Innovation in the face of uncertainty - from water use to watershed management use in Alberta's oil sands

Water Policy Session
Pacific Northwest Economic Region
26th Annual Summit
Calgary AB July 18, 2016

Brett Purdy PhD, Senior Director

Alberta Innovates
Energy and Environment Solutions

Presentation Outline

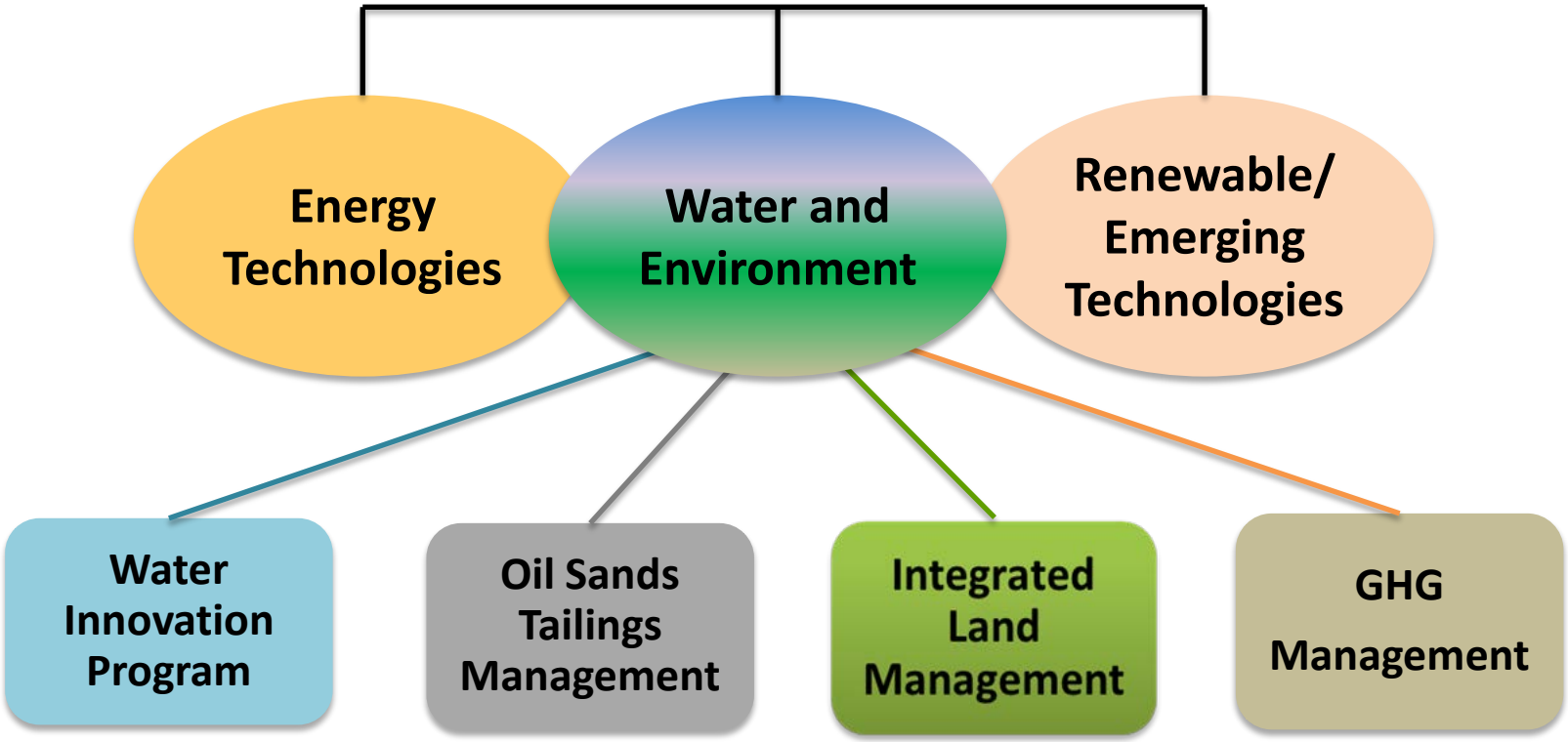
- Introduction
- Water use in oil sands
  - In-situ OS (CEP)
  - Mineable OS (tailings)
  - Water supply & watershed management
  - Contaminants
  - Dilbit transportation

AI-EES mandate

"…the research, innovation and technology implementation arm for the Government of Alberta ministries in energy and environment."

