess ecological condition at individual sites while ensuring that the methods integrate with regional monitoring and are relevant to regional stewardship objectives. This method will be used to assess ecological services using an integrated measure of environmental condition.

	Regulatory Efficiencies Concern over ecological cumulative effects of a rapidly increasing industrial footprint of in-situ oil sands operations has led to a variety of industry and GoA responses including an increase in biodiversity monitoring in approvals issued under the *Environmental Protection and Enhancement Act* (EPEA) for these facilities. Government and industry agree that there is a need for efficiency and effectiveness in the monitoring and assessment of biodiversity. ABMI is working with government and industry to use ABMI data as the basis for assessing regional environmental health and informing the management of landscapes in North-Eastern Alberta. This collaboration will reduce duplication, and provide cost effective ecosystem monitoring for the oil-sands region of Alberta.

APPENDIX 7: RAMP Fact Sheet

Organization and Program Profile [Who?]

Name	Regional Aquatics Monitoring Program (RAMP)
Start Date	1997
What question is the organization trying to answer?	The scope of RAMP focuses on the following six, key components of boreal aquatic ecosystems, which have been taken from the *RAMP Technical Design and Rationale* document (Hatfield Consultants 2009), a guidebook to the thinking and design of the monitoring program as it exists. *Climate and Hydrology Component* RAMP monitors changes in the quantity of water flowing through rivers and creeks in the RAMP study area, lake levels in selected water bodies and local climatic condition to identify possible changes in hydrology potentially related to oil sands development and to increase understanding of the linkages between the physical, chemical and biological characteristics of the aquatic environment. The objectives of the RAMP Climate and Hydrology component are to: 1. Provide a basis for assessing EIA predictions of hydrological changes. 2. Facilitate the interpretation of water quality, sediment quality, benthic invertebrate community, and fish population information by placing in context current hydrological conditions relative to historical mean or extreme conditions. 3. Document stream-specific baseline weather and hydrologic conditions to characterize natural variability and to allow detection of regional trends. 4. Support regulatory applications and meet requirements of regulatory approvals.

5. Support calibration and verification of regional hydrological models that form the basis of EIAs, operational water management plans and closure reclamation drainage designs.

The first four of these objectives derive from the overall objectives of RAMP, while the final objective has been included more recently as a result of ongoing discussions among members of the RAMP Technical Program Committee.

These five objectives lead to the following questions for the RAMP Climate and Hydrology component:

- What changes in hydrological variables are predicted in oil sands EIAs?
- What are the baseline conditions and range of natural variability of hydrological variables in the RAMP study area?
- Are hydrological conditions at monitored locations outside the range of natural variability?
- What hydrological information is required by other RAMP components to assist in interpretation?

The following hypotheses are formulated for the Climate and Hydrology component:

- Ho1: Hydrological conditions at each monitored location are within the range of natural variability.
- Ho2: Hydrological conditions are unaffected by development.

Water Quality Component

RAMP monitors water chemistry to identify human and natural factors affecting the quality of streams and lakes in the oil sands region. Monitoring the chemical signatures of water provides point-in-time measurements that help identify potential chemical exposure pathways between the physical environment and biotic communities relying on water quality. Specific objectives of the RAMP Water Quality component include:

1. Monitoring potential changes in water quality that may identify chemical inputs from point and non-point sources, with “change” defined as a change in a water quality measurement endpoint outside the range of natural variability.

2. Development of a water quality database to characterize natural or baseline variability, assess EIA predictions, and meet requirements of regulatory approvals.
3. Assessment of the suitability of water bodies to support aquatic life.
4. Provision of supporting data to facilitate the interpretation of RAMP biological surveys (i.e., fish and benthos components).

The first two of these objectives derive from the overall objectives of RAMP, while the latter two refer to assessment of water quality against accepted environmental quality guidelines and overall integration of RAMP components.

These four objectives lead to the following questions for the RAMP Water Quality component:

- What changes in water quality are predicted in oil sands EIAs?
- What are the baseline conditions and range of natural variability of water quality in the RAMP study area? Is water quality at monitored locations outside the range of natural or baseline variability?
- Is water quality in the RAMP study area suitable to support aquatic life?
- What water quality data are required by other RAMP components to assist in interpretation?

From these questions, the following null hypotheses were formulated for the water quality component:

- Ho1: Water quality at each location sampled is within the range of natural or baseline variability.
- Ho2: Water quality at sampled locations does not change over time.
- Ho3: Water quality at upstream and downstream sampling locations is similar.
- Ho4: Water quality characteristics at each sampling location do not exceed relevant environmental quality guidelines.
- Ho5: Process water quality is the same as natural water quality.

Benthos and Sediment Component: Benthic Invertebrates

RAMP monitors benthic invertebrate communities as a regulatory requirement (i.e., because the member companies require the studies as part of their Approvals to operate), and to complement the other biophysical components in an overall comprehensive assessment of conditions in the oil sands region. Benthic invertebrate communities serve as a sensitive biological indicator and are an important component of fish habitat. Oil sands EIAs have predicted that changes in hydrologic regimes, water and sediment quality, and changes in aquatic habitat would variously cause reductions in abundance, diversity and number of taxa benthic macroinvertebrate taxa, and changes in composition. The RAMP Benthic Invertebrate Community component thus has three general objectives as proposed in the RAMP five-year report.

1. Collect scientifically defensible baseline and historical data to characterize variability of indices of composition of benthic invertebrate communities in the oil sands area.
2. Monitor benthic macroinvertebrates in the oil sands area to detect and assess cumulative effects and regional trends in indices of composition.
3. Collect data against which predictions, pertaining to benthic invertebrates, contained in environmental impact assessments can be verified.

These objectives lead to the following questions for the RAMP benthic invertebrate component:

- What changes in benthic invertebrate composition are predicted from the EIAs?
- What are the baseline conditions and range of natural variability of indices of benthic invertebrate community composition in the RAMP study area?
- Do indices of benthic invertebrate community composition vary significantly between exposed (test) areas and unexposed (baseline) areas to oil sands development?
- Do indices of composition from test areas have the same time trend as indices in baseline areas?

- Where indices of community composition demonstrate a local change, either spatially or temporally, do those indices fall outside the range of natural variability as observed over time in baseline areas in the RAMP study area?

From these questions, the following hypotheses are formulated for the benthic invertebrate community component.

- Ho1: Indices of community composition are the same in areas exposed (test) and unexposed (baseline) to oil sands development.
- Ho2: Time trends in indices of community composition are the same in areas exposed (test) and unexposed (baseline) to oil sands development.
- Ho3: Indices of community composition in test areas are within the normal range of variability as expressed in baseline areas in the RAMP study area.

Benthos and Sediment Component: Sediment Quality

RAMP monitors sediments to provide supporting habitat data for interpretation of benthic invertebrate community monitoring results, to support the RAMP fish component, and to identify human and natural factors affecting sediment quality in streams and lakes in the oil sands region. Assuming that the sampled depositional areas accumulate sediments over time, monitoring the physical and chemical composition of sediment provides a time-integrated measurement of environmental quality. This helps to identify environmental change and potential chemical exposure pathways between the physical environment and biotic communities associated with bottom sediments and overlying waters.

The specific objectives of the Sediment Quality sub-component are to:

1. Provide data that can be used to aid interpretation of RAMP benthic invertebrate surveys.
2. Assess the suitability of water bodies to support aquatic life (e.g., benthic invertebrates, fish).

3. Provide data for inclusion in a sediment quality database, to characterize natural variability, assess EIA predictions, and meet requirements of regulatory approvals.

These objectives lead to the following questions for the RAMP sediment quality sub-component:

- What sediment quality data are required by other RAMP components to assist in interpretation of monitoring results?
- Is sediment quality in the RAMP study area suitable to support aquatic life?
- Are sediment quality measurement endpoints correlated with benthic invertebrate measurement endpoints?

From these questions, the following hypotheses are formulated for the sediment quality component:

- Ho1: Sediment quality characteristics at each sampling location do not exceed relevant environmental quality guidelines.
- Ho2: Sediment quality measurement endpoints are not correlated with benthic invertebrate measurement endpoints.

Fish Populations Component

The RAMP Fish Population component was established to monitor the health and sustainability of fish populations within the oil sands region. Fish populations are monitored because they are key components of the aquatic ecosystem and important ecological indicators that integrate effects from natural and anthropogenic influences. Fish also represent a highly valued recreational and subsistence resource. In this regard, there are expectations from regulators, Aboriginal peoples and the general public with respect to comprehensive ongoing monitoring of fish populations in the oil sands region. In addition, the oil sands EIAs have predicted that changes in hydrologic conditions, water quality, air quality (acidifying emissions) and changes in physical habitat (and to a lesser extent sediment quality and benthic communities) may variously influence fish health, fish abundance, tissue quality and fish habitat availability.

Specific objectives of the Fish Population component include:

1. Collecting fish population data to characterize the natural or baseline variability, assess EIA predictions, and meet requirements of regulatory approvals.
2. Monitoring potential changes in fish populations due to stressors or impact pathways (chemical, physical, biological) resulting from oil sands development by assessing attributes such as growth, reproduction and survival.
3. Assessing the suitability of fisheries resources in the oil sands region for human consumption.

