


**Welcome to the 2016  
Oil Sands Science Symposium**

Dr. David Boerner and Dr. Fred Wrona

2016 **OIL SANDS**  
Science Symposium November 22-23, 2016



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**Objective**

*To provide a forum where the latest scientific results pertinent to understanding and dealing with any environmental impacts of oil sands development can be shared and discussed.*

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**You are invited to...**

Listen Actively,  
Participate Respectfully,  
Assess Evidence Objectively,  
Clarify Assumptions, and  
Think Critically.

Thank you

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**Environmental Science  
Regarding  
Oil Sands Development**

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**Why convene a science symposium?**

- Several expert reviews found **no consensus** on the degree of environmental impacts from oil sands development, despite extensive efforts. This was attributed to:
  - Inadequate monitoring design
  - Uncoordinated monitoring by multiple, independent monitoring organizations
  - Ill-defined or undefined baselines for assessing change
  - Inadequate analytical capabilities
  - A lack of scientific leadership
- Recommendation: Strengthen governance and conduct more rigorous scientific and holistic monitoring

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**A lot of evidence already exists**

Vast amounts of Indigenous Wisdom and Knowledge

Many, many excellent independent studies by government, academic, industry and other scientists

The Alberta Oil Sands Environmental Research Program (1975 to 1985)

- Led by governments of Canada and Alberta
- Monitored air, land and water systems and was “the first step toward any in-depth assessment of ecosystems and social impacts” of oil sands development

Northern Rivers Basin Initiative (NRBI) (1992 to 1996)

Northern Rivers Ecosystem Initiative (1998 to 2003)

Joint Oil Sands Monitoring (started 2012)

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### Monitoring in the Last Four Years

- Monitoring indicates low level effects in air, water, land and some wildlife, associated with oil sands development
  - Current observed levels of contaminants generally do not exceed applicable guidelines and are not yet cause for concern.
  - Contaminant levels are highest close to mining sites & upgraders and decrease with distance.
  - Land disturbance has caused changes to species abundance.
  - Is the evidence robust and sufficient?
  - Are these levels resulting in chronic effects?
- JOSM's improved ability to detect low level effects is important for having confidence and credibility in identifying and tracking any trends and to better anticipate potential future effects
- Tracking low level effects is important for assessing environmental performance and informing predictive models.

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### Assessment of progress towards JOSM Objectives

- 2015 independent expert review of JOSM scientific integrity concluded that "JOSM has made good progress since 2012 in improving the scientific integrity of oil sands monitoring, but more work is needed going forward"
- Progress to-date
  - Enhanced monitoring activities
  - Integration into JOSM of activities from the industry-run programs such as Regional Aquatics Monitoring Program (RAMP)
  - More open, integrated and accessible planning and data and reporting
  - More unified consistent monitoring approaches



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### "but more work is needed"

- Monitoring efforts are generally appropriate, however optimization and integration of results and reporting within and across media is only starting
- Some pre-existing monitoring designs are unlikely to identify important environmental changes with sufficient time to allow mitigation efforts to be effective
- Limited data and integrated information poses challenges for determining if the current level (and design) of monitoring is appropriate to assess ecosystem impact
- Transparency and open data objectives have started; multiple data sites need to be better integrated into a single access point to access all relevant JOSM information including data, maps, SOPs, activity plans, etc.
- A more rigorous approach to the QA process is needed including a QA program plan, detailed SOPs, a QA annual report and a QA audit plan.

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**We want to start a discussion about...**

- Sharing the relevant evidence
- Strengthening the evidence base
- Clarifying objectives
- Clarifying assumptions
- Resolving apparently conflicting interpretations
  
- Facilitating the good use of evidence

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**Scientific Integrity and Oil Sands  
Monitoring: Status and Direction**

Dr. Frederick Wrona

and

Dr. David Boerner

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### Questions Addressed by the Oil Sands Monitoring Program

- *What are the sources and types of substances being released?*
- *How are these substances being distributed through air, water, and land?*
- *What are the spatial and temporal trends in these substances?*
- *How are these substances being transported and transformed?*
- *What happens to these substances in the environment?*
- *To what extent do these substances affect organisms (terrestrial and aquatic) and ecosystem structure and function?*
- *To what extent does habitat disturbance impact regional biodiversity?*
- *What effects on biodiversity are associated with different types of disturbance / environmental stressors?*