OUR CORE BUSINESS:
Enable cost effective production of higher value energy resources, while mitigating environmental impacts and driving toward a diversified energy economy.

AI-EES Program Areas



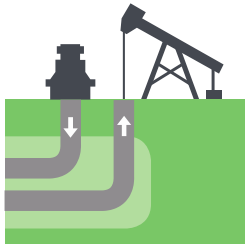
2030 Targets – Innovation begins with focus and vision

GHG EMISSIONS REDUCTIONS

50%
reduction in
GHG Intensity

50%
sustainable
oil production

PRODUCTION AND VALUE-ADDED



20%
in situ production
partially upgraded

WATER AND LAND

safe, secure
water for
6 MILLION

30%
increase in
water effeciency

Working with partners for solutions

Water Challenges & Opportunities

- Droughts / floods
- Resource extraction
- Food production
- Urban expansion
- Reuse
- Eutrophication
- Invasive species
- Contaminants
- …..

AI-EES Water Innovation Program: Key Research Themes

Future Water Supply and Watershed Management

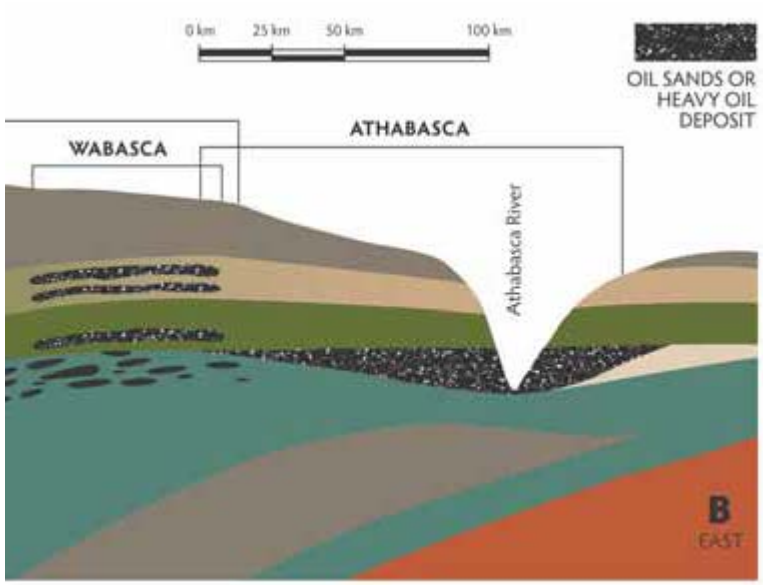
Water Quality Protection

Water Use Conservation, Efficiency, & Productivity

Healthy Aquatic Ecosystems

Oil Sands Deposits

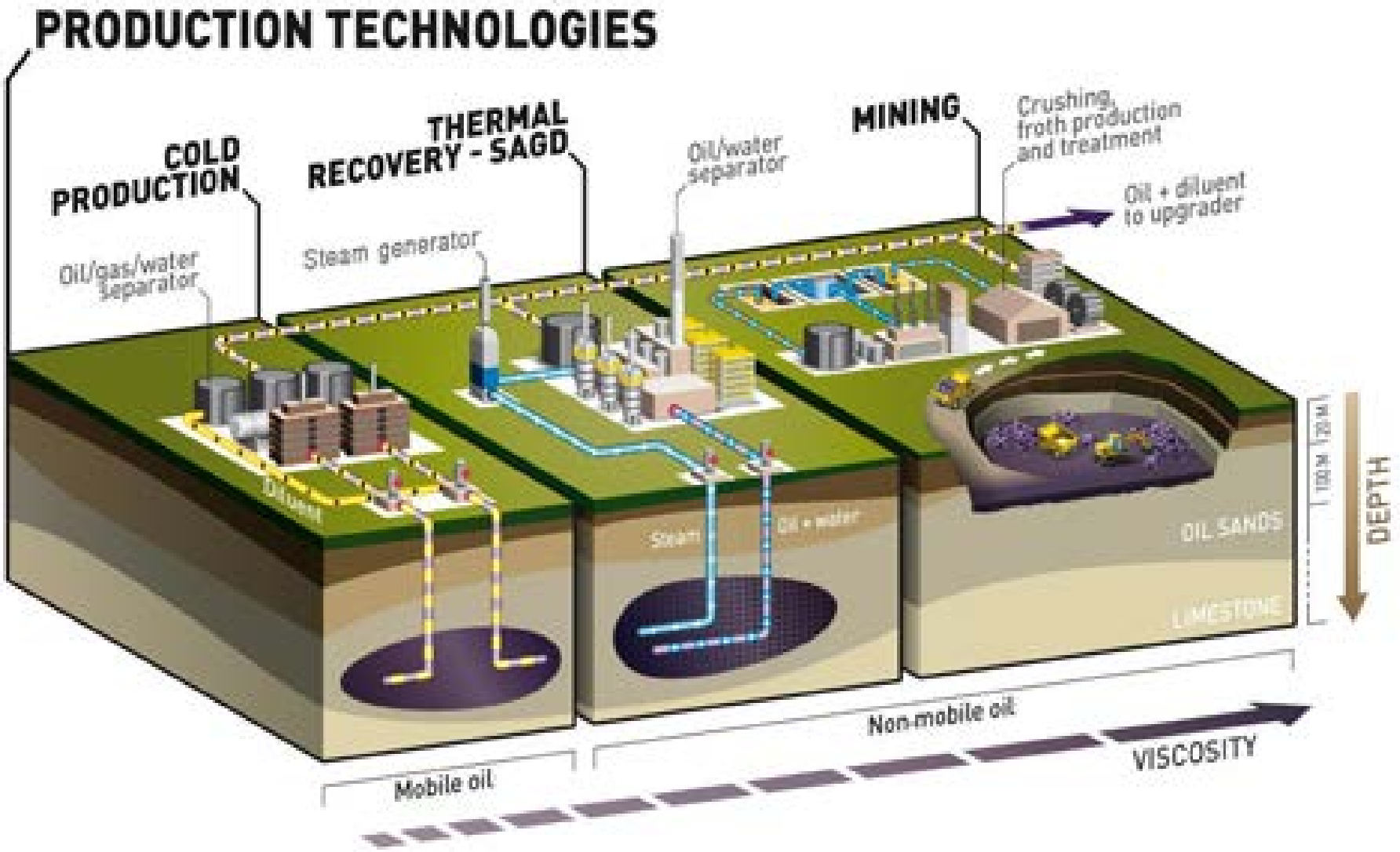
West to east transect



Extraction through

- surface mines
- In situ technologies

Current state – water based extraction



Requirements for water

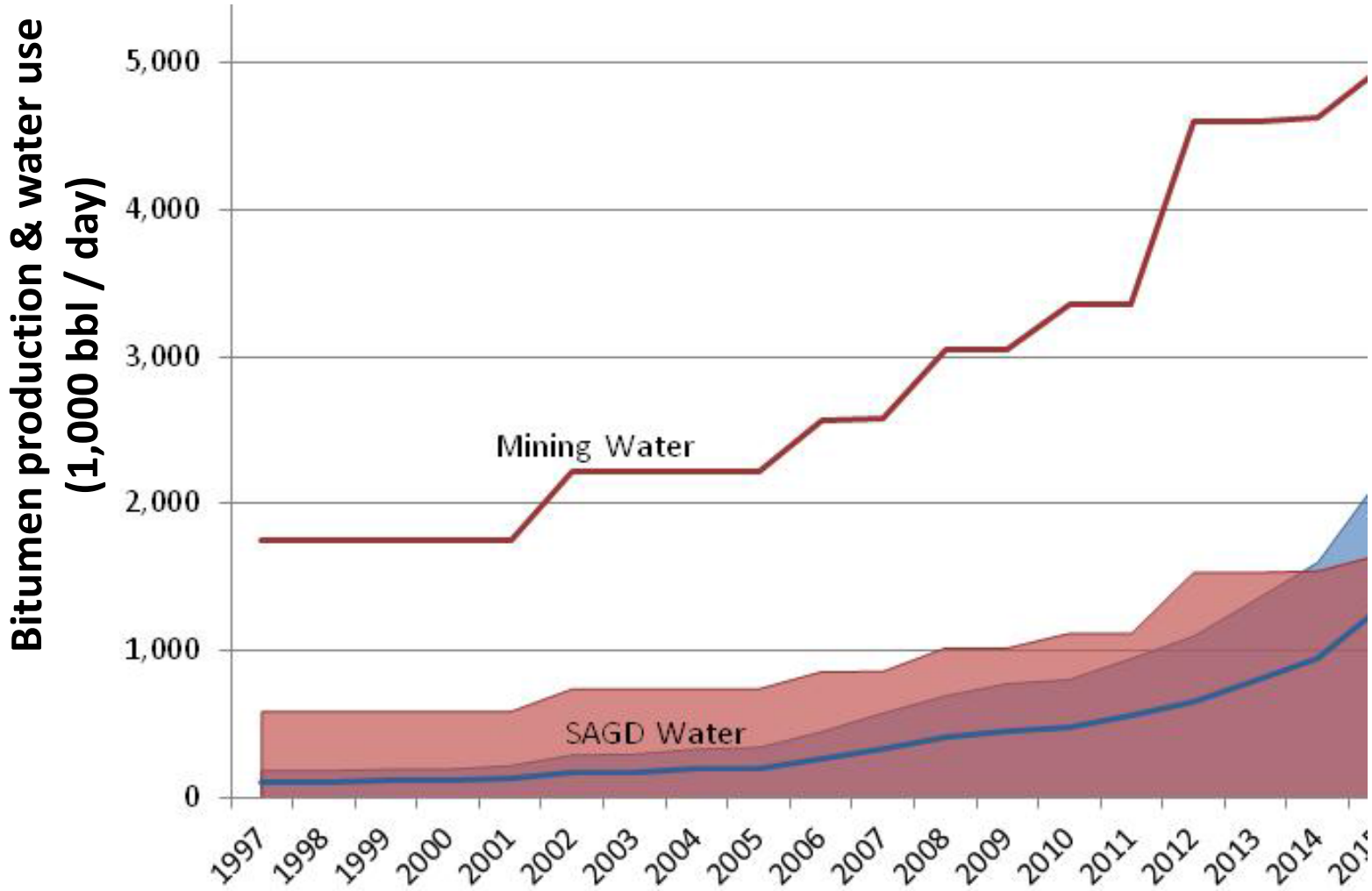
In-Situ

- 2.5-4 bbl H_20 processed per bbl of bitumen produced
- Recycle rates of 70--90% … consumption of **0.4 bbl H_20/ bbl**
- Makeup source: Ground water (fresh & saline)
- Return: Deep well injection or Evaporation

Mining

- 8-10 bbl H_20 processed per synthetic crude bbl produced
- Recycle rates of 40--70% … consumption of **2--4 bbl H_20/ bbl**
- Makeup Source: Athabasca River & Surface Water
- Return: Minimal

Bitumen production & water use



Energy Technologies – GHG Mitigation – Water Technology Development

50%
reduction in
GHG Intensity

30%
increase in
water effeciency

Improved Efficiency of Treatment

- Do more with what we have
- Estimated 30% energy reduction potential
- Field pilots, commercial demonstrations

Photo source: IDE

IDE Technologies

VEOLIA

Saltworks

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High Temperature / High Pressure Treatment to Reduce Energy Input

- Water comes out of reservoir hot and is cooled for treatment
- Potential to save energy to reheat water if treatment temperature increased