The first two objectives derive from the overall objectives of RAMP, whereas the third objective addresses local community and Aboriginal concerns regarding the quality and safety of fish captured in the region for consumption. These objectives lead to the following questions for the RAMP fish population component:

- What changes in fish populations and fish health are predicted in oil sands EIAs?
- What are the baseline conditions and range of natural variability of fish measurement endpoints in the RAMP study area?
- Do fish measurement endpoints vary significantly between areas or water bodies exposed (test) and unexposed (baseline) to oil sands development?
- Do fish measurement endpoints from test areas exhibit time trends reflective of effects associated with increasing oil sands development?
- Do tissue concentrations of select organic and inorganic compounds in fish captured in the region exceed established guidelines for safe consumption?
- What data on fish populations are required by other RAMP components to assist in interpretation?

From these questions, the following hypotheses are formulated for the fish population component:

- Ho1: Population characteristics of key indicator fish species do not change over time.
- Ho2: Growth, reproduction and survival of sentinel species are similar between test and baseline areas, and over time.
- Ho3: Chemical constituents in fish tissues of key indicator species do not change over time.
- Ho4: Chemical constituents in fish tissues of key indicator species do not exceed relevant environmental quality and consumption guidelines.

Acid Sensitive Lakes Component

The RAMP Acid Sensitive Lakes (ASL) component was originally designed to monitor lake water chemistry in regional lakes "as an early-warning indicator of excessive acid deposition". Acid sensitive lakes were expected to show changes in their buffering capacities before soils or vegetation could provide a clear indication that acidic thresholds have been reached. While the order of these events (observed effects in lakes preceding those in soils) may be debated, the basic objective of the ASL program remains relatively simple: the lakes are monitored to detect effects of acidifying deposition on water quality and lake biology. Currently, the RAMP ASL component is focused on monitoring for potential changes in water quality. However, Alberta Environment (AENV), in collaboration with Environment Canada, has undertaken concurrent collections of phytoplankton and zooplankton to assess possible changes in lake biology.

Specific objectives of the ASL program include:

1. Establishment of a database on water quality to detect and assess cumulative effects and regional trends. In the case of the ASL program, these data would provide specific measurement endpoints capable of detecting incipient lake acidification.
2. Collection of scientifically defensible baseline and historical data (both chemical and biological) to characterize the natural variability of these measurement endpoints in the ASLs.

	3. Collection of data on the regional lakes against which predictions contained in EIAs could be verified. 4. Quantification and documentation of individual lake sensitivity to acidification. This fourth objective, although not stated explicitly in the RAMP literature, has evolved in the 2003 and 2004 reports. These objectives of the ASL component suggest the following questions that have been discussed in RAMP technical meetings: • What is the natural or normal range of variability of measurement endpoints used to detect acidification in these lakes? • Are there trends in lake chemistry that would indicate incipient acidification? • Are the predictions of the EIAs on the potential for lake acidification supportable? These questions can be re-phrased as null hypotheses to be tested by the RAMP program: • Ho1: The RAMP lakes do not show any evidence of incipient acidification beyond the natural variability of relevant measurement endpoints. • Ho2: There are no effects of Athabasca oil sands developments on the potential for acidification of the RAMP lakes.
What is the nature of the Organization (governance structure)?	RAMP is an industry-funded, multi-stakeholder environmental monitoring program initiated in 1997.

Organizing structure (how do they do what they do)?	*RAMP Organization* RAMP is governed by a multi-stakeholder, decision-making body known as the *Steering Committee*. Functions of the Steering Committee include: • Prioritizing projects within the program objectives to maximize use of available resources. • Reviewing program progress against budget and schedule. • Reviewing program results for relevance to program objectives. • Communicating results and soliciting input from interested parties. • Facilitating communication and linkage with other regional environmental initiatives. RAMP also has a *Technical Program Committee* responsible for the development and review of the RAMP technical monitoring program. The Technical Program Committee is divided into discipline-specific sub-groups that are responsible for identifying and recommending monitoring activities specific to their discipline for integration into the overall monitoring program. Investigators (i.e., a consultant team, government agencies, industry, Aboriginal members, etc.) primarily carry out the fieldwork, data analysis and reporting, as defined by the program. A *Finance Subcommittee* focuses on issues related to the budget and funding for the annual monitoring program. All budget-related information is then submitted to the Steering Committee for final approval. Finally, RAMP has a *Communications Coordinator* who assists members of the Steering Committee in the transfer of information and monitoring results to local stakeholders and the scientific community. When appropriate, RAMP also participates in communications activities in collaboration with WBEA and CEMA. The RAMP organizational structure is shown below.

The Organizational Structure of RAMP
source RAMP 2007 - updated to 2008

Constituency (who is the client)?	Industry, government, regional stakeholders and Aboriginal communities

Funding (where and how does the funding break down - industry / government / others)?	Funding for RAMP is provided by industry members. With the exception of the Acid-Sensitive Lakes component, the costs are apportioned based on relative 20-year bitumen production forecast for the various projects of industry members[1]. The following is a summary of the approach used: 1. Program administration and communication activities and monitoring at "core" stations are funded by all industry members. 2. Monitoring at stations located on a water body is funded by industry members with projects in the specific watershed. 3. The cost of monitoring acid sensitive lakes is apportioned based on the sum of SO_2+NO_x emissions from each company during the previous calendar year. 4. In addition, other RAMP members provide in-kind support from time to time to assist with the ongoing annual monitoring program. [1] *Each project is assessed the proportion of the total production that it contributes. Thus, if a project accounts for 20% of the total production, it would be assessed 20% of costs related to administration, communications and core stations. For other stations, a new total would be computed for each tributary station and a separate ratio computed. For the example above, if three projects of equal size were to be involved in a particular stream, each would bear 33% of the costs.*
What are the organizational objectives?	The objectives of RAMP are to: • Monitor aquatic environments in the Athabasca oil sands region to detect and assess cumulative effects and regional trends. • Collect baseline data to characterize variability in the Athabasca oil sands region. • Collect and compare data against which predictions contained in EIAs can be assessed. • Collect data that assists with the monitoring required by regulatory approvals of oil sands and other developments. • Collect data that assists with the monitoring requirements of company-specific community agreements with associated funding. • Recognize and incorporate traditional knowledge into monitoring and assessment activities.

	• Communicate monitoring and assessment activities, results and recommendations to communities in the Regional Municipality of Wood Buffalo, regulatory agencies and other interested parties. • Continuously review and adjust the program to incorporate monitoring results, technological advances and community concerns and new or changed approval conditions. • Conduct a periodic peer review of the program's objectives against its results, and to recommend adjustments necessary for the program's success.

Purpose [Why?]

What is the reason for the organizations existence?	The intent of RAMP is to integrate aquatic monitoring activities across different components of the aquatic environment, different geographical locations, and Athabasca oils sands and other developments in the Athabasca oil sands region so that long-term trends, regional issues and potential cumulative effects related to oil sands and other developments can be identified and addressed.
What has the organization been charged with?	The mandate of RAMP is to determine, evaluate and communicate the state of the aquatic environment and any changes that may result from cumulative resource development within the Regional Municipality of Wood Buffalo. RAMP is a science-based and results-focused environmental monitoring program that is designed to fulfill the aquatic monitoring needs of all RAMP stakeholders. The program strives to achieve a holistic understanding of potential effects of oil sands development on aquatic systems, as well as address specific issues important to communities of the region.

Monitoring Overview [Where, What, How and Why?]

Subject Matter Extent / Focus	Aquatics

Rationale / Causal Logic *What is the nature of their casual logic?*	RAMP incorporates both stressor- and effects-based monitoring approaches. Using impact predictions from the various oil sands EIAs, specific potential stressors have been identified that are monitored to document baseline conditions, as well as monitor potential changes related to development. Examples include specific water quality variables and changes in water quantity. In addition, there is a strong emphasis in RAMP on monitoring sensitive biological indicators that reflect the overall condition of the aquatic environment. By combining both monitoring approaches, RAMP strives to achieve a more holistic understanding of potential effects on the aquatic environment related to oil sands development.
Geographic Extent	Regional Municipality of Wood Buffalo (link to map)
Sampling Approach • How are they stratified? • What is the geographic layout? • What is the periodicity? • What is being measured?	RAMP has focused on these main aquatic systems**:** • The Athabasca River and Athabasca River delta. • Tributaries to the lower Athabasca River including the Steepbank, Clearwater-Christina, Hangingstone, Ells, Tar, Firebag, Calumet, Muskeg, MacKay Rivers as well as several smaller tributaries • Wetlands and lakes occurring near current and proposed oil sands developments (Isadore's Lake, Shipyard Lake, McClelland Lake and Kearl Lake). • Acid sensitive lakes in northeastern Alberta. • Regional lakes important to sport and subsistence fisheries. RAMP monitors the following environmental components: 1. Climate and hydrology 2. Benthic invertebrate communities and sediment quality 3. Water quality 4. Fish populations 5. Acid-sensitive lakes

	Monitoring Details (Indicators, Frequency, Thresholds, Methods) Each year, RAMP collects information about key components of the aquatic environment through field sampling and the collection of various samples for laboratory analysis. *Monitoring Summary by Component* Click here to see the water bodies where RAMP monitoring is conducted.