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### JOSM Program Science Integrity Review: February 2016


**Alberta Oilsands Monitoring Needs Clearer Goals: Review**

Author Information  
CFP | By Gail Webster, The Canadian Press  
 Article Byline Information  
 Posted: 02/22/2016 11:15 am EST Updated: 02/22/2016 5:59 pm EST

November 19, 2015  
**HUFFPOST ALBERTA**  
CANADA

**Panel grades Alberta oilsands monitoring work as 'a solid B'**


BY GORDON KENT  
FIRST POSTED: MONDAY, FEBRUARY 22, 2016 03:57 PM MST | UPDATED: MONDAY, FEBRUARY 22, 2016 08:00 PM MST



Oilsands monitoring agency has work to do, says expert panel

MARCY HENTON CALGARY HERALD  
POSTED ON FEBRUARY 22, 2016 12:00 PM MST

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### JOSM Science Integrity Review: Key Recommendations

- Better define and document specific policy and scientific goals of the Governments of Canada and Alberta for the monitoring of the oil sands.
- Conduct more comprehensive data analysis and interpretation.
- Take the necessary steps to enhance the integration of the monitoring within and across the four components.
- Develop and document a uniform QA approach that is implemented and tracked across all monitoring activities.
- Make monitoring data and information more readily available and accessible to stakeholders.



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### Linkages Between Drivers/Stressors -> Environmental Effects

**Anthropogenic Drivers**  
Development Sectors  
Activities  
Stressors

**Abiotic Environment**  
Air  
Water  
Land

**Biotic Environment**  
Habitats and Species

**Natural Drivers**

**Environmental Drivers/Stressors**

- Point and Non-point source release of substances
- Habitat loss, disturbance
- Water withdrawals
- Changing regional climate
- Others ...

**Effects on Abiotic/Biotic Environment**

- Changes in air, water, soil quality and water quantity
- Contaminants in biota
- Changes in distribution, and abundance of species & habitats
- Changes in ecological processes
- Potential for human exposure
- Others ...

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### Integration

**Integration is the act of bringing together smaller components into a single system that functions as one**

**End result of a process that aims to bring together different, often disparate, subsystems so that the data contained in each becomes a necessary part of a larger, more comprehensive system**

Co-location of Sampling in time and space; QA/QC standardization

Hypothesis/Process Driven; outcome requires explicit linkage of multiple parts-systems

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### Multiple Approaches to Achieving Integration

**Integration of Monitoring Sampling Program Design**

- co-location of air, water, land sampling locations in space and time
- standardization of data and sampling SOPs, QA/QC
- assessing congruence of remote sensing and ground-base measurements

**Sampling methods that integrate environmental information**

- water chemistry auto-samplers (event-based sampling; semi-permeable membrane devices)
- simultaneous co-measurement of physical/chemical/biolo parameters (automated buoys, sondes, artificial substrate)

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## Integration


**Using Biological/Ecological Attributes/Processes as Integrators**

- weight/age adjusted contaminant body burdens in invertebrates, fish, wildlife
- environmental effects endpoints (growth, condition factor,





**Hypothesis/Process Driven Integration**

- multi-tiered, multi-media** approaches to assess the effects of anthropogenic and natural environmental drivers / stressors on ecosystem physical/chemical attributes and biological/ecological structure and function.
- investigation of causality; stressor->response pathways



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## Air Quality – What are we doing?




**Monitoring regional air quality**

- monitor PM, SO<sub>2</sub>, NO<sub>x</sub>, O<sub>3</sub>, H<sub>2</sub>S, particulate matter to compare against established Ambient Air Quality Standards




**Identifying and evaluating all sources of emissions**

- assessing and rationalizing various existing inventories of emissions
- characterizing and quantifying sources of emissions which were previously unknown (mine faces, tailings ponds) using multiple sampling technologies
- evaluating the chemical reactions that are transforming emitted material




**Measuring deposition of substances to the landscape**

- measuring deposition of VOCs, PAHs, metals to snow and terrestrial & aquatic systems
- evaluating acidification of forests and lakes





**Integrating results**

- Constraining satellite measurements with ground-based measurements
- Combining atmospheric models with meteorological models for prediction



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## Water Quality / Quantity – What are we doing?