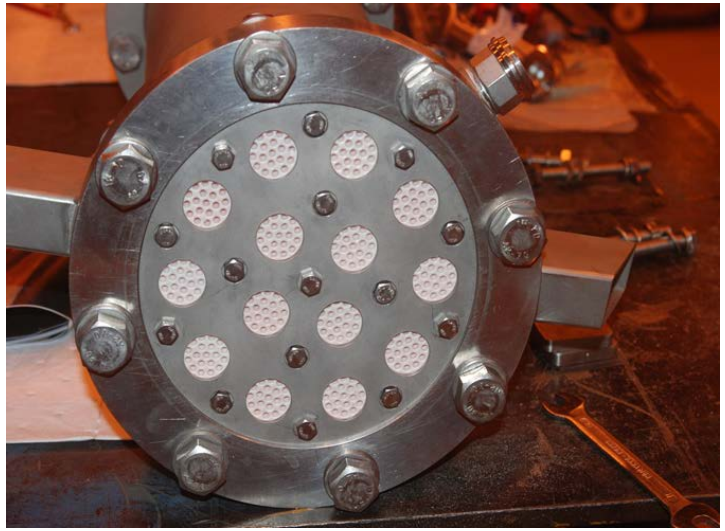

Photo source: Shell

signals

Fraunhofer IKTS

RJ OIL INC ENVIRONMENTAL SOLUTIONS

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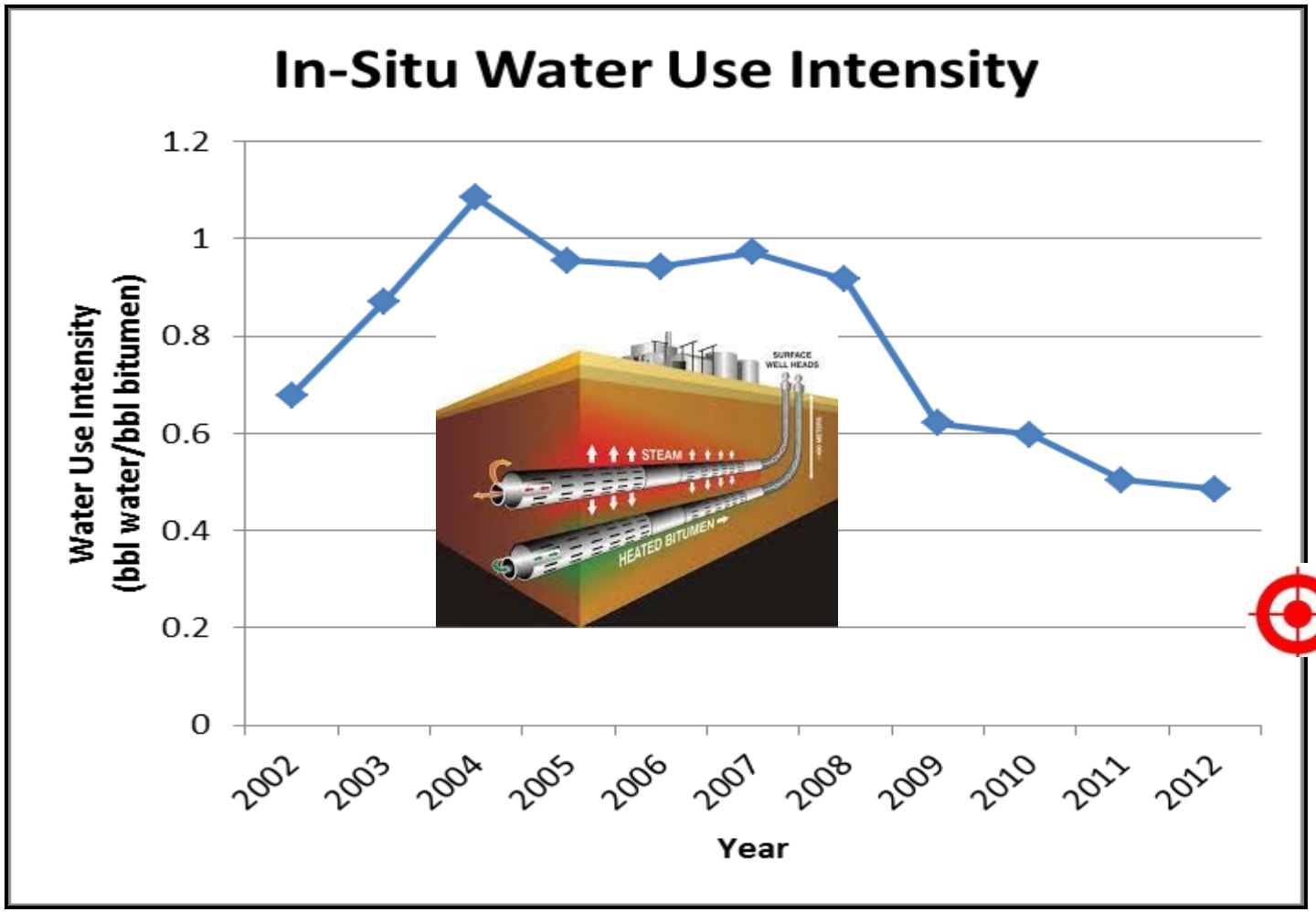
Other Benefits for Alberta