Monitoring [The Means and How?]

What are the effects of Oil Sands operations on ecosystem health and human health?	*Climate Hydrology* The RAMP Climate and Hydrology component has established several monitoring stations throughout the RAMP study area (see map). At some of these stations, data are collected using automated sensors, while at others, on-the-ground personnel complete field measurements. Variables measured for the Climate and Hydrology component include the following (although not every variable is measured at every station): • Air temperature • Rainfall and snowfall • Relative humidity • Wind speed and direction • Solar radiation • Snow on the ground • Snow depth and mass (for snow water equivalent and snow density calculations) • Water level • Discharge *Water Quality* Water quality samples are collected at stations on rivers, streams, and lakes throughout the RAMP study area. Multiple stations may be located on the same river or stream to assess

gradients of change in water quality along a river, or differences in water quality between stations located upstream and downstream of oil sands developments. RAMP attempts to collect at least three years of baseline data at stations of interest before development occurs, to facilitate comparison of post-development water quality with natural conditions and variability in water quality. RAMP water quality sampling occurs in each season, although most samples are collected in fall, when rivers and lakes are still free from ice and river flows are relatively low.

Water quality samples are submitted to analytical laboratories for measurement of the following variables:

1. Conventional variables: Colour, dissolved organic carbon (DOC), pH, specific conductance, total alkalinity, total dissolved solids (TDS), total hardness, total organic carbon (TOC), and total suspended sediments (TSS).
2. Major ions: Bicarbonate, calcium, carbonate, chloride, magnesium, potassium, sodium, sulphate, and sulphide.
3. Nutrients: Nitrate + nitrite, ammonia, total Kjeldahl nitrogen (TKN), and total and dissolved phosphorus.
4. Biological oxygen demand.
5. Organics: Naphthenic acids, total phenolics, and total recoverable hydrocarbons.
6. Total and dissolved metals.

Benthic Invertebrate

Benthic invertebrate communities are monitored in rivers, streams, and lakes throughout the Athabasca oil sands region. Sampling is conducted in the fall of each year to limit variability related to seasonal changes. Supporting environmental data, including flow velocity, water depth, substrate grain size (e.g., percent gravel, sand, etc.), sediment organic matter content, and substrate chlorophyll-*a* content, are collected at relevant stations in order to separate the effects of natural environmental variability from effects potentially related to oil sands development. Multiple individual samples of surface sediments within a river reach or lake are

collected with samplers that remove a known amount of sediment (e.g., the Ekman grab used to sample soft sediments has an area of 15 cm by 15 cm, and thus collects sediment from a 225 cm^2 area). Benthic invertebrate organisms are separated from these samples, identified to the lowest practical taxonomic level, and counted. These data are then used to calculate the following indices or measurement endpoints for each individual sample:

Abundance (total number of organisms/m^2). Higher abundance, or density, of organisms is generally seen in systems that are rich in nutrients, while low abundance can be related to short- or long-term toxicity caused by chemicals or by physical disturbance of aquatic habitat.

Taxon richness (the number of distinct taxa per sample). The number of taxa (classifications of organisms, such as *species*, *genus*, *family* or *order*) is a measure of community composition; sites with more taxa are generally considered to be in better condition. The number of taxa can increase with moderate nutrient enrichment, but can decrease with excessive levels of nutrients, toxic conditions, or physical disturbance of habitat.

Simpson's Diversity Index and Evenness. The Simpson's Diversity index and evenness are related to the proportion of total organisms contributed by each taxon. Diversity and evenness are low when the benthic community is dominated by a few taxa, and higher when the number of organisms is more evenly distributed across numerous taxa. High diversity and evenness indicate better environmental conditions, while low values can indicate stresses on the system.

EPT Index. The EPT index is a measure of the percent of organisms belonging to the taxa *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies). These taxa are generally considered to be sensitive to pollution, and high abundance of these organisms can indicate good environmental conditions.

Sediment Quality

The objectives of the RAMP Sediment Quality component are to:

- Collect data to characterize the natural variability of sediments in the Athabasca oil sands region, assess predictions documented in EIAs, and meet monitoring requirements of regulatory approvals.

- Provide supporting information to facilitate interpretation of data from other RAMP components, including Benthic Invertebrates, Climate and Hydrology, and Fish.
- Identify potential changes in sediment quality that may be indicative of environmental change and chemical inputs from point or non-point sources.

Sediment samples are collected in the fall from the most downstream sampling location in each depositional river reach sampled for benthic invertebrates, and from each of the lakes and wetlands sampled for benthic invertebrates. Sediment samples are submitted to analytical laboratories for analysis of the following variables:

- Physical variables: Percent sand, silt, and clay.
- Carbon content: Total inorganic carbon, total organic carbon, total carbon.
- Organics: BTEX (benzene, toluene, ethylene, xylene), hydrocarbons by size class (CCME 4-fraction total hydrocarbons; C_6-C_{10}, C_{10}-C_{16}, C_{16}-C_{34}, and C_{34}-C_{50}), total hydrocarbons.
- Total metals.
- Target Polycyclic Aromatic Hydrocarbons (PAHs).
- Alkylated PAHs.
- Toxicity: survival and growth of the amphipod *Hyalella azteca* and survival and growth of *Chironomus tentans* midge larvae.

Fish Populations

In an effort to address multiple issues related to fish populations, RAMP implements four different sampling programs on the Athabasca River and its tributaries, as follows:

Fish Inventories

Fish inventory studies are conducted by RAMP to examine trends in abundance and population variables for key indicator fish species, including walleye, northern pike, longnose sucker, white sucker, lake whitefish, goldeye, and trout perch. Inventories are generally conducted on larger rivers (e.g., the Athabasca and Clearwater) in two seasons each year to account for the different species' life histories. Fish are temporarily stunned using an electro-fishing boat, captured with dip nets, and held on board for counting, measurement of length

and weight, and assessment of age, sex, and health. Fish are then tagged, sampled for aging structures, and released.

Measurement endpoints used to assess population trends include:

- Relative abundance (catch per unit effort of fishing), an approximate measurement of population size, and percent composition. The percent composition of each species in the sampled population indicates the dominant species in the population; shifts in dominance and abundance can reflect species-specific sensitivity or tolerance to different environmental conditions.
- Length/Age frequency, to identify the age or size classes potentially affected by stressors in the environment.
- Condition factor, which indicates how "fat" a fish is. Fish may allocate energy to growth, reproduction, or storage differently depending on environmental conditions; condition factor reflects the nutritional health and status of the fish, with higher values indicating that more energy was allocated to storage.

Acid Sensitive Lakes

RAMP samples approximately 50 regional lakes each year in late summer-fall. Water samples are collected from the euphotic zone (upper water layer exposed to sunlight) and sent to an analytical laboratory for analysis of the following variables:

- Conventional variables: pH, turbidity, colour, total suspended solids, total dissolved solids, dissolved organic carbon, dissolved inorganic carbon, conductivity, total alkalinity, and Gran alkalinity.
- Ions: Bicarbonate, Gran bicarbonate, chloride, sulphate, calcium, potassium, sodium, and magnesium.
- Nutrients: Total dissolved nitrogen, ammonia, nitrate + nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus, and total dissolved phosphorus.
- Chlorophyll-a.
- Total and dissolved fractions of 27 metals.
- Phytoplankton and zooplankton on behalf of AENV and EC.

Evaluation, Analysis and Reporting

What is the communications framework?	The annual technical document represents the key scientific output from the program. The report is reviewed by all members of RAMP and submitted to AENV (Regional Approvals, Northern Region) for review and assessment. In 2010, RAMP will undertake a scientific peer review of the program to solicit independent feedback, comment and recommendations for the purpose of strengthening and refining the program. The last review was completed in 2004 and resulted in important improvements in the program design and the documentation describing the program. *Outputs* • Providing Annual Technical Report to members, AENV approvals office and stakeholders. • Incorporating data into the long-term RAMP database for use by members. • Developing a Community Report of the past year's monitoring program (often in collaboration with WBEA and CEMA). • Making PowerPoint presentations to local communities, the scientific community, and Elder's Advisory Group of Fort McKay. • Publishing RAMP data in scientific journals (ongoing in 2010). • Providing fish tissue data to Alberta Health and Wellness and Health Canada. • Providing technical and community reports through the website. • Developing an environmental report card (in progress).

Adjustment Mechanism (Actions that respond to the "So What"?

How do you now take this information and, reflecting on your mandate and authority, what do you then do with it?	• Undertaking an annual review process by RAMP members, followed by two meetings per year by the Technical Program Committee to review results and refine the monitoring design. RAMP Tech is made up of scientific experts from government agencies, industry and consultants. • Holding component-specific subgroup meetings as required. • Undertaking scientific peer review of the entire monitoring program, periodically. • Soliciting component-specific assistance as required by scientific experts (e.g., Fish component recently solicited input from scientists from Oregon State University / Environmental Protection Agency (EPA) to review work related to fish assemblage monitoring). • Undergoing an annual review by AENV Regional Approvals office. • Reviewing RAMP Terms of Reference every two years, including mandate and objectives, structure and governance model.