**Measuring chemical substance concentrations in**

- mainstem rivers (Athabasca, Peace), tributaries, lakes, wetland - surface waters
- suspended and depositional sediments
- shallow groundwater
- defining baseline conditions



**Testing time integrated measures of contaminant exposure**

- Semi-permeable Membrane Devices (SPMDs) - PAHs




**Measuring water flow and levels**

- mainstem rivers and tributaries (regional hydrometric network) – mass balance loading design



**Measuring aquatic biological health**

- benthic invertebrate diversity, food webs, contaminant levels
- fish health indicators
- toxicological studies (field, lab)



**Integrating results**

- modeling of sediment transport, integrated water quality/quantity prediction
- synthesis of existing water information

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### Terrestrial Biodiversity and Ecosystem Health - What are we doing?

**Monitoring human footprint**

- Linear disturbances, clear cutting, mining, etc.
- Habitat Disruption Monitoring (terrestrial, watershed and wetlands)

**Monitoring changes in regional biodiversity**

- insects, lichens, mosses, plants, animals, birds – Provincial Biodiversity Program
- distribution/abundance of migratory birds (ducks, whooping cranes, shorebirds); ungulates (caribou, moose)


**Measuring contaminants in animal, bird and plant tissue**

- nesting boxes near oil sands development, bird eggs
- hunter and trapper gathered carcasses
- forest lichen, berry contaminant levels

**Integrating results**

- co-location wildlife health sampling with air and water quality monitoring sites

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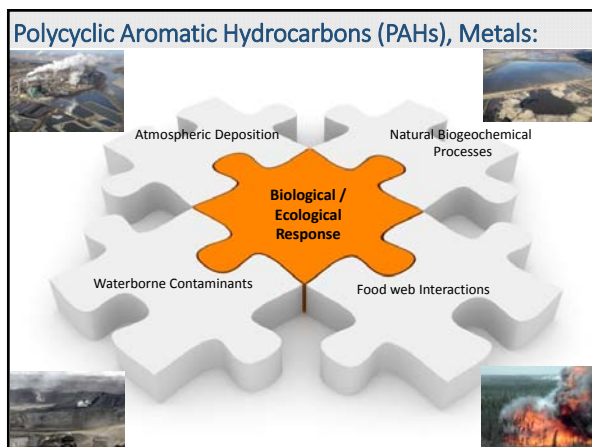
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### Data Management, Evaluation and Reporting

Maintain an open data, federated, digital archive of all data collected by this initiative.

Ensure monitoring data can be properly archived, maintained and easily retrieved through a single public access point.

- Integration and Evaluation of Atmospheric, Watershed, and Ecosystem Health Information - Regular activities to synthesize and report new knowledge resulting from Oil Sands Monitoring
- Reporting Ambient Monitoring Results – General Audience: Communication focused on knowledge transfer to makes the oil sands monitoring results accessible to non-specialist audiences.

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### Indigenous Peoples' Engagement and Community-Based Monitoring

Meaningfully involvement of Indigenous communities and proper application of Traditional Ecological Knowledge a program priority.

2016-17 projects include:

- Contaminant monitoring of aquatic species (fish, muskrat)
- Atmospheric monitoring at Oski-Otin site
- Water quality monitoring
- Traditional Ecological Knowledge - Berry Health study
- Environmental Monitoring Technician training program

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### Adaptive Monitoring - Continuous Improvement

In a region experiencing change as rapidly as the oil sands, it is vital that the monitoring, evaluation and reporting programs reflect changing realities.

The initial 5-years of monitoring was designed to cast a "wide net" to identify baselines, issues of concern and to improve standardization of protocols, data QA/QC.

Moving forward, the OS Monitoring Program is:

- Increasing engagement with the environmental scientific community
- Broadening the science base by increasing Indigenous science, community-based monitoring and TEK
- Expanding knowledge and standardization of "baseline" conditions
- Focusing resources on evaluation and reporting – including network assessments and synthesis reports
- Enhancing open availability of monitoring data from all sources
- Improving understanding and prediction of stressor-response pathways to inform assessment of cumulative effects at appropriate spatial and temporal scales

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### Questions



Canada-Alberta Oil Sands Environmental Monitoring Information Portal:

<http://jointoilsandsmonitoring.ca/>

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