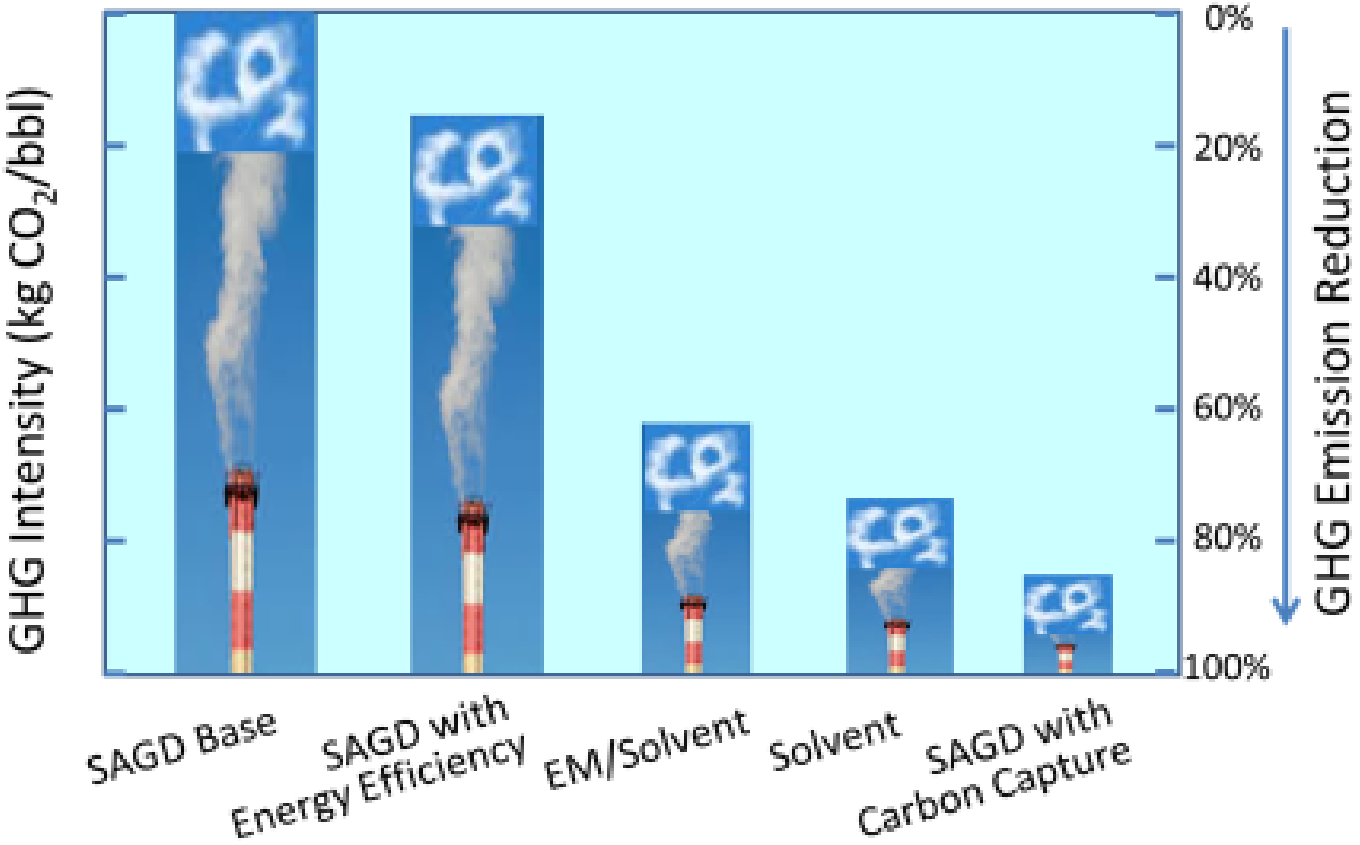
- Water technologies have additional benefits
  - Cost reduction
  - Smaller footprint (land & GHG)
  - Enable use of non-fresh make-up water
  - Improved or maintained water recycle rates