APPENDIX 8: WBEA Fact Sheet

Organization and Program Profile [Who?]

Name	Wood Buffalo Environmental Association (WBEA)
Start Date	1985
What question is the organization trying to answer?	• What is the air quality in the Region of Wood Buffalo? • What are the long-term impacts of air quality (indoor or outdoor or both), if any on human health in the WBEA area? • What are the Terrestrial Environmental Effects as a result of air quality on the WBEA area? • Of what are the air emissions comprised? (understand the source) • How are air emissions dispersed and deposited? • To what level is the ecosystem exposed to air emissions? • How can the overall predictability of the passive regional monitoring network be improved? • How can early indication of air-related impacts on vegetation occurring in the region be identified?
What is the nature of the Organization (governance structure)?	WBEA is an independent, community-based, not-for-profit association that grew out of the following circumstances: • In 1985, Fort McKay First Nation expressed concern about the environment. • In response, government and industry formed an Air Quality Task Force which described issues, established priorities and recommended on-going dialogue and a consensus based approach to air quality concerns. • The Air Quality Task Force becomes the Regional Air Quality Coordinating Committee (RAQCC) prioritized regional air quality concerns and coordinated a program to manage air quality in the region. • In 1993, the Government of Alberta developed a regional approach to air quality monitoring under the umbrella of the Clean Air Strategic Alliance (CASA). • In 1997, RAQCC was reformed into the WBEA.

	• In 1996, CASA formally endorsed the WBEA Monitoring Program. • In 1997, WBEA assumed responsibility for ownership and operation of a regional consolidated air quality monitoring network in the region. • Capital costs provided originally by Suncor and Syncrude. • Alberta Environment provided equipment on a long term basis, as well as expertise and in-kind contributions. • In 1999, WBEA included an ecological monitoring program, Terrestrial Environmental Effects Monitoring (TEEM). • In 2005, WBEA included the ongoing Human Exposure Monitoring Program (HEMP). Membership, funding and in-kind contributions have continued to rise with the increase in industry activity.
Organizing structure (how do they do what they do)?	The following diagram depicts the organizational structure at WBEA. They currently have eight full-time employees. 

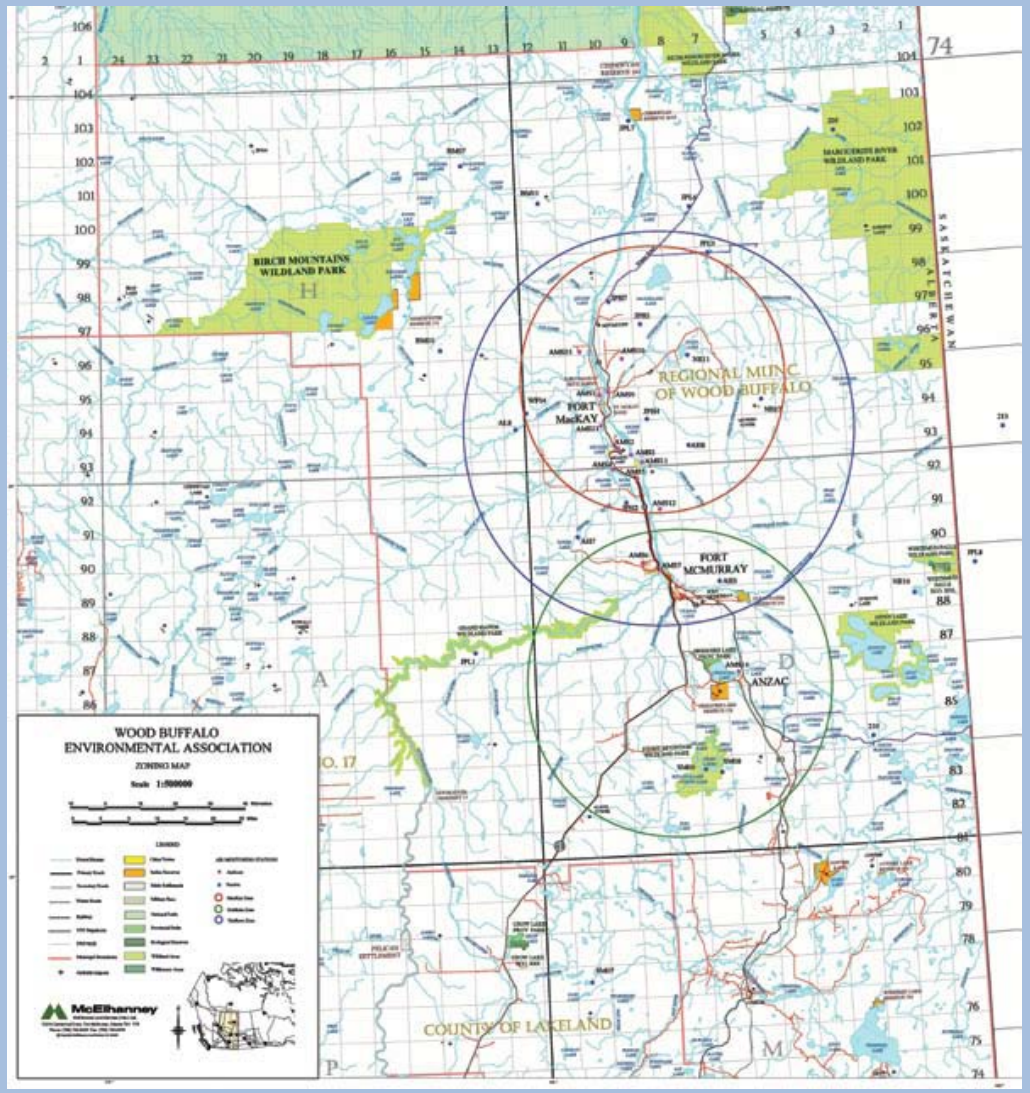
Constituency (who is the client)?	• The people of Wood Buffalo Municipality • WBEA Stakeholders
Funding (where and how does the funding break down - industry / government / others)?	• 98% of the 2008 Annual budget of $8,787,547.00 came from industry (see schedule 1 – contributions of WBEA 2008 Annual Report). • The remaining 2% of the budget came from an unspecified grant. • An estimated budget breakdown is below: Organization Operations $1,280,546 15% Air Monitoring $3,156,552 36% Teem program $2,987,794 34% Human Exposure $134,638 2%

Purpose [Why?]

What is the reason for the organizations existence?	WBEA monitors air quality and air quality related environmental impacts to generate accurate and transparent information which enables stakeholders to make informed decisions. ***Vision:*** State-of-the-art air monitoring system that meets the needs of residents and stakeholders in the Wood Buffalo Region.
What has the organization been charged with?	WBEA monitors the air in the Regional Municipality of Wood Buffalo, 24 hours a day, 365 days a year. They do this through a variety of air, land and human monitoring programs. The information collected is openly shared with stakeholders and the public.

Monitoring Overview [Where, What, How and Why?]

Subject Matter Extent / Focus	Air Quality and Emissions
Rationale / Causal Logic *What is the nature of their casual logic?*	The air monitoring component of WBEA is the cornerstone of the organization and is directed by the Ambient Air Technical Committee. Some background information includes: • The WBEA air quality monitoring program operates 24 hours a day, 365 days a year and provides scientifically credible data, focusing on air quality with respect to human and ecosystem health. • WBEA operates a network of fifteen air monitoring stations in the Regional Municipality of Wood Buffalo. Each station costs approximately $250,000. • There are two stations in Fort McMurray, one in Fort Chipewyan, six around the Syncrude/Suncor corridor, one at the Albian Sands site, one in the community of Fort McKay, two around Fort McKay, one at CNRL and one in the community of Anzac. • TEEM operates ten passive monitoring sites to measure concentrations of sulphur dioxide, nitrogen dioxide and ozone at remote forest locations. • There are four passive monitoring sites surrounding the Petro-Canada MacKay River Project that monitor concentrations of sulphur dioxide, hydrogen sulphide, nitrogen dioxide and ozone. If there is an exceedance, the WBEA network records it and issues a Ground Level Concentration (GLC) Exceedance Notification. Alberta Environment and industry, including various WBEA members, are immediately informed. The GLCs are reviewed by industry members to determine if plant operations or events may have contributed to the exceedance.

Geographic Extent	*Regional Municipality of Wood Buffalo (70 000 km^2)* 

Sampling Approach • How are they stratified? • What is the geographic layout? • What is the periodicity? • What is being measured?	*Air Quality Monitoring* WBEA's Air Quality Index allows the non-scientist to easily gauge air quality. The measurement is made up of several different compounds in the air, including carbon monoxide, nitrogen dioxide, sulphur dioxide, ozone, and fine particulate matter. The raw data are transmitted in real time to Alberta Environment where the index is calculated. The Air Quality Index is calculated every hour for five key locations in Wood Buffalo: Athabasca Valley, Fort Chipewyan, Fort McKay, Patricia McInnes, and Syncrude UE-1. All WBEA air monitoring data are sent to the Clean Air Strategic Alliance Data Warehouse (www.casadata.org), an on-line database for all of Alberta's air monitoring data. ***Air Quality Objective*** WBEA monitors air quality and air quality related environmental impacts to generate accurate and transparent information which enables stakeholders to make informed decisions. There are five approaches to monitoring air quality, as described below: 1. *Continuous air monitoring*: • There are 15 air monitoring stations that continuously monitor the air 24 hr/day, 365 days/yr. • The stations transfer raw, real-time data to Alberta Environment where an air quality index is calculated. • The stations are located from Fort Chipewyan (200 km north of industry) to Anzac (50 km south). • The stations monitor SO_2, NOx (NO, NO_2), O_3, PM_{10}, $PM_{2.5}$, H_2S, TRS, CO • Meteorology (Temperature, Relative Humidity, Wind Strength, Wind Direction) is monitored at AMS. • Two tall towers measure meteorology at various levels up to 167 m, for regional dispersion model input. 2. *Semi-continuous air monitoring*: • This involves precipitation chemistry. • VOCs are monitored (24 hr period, every 12 days; 8 stations). • PAH's (23 species) are monitored (once monthly at 4 stations for 10 days) 3. *Passive air monitoring*: • Passively collected monthly exposure to SO_2, NO_2, O_3, HNO3, NH_3 at over 30 sites. • These stations are co-located with continuous monitors at 15 air monitoring stations. 4. *Advanced air monitoring*: • Ambient ion monitor (URG 9000D) at Fort McKay (AMS 1) completes semi-continuous

Monitoring [The Means and How?]

What are the effects of Oil Sands operations on ecosystem health and human health?

Monitoring Approach

WBEA conducts Continuous, Semi-Continuous, Passive, Advanced and Mobile Air Monitoring. Real time information is communicated through the use of the Air Quality Indicator.

Monitoring Details (Indicators, Frequency, Thresholds, Methods)

The Air Quality Index (AQI) is a measure of outdoor air quality based on five parameters: carbon monoxide, fine particulate matter, nitrogen dioxide, ozone and sulphur dioxide. Five WBEA ambient air monitoring stations have the technology to measure and monitor these air emissions in real time. It should be noted that factors such as weather changes and forest fires can increase an AQI reading.

How is the Air Quality Index Calculated?

The AQI is calculated every hour for each air quality parameter using the formulas indicated below.

Parameter	**Concentration**	**Units**	**AQI Formula**
Carbon Monoxide	> 13	ppm	AQI = (1.47 x concentration) + 5.88
	If <= 13		AQI = 1.92 x concentration
Ozone	If <= .05	ppm	AQI = 500 x concentration
	If > .05 <= .08		AQI = (833 x concentration) - 16.67
	If > .08		AQI = (714 x concentration) - 7.14
Sulphur Dioxide	All	ppm	AQI = 147.06 x concentration
Nitrogen Dioxide	If <= 0.21	ppm	AQI = 238.09 x concentration

	If > 0.21		AQI = (156.24 x concentration) + 17.19
Respirable Particulate Matter ($PM_{2.5}$)	If <= 30	ug/m^3	AQI = 0.8333 x concentration
	If > 30		AQI = (0.5 x concentration) + 10

All Air Monitoring Stations

Fort McKay (AMS 1)	Barge Landing (AMS 9)
Mildred Lake (AMS 2)	Albian Mine Site (AMS 10)
Lower Camp Met Tower (AMS 3)	Lower Camp (AMS 11)
Buffalo Viewpoint (AMS 4)	Millennium (AMS 12)
Mannix (AMS 5)	Syncrude UE-1 (AMS 13)
Patricia McInnes (AMS 6)	Anzac (AMS 14)
Athabasca Valley (AMS 7)	CNRL Horizon (AMS 15)
Fort Chipewyan (AMS 8)	Albian Muskeg River (AMS 16)

Data from the following stations are used calculate the Air Quality Index (AQI) in real time:

- Air Monitoring Station 1 – Fort McKay
- Air Monitoring Station 6 – Patricia McInnes (Timberlea, Fort McMurray)
- Air Monitoring Station 7 – Athabasca Valley (Downtown, Fort McMurray)
- Air Monitoring Station 8 – Fort Chipewyan
- Air Monitoring Station 13 – Syncrude UE-1

	Mobile Monitoring Unit The Mobile Air Monitoring unit is used to temporarily record air quality at designated locations in the Wood Buffalo region. The Mobile Air Monitoring unit contains analyzers that continuously measure SO_2, H_2S, THC, NH_3, NO, NO_2, NO_X, PM $_{2.5}$, wind speed and direction, and temperature. *Data to support the Programs reflects the following:* • Air quality data are obtained by the WBEA network with a clear chain of custody. • Five minute minimum continuous data are received from instruments at fifteen stations for air quality. • The air network is supervised by WBEA and the work is carried out under contract. • Terrestrial indicators are measured by Canadian/international scientists under contract to WBEA. • Until 2009, human exposure indoor/outdoor air data along with volunteer data were collected for WBEA by a local contractor. Data analysis was completed, and reports submitted to WBEA by Alberta Health and Wellness. • Retrospective analysis of Canadian, US and European monitoring programs is clear in finding beyond thoughtful, science-based design, that continuity in funding is essential to success in monitoring for environmental effects. • WBEA programs have been approved by members with input from internationally-recognized, senior scientists who are highly published in air quality and effects; three advisors have over 100 years combined experience.

Evaluation, Analysis and Reporting

What is the communications framework?	*Wood Buffalo Air Information Line* August 1st, 2008 saw the official launch of the Wood Buffalo Air Information line. The phone line provides a way for the public to receive up-to-date information during odours and other air events in the region. The information line, developed in a concerted effort by WBEA and

	its members, will provide messages on odour events from forest fires, to industry exceedences, to cautionary reports related to performing scheduled facility maintenance or flare-ups. The Air Information Line also provides the telephone numbers for the Alberta Environment hotline and Health Link Alberta so that residents who have further environmental or health related concerns can follow up with these agencies. *Outputs* • Real time 24-7 Air Quality Index information. • Historically corrected and validated air quality data. *Program Annual Reports* • All air quality data is archived in the Clean Air Strategies Alliance (CASA) data warehouse. *Communications* • Ongoing reporting to members through committee meetings, GM's, AGM. • Annual report. • Project reports that are reviewed, circulated to members, posted on members web. • Open houses at local communities; presentation of results to public i.e., Janvier/Conlin, HEMP. • Radio spots and general media. • Media currently lagging without media person; senior media person to be sought nationally/north America in March; timing coincident with rolling out of results from multi-year TEEM program and analysis of long-term air data. Beginning 2010 major effort to "get the word out"; i.e., scientists publishing book chapters, proceedings papers at scientific conferences and peer-reviewed papers. • Special technical session on WBEA results/program to be held June 2010 in Calgary at AWMA, 3000 scientists/regulators/managers etc. attending.

Adjustment Mechanism (Actions that respond to the "So What"?)

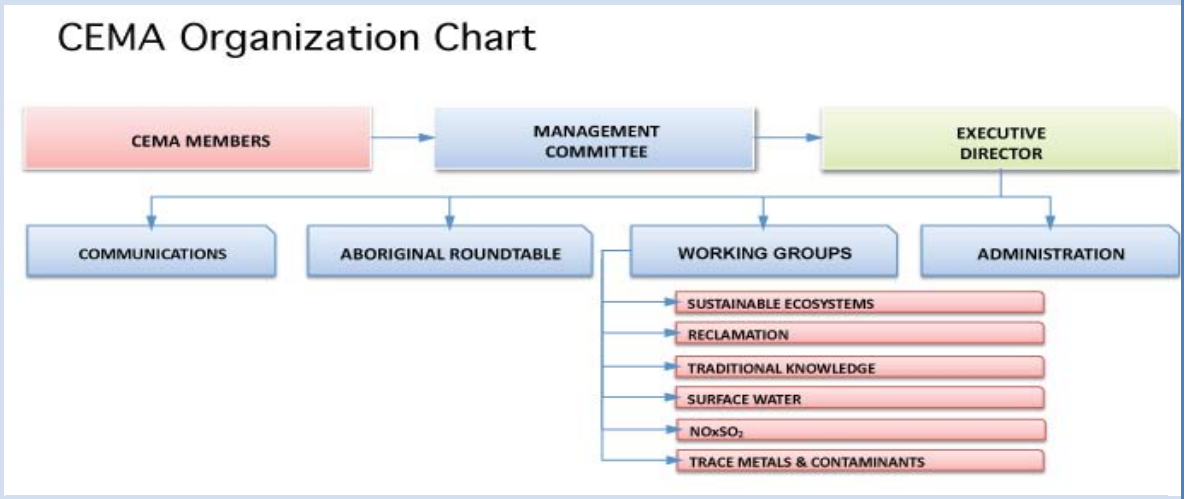
How do you now take this information and, reflecting on your mandate and authority, what do you then do with it?	The organization is charged with publishing a number of real time reports based on air events that include: • odour events from forest fires, • industry exceedences, • cautionary reports The regional mandate fits within an Alberta mandate managed by CASA.

APPENDIX 9: CEMA Fact Sheet

Organization and Program Profile [Who?]

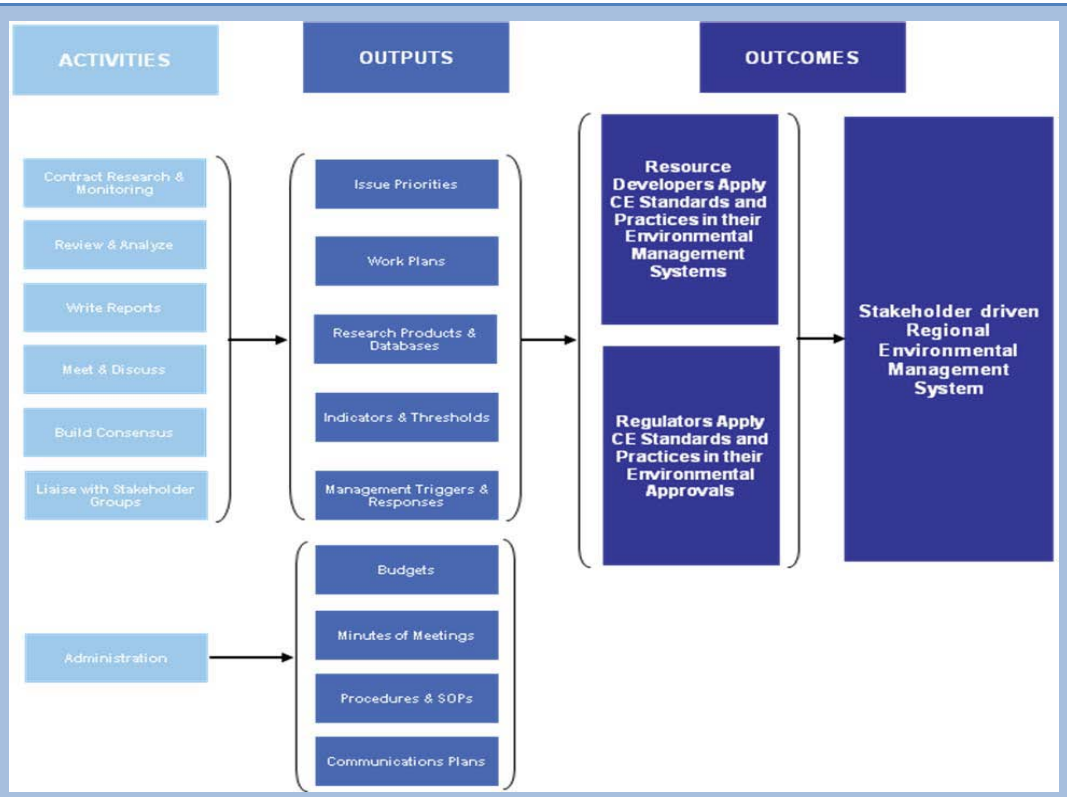
Name	Cumulative Environmental Management Association (CEMA)
Start Date	1999
What question is the organization trying to answer?	CEMA does not consider itself a monitoring organization nor would their activities be described as those taken on by a traditional monitoring program. However the activities and actions they have endeavored to take on, and the resultant impacts of that work, is an important highlight of their program and its essence needs to be understood within the context of their monitoring system. CEMA has executed projects within multi-stakeholder environments to provide guidance, recommendations and improvements to monitoring systems as a whole. Below is a short summary of the types of impacts the CEMA work has had. *Implementation of CEMA Recommendations* CEMA recommendations have been implemented by the Government of Alberta in a number of ways: • Referenced in EPEA approvals for operators to use as guidance documents when developing plans. • Used by operators in the development of environmental impact assessments. • Influenced changes to environmental monitoring and research. • Referred to by Government of Alberta as guidance documents and published on the Government website.

What is the nature of the Organization (governance structure)?	CEMA is a not-for-profit society whose members are government departments or agencies, resource developers, aboriginal groups and environmental organizations having an interest in the Wood Buffalo region. Currently, 44 organizations are listed as members on CEMA's website (OSRIN and the Fort McMurray Environmental Association joined in October 2010). Additional organizations may become members by making a written application, paying an annual fee and being accepted by the existing membership. Members are responsible for • achieving CEMA's "vision, purpose, and objectives"; • setting terms of reference for and endorsing recommendations from working groups; • approving business plans and budgets; and • reporting "in a timely fashion all issues that need to be brought to the attention of Members." In addition, individual Members are expected to "have a role in ensuring the effective communication between CEMA and their respective organizations".

Organizing structure (how do they do what they do)?	Five working groups have been established within CEMA (Note: in October 2010 the Trace Metals and Contaminants and NO_xSO_2 working groups were combined into one Air Working Group). Working groups have "primary responsibility" for developing management recommendations. Subcommittees called task groups undertake specific technical components of the work. A depiction of their pre-October 2010 organizational chart is below: 
Constituency (who is the client)?	The citizens of the Regional Municipality of Wood Buffalo and other CEMA Stakeholders

Funding (where and how does the funding break down - industry / government / others)?	*Excerpt from CEMA 2009 Review* CEMA budgets have grown from initial levels of around $2 million to a proposed $8.8 million budget for 2009. Until recently, 100% of funding was provided by oil sands operators and developers. Annual budgets are now driven by business plans brought forward from working groups, then consolidated with projected administrative overheads, and approved by the members as a whole. Funding is largely provided, on a pro-rated basis, by industry members. In addition, extensive in-kind resources are provided by various members. Member representatives are responsible for their own time and expenses. Funding is made available to some aboriginal and non-governmental organizations (NGO), Committee or Working Group Members in exchange for their participation. In the past, CEMA's Funding Committee was tasked with securing funding sources from industry and determining the pro-rated split of funds required by industry. However, funding is now handled by the Management Committee, with CEMA members approving budgets through the Members' Board. Industry funding is now primarily provided by the Oil Sands Developers Group (OSDG), which results in determining the split of the remaining funding requirements among other industry-based funders.
What are the organizational objectives?	CEMA's objectives are to: 1. Ensure that an effective and efficient, stakeholder - driven, regional environmental management system is established. 2. Ensure regional environmental guidelines, objectives and thresholds are in place or established and recommended to Alberta Environment's Regional Sustainable Development Strategy (RSDS) where appropriate for effective implementation.

	3. Develop the basis for the ongoing management of impacts of industrial development on the regional environment, including recommending the priorities and objectives for, and content of, monitoring and research, and both employing and recommending mitigation options. 4. Respond to issues brought forward by stakeholders. Issues not within the mandate of the Association will be referred to an appropriate organization for a response. 5. Work cooperatively with other activities and organizations that also have responsibilities with respect to managing the regional environment, including establishing appropriate linkages to other environmental management initiatives or activities in the region: e.g., Wood Buffalo Environmental Association (WBEA), Alberta Environment's Regional Sustainable Development Strategy (RSDS). Canadian Oil Sands Network for Research and Development (CONRAD). 6. Effectively communicate the need, activities, and results of the Association to internal and external stakeholders. 7. Prepare a work plan and budget annually. *Functional Diagram* A functional diagram of CEMA is included below:


ACTIVITIES
OUTPUTS
OUTCOMES
Contract Research & Monitoring
Review & Analyze
Write Reports
Meet & Discuss
Build Consensus
Liaise with Stakeholder Groups
Issue Priorities
Work Plans
Research Products & Databases
Indicators & Thresholds
Management Triggers & Responses
Resource Developers Apply CE Standards and Practices in their Environmental Management Systems
Regulators Apply CE Standards and Practices in their Environmental Approvals
Stakeholder driven Regional Environmental Management System
Administration
Budgets
Minutes of Meetings
Procedures & SOPs
Communications Plans

Purpose [Why?]

What is the reason for the organizations existence?	To study the cumulative environmental effects of industrial development in the region and produce guidelines and management frameworks. *Vision* The environment of the region, including the land, forest, air, water, wildlife and biodiversity, will be protected, sustained, and restored over the long term and that the collective activity of industrial activity in the region will not cause any lasting harm to the environment or adverse effects to the health of humans. Should these impacts be evident, the Association and its Members will recommend, promote and implement mitigation action to reverse their effects.
What has the organization been charged with?	• Achieve the Vision, Purpose and Objectives of the Association and ensure the principles of the Association are consistently applied with respect to its activities. • Set Terms of References for Working Groups, review and endorse Working Groups recommendations and provide comments and guidelines to Working Groups. • Approve business plans and budgets according to the requirements of members. • Report in a timely fashion all issues that need to be brought to the attention of members. • Develop and apply environmental management tools, thresholds, guidelines and objectives. • Provide a forum for stakeholders to discuss and make consensus-based decisions, forming the basis for action by members, and make recommendations to Alberta Environment's RSDS, as appropriate, on managing the region's cumulative environmental effects. Thereby forming the core of a proactive regional environment management system that addresses cumulative biophysical, health and recourses-use impacts of regional developments.

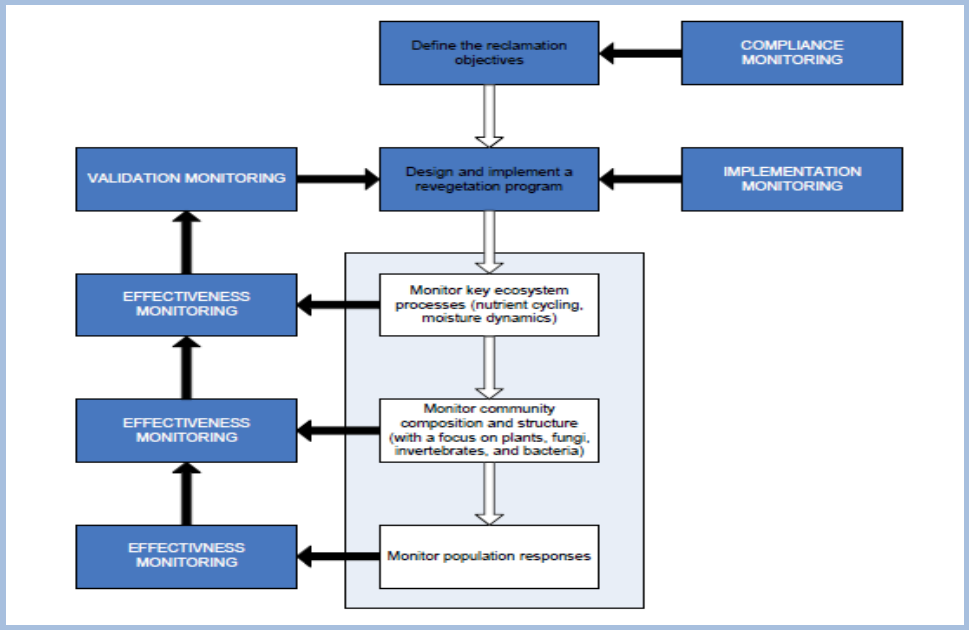
Monitoring Overview [Where, What, How and Why?]

Subject Matter Extent / Focus	*Scope: Better understand and scientifically inform the causal logic.* CEMA focuses on issues that can be broken into broad categories, dealing with the impacts of industrial activity on the land, water and air: *Land* • Oil sands development has the potential for creating significant changes to the landscapes, wildlife populations and habitats. CEMA is determining and recommending the best management tools available to protect, sustain, and restore the health of the landscape, vegetation, soil, and watersheds, while balancing industrial development and environmental considerations. CEMA also looks at the best measures and methods available to protect the environment in areas where reclamation activities need to occur. *Water* • CEMA's work on water issues relates mostly to the health of aquatic ecosystems (rivers, lakes, streams, etc.) and understanding how the natural environment is likely to respond to increasing oil sands development. CEMA is working to develop a system that minimizes the long-term environmental impacts on surface water quantity and quality so that the water systems will remain healthy. *Air* • The focus of CEMA's air related research is to increase understanding of potentially harmful emissions. CEMA is working to assess the potential impacts of oil sands air emissions (i.e., discharges from smoke stacks) on the environment and recommend actions to keep the air clean and minimize the effects of emissions.

From a monitoring perspective CEMA is engaged in data collection activities and the analysis related to monitoring that is required to support the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (CEMA Terrestrial Subgroup 2009). This type of monitoring activity might be classified as a combination of implementation monitoring and validation monitoring, as CEMA seeks to validate assumptions and frameworks as oil sands are reclaimed and develop guidelines and best practices to support the community of practice. Within Appendix B of the Guidelines document the following monitoring analysis and philosophy is presented:

> *Monitoring the success of the re-vegetation program is a key component in demonstrating that community development on reclaimed sites is, or is likely to, fulfill long-term objectives. When properly implemented, a monitoring program can also provide valuable information regarding successful activities and highlight issues that need to be addressed. There are four basic types of monitoring, each of which is designed to address a specific question (Todd et al. 2007):*
>
> 1. Compliance monitoring – do the activities meet legal obligations?
> 2. Implementation monitoring – were activities consistent with what was planned?
> 3. Effectiveness monitoring – are desired outcomes being met?
> 4. Validation monitoring – are the original assumptions correct regarding the efficacy of the re-vegetation prescriptions in meeting goals and objectives?

The information contained in the figure below illustrates the four types of monitoring and their relation to reclamation activities and the monitoring program. Monitoring directly relevant to re-vegetation outcomes is depicted within the shaded box.

	
Rationale / Causal Logic *What is the nature of their casual logic?*	N/A
Geographic Extent	Wood Buffalo Regional Area

Sampling Approach • How are they stratified? • What is the geographic layout? • What is the periodicity? • What is being measured?	N/A

Monitoring [The Means and How?]

What are the effects of Oil Sands operations on ecosystem health and human health?	CEMA makes specific recommendations and presents frameworks and guidelines to support an underpinning approach to monitoring which is laid out in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (CEMA Terrestrial Subgroup 2009), which includes the following: • Steps to develop a Monitoring Evaluation framework • Indicator selection • Indicator assessment and classification (fit for use analysis) • Interpretation of monitoring results • Use of indices to support your monitoring framework

Evaluation, Analysis and Reporting

What is the communications framework?	*Activities* • Contract research and monitoring • Review and analyze • Write reports • Meet and discuss • Build consensus • Liaise with stakeholder groups *Outputs* • Issue priorities • Work plans • Research products and databases • Indicators and thresholds • Management triggers and responses *Outcomes* • Stakeholder driven Regional Environmental Management System (EMS) • Resource developers apply cumulative effects (CE) standards and practices in their EMS • Regulators apply CE standards and practices in their Environmental Approvals

APPENDIX 10: Technical Forms of Integrated Environmental Monitoring

Following are some examples of different forms of information integration**.**

1. **Content integration –** bringing together information from multiple content sources to look at relationships between environmental monitoring data and other information and to provide context (e.g., ownership, roads, vegetation maps, images, etc.)
2. **Location integration –** bringing together environmental monitoring information from multiple locations or map sheets (often from multiple sources); for spatial applications, may require inter/intra-map area or project correlation and edge-matching "integration"
3. **Temporal integration –** bringing together information from multiple dates or time periods
4. **Use of common integrated entities or units (e.g., ecosystem types or site series, watershed units, soil-landform units) –** bringing together commonly used sampling and reporting units to emphasize the relationships between/among their physical and biological components. Note integrated entities are often a part of a hierarchy with lower and higher order entities (e.g., ecological land/aquatic classification systems or watershed stream order classification systems)
5. **Integration of environmental monitoring operations technically –** bringing together innovative and efficient technical approaches to the capture, analysis and reporting on environmental monitoring information
6. **Visual (display) integration of information –** bringing together information such that it is displayed, but not physically combined, to see possible interactions
7. **Decision- or report-driven integration –** bringing together monitoring information to support a particular decision or management unit (e.g., a project, management unit, park, watershed, region, province, etc.)
8. **Combinations of all the above –** e.g., bringing together information from two or more data sources based on coincident location and/or time

Benefits of Integrated Environmental Monitoring

In addition to obvious cost savings and resource efficiencies, there are a number of potential benefits to taking a more integrated approach to environmental monitoring. These are summarized as follows.

1. **Simplify and reduce complexity –** View and understand relationships between different and often numerous environmental information features more easily. Note, while this may be one rationale for integration, the process of achieving this can be complex.
2. **Understand relevant relationships between information components –** Relationships between different environmental components offer greater insight, and analysis and interpretive value (e.g., cause-and-effect).

3. **Add greater information value to and reduce risk of environmental management decisions –** Increased awareness, consideration, and interpretation of related spatial, temporal, or contextual information that may add to or mitigate decision risk.

4. **Make better use of existing information system investments –** greater sharing between databases and of analysis and reporting applications.

5. **Improve efficiency of environmental planning and decisions –** All relevant information is quickly and easily assembled and ready for analysis to support planning and decision making.

6. **More informed and better decisions –** The assembly, consideration, and interpretation of relevant, coincident or contiguous environmental information together leads to better informed decisions.

APPENDIX 11: Example NPRI Database Inquiry

Return to 2008 Facility & Substance Information for SUNCOR ENERGY - Suncor Energy Inc. Oil Sands

2008 Facility Information

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SUNCOR ENERGY - Suncor Energy Inc. Oil Sands

NPRI ID: 2230
PO Box 4001
Hwy 63N, 22km NE of Fort McMurray
Fort McMurray, AB
T9H 3E3
canada

Number of employees: 3743

DUNS: 243983418

Website: www.suncor.com

Contact Information

Ms. Brenda Erskine
Position: Director, Communications
Phone: (780) 743-6770
Fax: (780) 791-8300
berskine@suncor.com

Parent Companies

Suncor Energy Inc. (100 %)
112 - 4th Avenue S.W.
Calgary, AB
T2P 2V5
Canada

Geographical Coordinates

Latitude: 57.0033
Longitude: -111.4661
Datum: 1983

Standard Industrial Classifications

- Canadian SIC: 07 - Crude Petroleum and Natural Gas Ind.
- Canadian SIC: 0712 - Non-Conventional Crude Oil Ind.
- American SIC: 1311 - Crude Petroleum and Natural Gas
- NAICS 2 Code: 21 - Mining & Oil & Gas Extraction
- NAICS 4 Code: 2111 - Oil & Gas Extraction
- NAICS 6 Code: 211114 - Non-Conventional Oil Extraction

Pollution-Prevention Planning

This facility is preparing or implemeting P2 plans.

Comments on Pollution Prevention Activities
The facility did not provide any comments.

Comments

Reporter Comments (Facility)
- Millenium Coker Unit came into full production in 2008 - For 2008 NPRI reporting, a speciation profile was developed from measured data and new methodology was used to speciate hydrocarbon and reduced sulphur emissions from the tailings ponds, resulting in significant increases in estimated emissions for some Part 1 and Part 2 substances.

Substance Reports (Excluding Criteria Air Contaminants)

- Other Years' Substance Reports

Sort by: CAS Number | Ascending | Sort

Information on the sources, effects and management of certain substances (CEPA Schedule 1) can be accessed by clicking on the icon in the "Substance Information" column (where available). Information on other substances may be found in the Substance Information Links.

Substance	CAS Number	On-Site Releases	Disposal		Off-Site Recycling	Units	Substance Information >> Click on the icons below
		Details	On-Site Details	Off-Site*	Details		
1,2,4-Trimethylbenzene	95-63-6	490	-	-	-	tonnes	
2-Butoxyethanol	111-76-2	-	-	-	-	tonnes	
7H-Dibenzo(c,g)carbazole - PAH	194-59-2	823	-	-	-	kg	
Acenaphthene - PAH	83-32-9	19	-	-	-	kg	
Acenaphthylene - PAH	208-96-8	5.9	-	-	-	kg	
Aluminum oxide (fibrous forms)	1344-28-1	-	-	-	37	tonnes	
Ammonia (total)	NA - 16	0.056	-	-	-	tonnes	
Arsenic (and its compounds)	NA - 02	65	-	-	5.1	kg	
Benzene	71-43-2	81	-	-	-	tonnes	
Benzo(a)phenanthrene - PAH	218-01-9	5.8	-	-	-	kg	
Cadmium (and its compounds)	NA - 03	73	-	-	-	kg	
Carbon disulphide	75-15-0	54	-	-	-	tonnes	
Carbonyl sulphide	463-58-1	44	-	-	-	tonnes	
Copper (and its compounds)	NA - 06	0.267	-	-	20	tonnes	
Cumene	98-82-8	48	-	-	-	tonnes	
Cyclohexane	110-82-7	266	-	-	-	tonnes	
Diethanolamine (and its salts)	111-42-2	-	-	-	-	tonnes	
Dioxins and furans - total	NA - D/F	-	-	-	-	g TEQ	
Ethylbenzene	100-41-4	508	-	-	-	tonnes	
Ethylene	74-85-1	21	-	-	-	tonnes	
Ethylene glycol	107-21-1	-	-	-	-	tonnes	
Fluorene - PAH	86-73-7	24	-	-	-	kg	
Formaldehyde	50-00-0	8.0	-	-	-	tonnes	
Hexachlorobenzene	118-74-1	-	-	-	-	grams	
Hydrogen sulphide	7783-06-4	708	-	-	-	tonnes	
Lead (and its compounds)	NA - 08	491	-	-	29,377	kg	
Mercury (and its compounds)	NA - 10	51	-	-	0.034	kg	
Methanol	67-56-1	-	-	-	-	tonnes	
Molybdenum trioxide	1313-27-5	-	-	-	283	tonnes	
n-Hexane	110-54-3	244	-	-	-	tonnes	
Nickel (and its compounds)	NA - 11	0.710	-	-	59	tonnes	
Phenanthrene - PAH	85-01-8	51	-	-	-	kg	
Propylene	115-07-1	81	-	-	-	tonnes	
Pyrene - PAH	129-00-0	10	-	-	-	kg	
Sulphuric acid	7664-93-9	274	-	-	17	tonnes	
Toluene	108-88-3	1,353	-	-	-	tonnes	
Total Reduced Sulphur (TRS) **	NA - M14	1,058	-	-	-	tonnes	
Xylene (all isomers)	1330-20-7	2,652	-	-	-	tonnes	
Zinc (and its compounds)	NA - 14	0.872	-	-	11	tonnes	

** NOTE: Off-site column under Disposal in this table includes 'Off-site Disposal' and 'Off-Site Treatment Prior to Final Disposal'.*

Substance Information

Substance name: Toluene
CAS Number: 108-88-3
Units: tonnes

Comments for this Substance
The facility did not provide any comments.

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Nature of Facility Activities Related to this Substance

The following Indicate whether the substance was manufactured, processed or otherwise used, and the nature of such activities.

- **Manufactured**

  For on-site use/processing.
  For sale/distribution.
- **Processed**

  N/A.
- **Otherwise Used**

  N/A.

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On-Site Releases

Medium	Release	Quantity (tonnes)	Basis of Estimate Code*
Releases to Air	Stack or point releases:	8.377	M3
	Storage or handling releases:	3.277	M3
	Fugitive releases:	1341.19	O
	Spills:	0.008	O
	Other non-point releases:	-	NA
	Sub-total:	**1352.852**	
Releases to Surface Water	Direct discharges:	-	NA
	Spills:	-	NA
	Leaks:	-	NA
	Sub-total:	**0**	
Releases to Land	Spills:	0	O
	Leaks:	-	NA
	Other:	-	NA
	Sub-total:	**0**	
Total Releases:		**1352.852**	

* There may not be detailed release information for certain substances, because if the total releases of an NPRI Part 1A substance were less than one tonne, only the total releases may be reported.

Reasons for Changes in Quantities Released from Previous Year

- Changes in estimation methods.

Quarterly Releases

Quarter	Release Percentage
1st	25 %
2nd	25 %
3rd	25 %
4th	25 %

Anticipated Releases

Year	Anticipated Release (tonnes)
2009	1714
2010	1714
2011	1714

Reporter Comments (Releases)
Estimation methods M3, E2, O were used to estimate emissions. Changes in estimation methods - speciation of air emissions from tailings ponds.

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Disposals

Type	Disposal Method	Quantity (tonnes)	Basis of Estimate Code*
On-Site disposal	Landfill:	-	N/A
	Land treatment or application farming:	-	N/A
	Underground Injection:	-	N/A
	Sub-total:	**0**	
Off-Site disposal	Containment, landfill:	-	N/A
	Land treatment:	-	N/A
	Underground injection:	-	N/A
	Containment, other storage:	-	N/A
	Sub-total:	**0**	
Off-Site treatment prior to final disposal	Physical treatment:	-	N/A
	Chemical treatment:	-	N/A
	Biological treatment:	-	N/A
	Incineration or thermal:	-	N/A
	Municipal sewage treatment plant (MSTP):	-	N/A
	Sub-total:	**0**	
Total Disposals		**0**	

Reasons for Changes in Quantities Disposed from Previous Year

- No significant change. (less than 10% change)

Anticipated Disposals

Year	Anticipated Disposals (tonnes)
2009	0
2010	0
2011	0

Reporter Comments (Disposals)
The facility did not provide any comments.

Off-Site Transfers for Recycling

Recycling Activities	Quantity (tonnes)	Basis of Estimate Code*
Energy Recovery	-	N/A
Recovery of Solvents	-	N/A
Recovery of Organics (not Solvents)	-	N/A
Recovery of Metals	-	N/A
Recovery of Inorganics (not metals)	-	N/A
Recovery of Acids or Bases	-	N/A
Recovery of Catalysts	-	N/A
Recovery of Pollution Abatement Residues	-	N/A
Refining or reuse of Used Oil	-	N/A
Other	-	N/A
Total Transfers for Recycling	0	

Reasons for Changes in Quantities Recycled from Previous Year

- No significant change. (less than 10% change)

Anticipated Recycling

Year	Anticipated Recycling (tonnes)
2009	0
2010	0
2011	0

Reporter Comments (Recycling)
The facility did not provide any comments.

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Pollution Prevention (P2) Activities

No new pollution-prevention activities

Comments on Pollution Prevention Activities
The facility did not provide any comments.

Facility Information

SUNCOR ENERGY - Suncor Energy Inc. Oil Sands

NPRI ID: 2230
PO Box 4001
Hwy 63N, 22km NE of Fort McMurray
Fort McMurray, AB
T9H 3E3
canada

Industrial Classifications

- 2-Digit Canadian SIC - 07 Crude Petroleum and Natural Gas Ind.
- 4-Digit Canadian SIC - 0712 Non-Conventional Crude Oil Ind.
- American SIC - 1311 Crude Petroleum and Natural Gas
- NAICS Code - 2111 Oil & Gas Extraction