- Water technologies likely commercial within next 5 years

Water Use – Piloting New Technologies for SAGD Water Treatment & Steam Generation

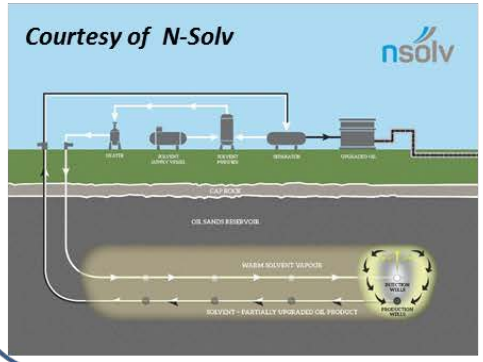


GHG Reduction Potential

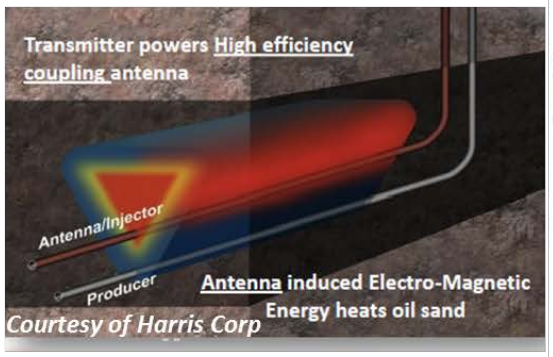


Advanced recovery: low-carbon, low water

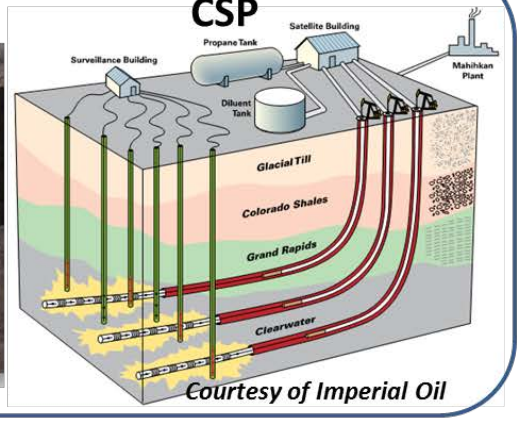
BEST



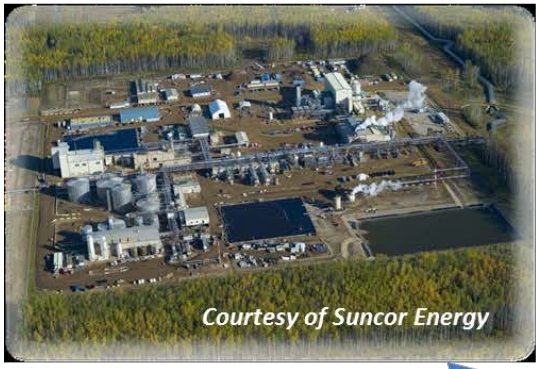
ESEIEH



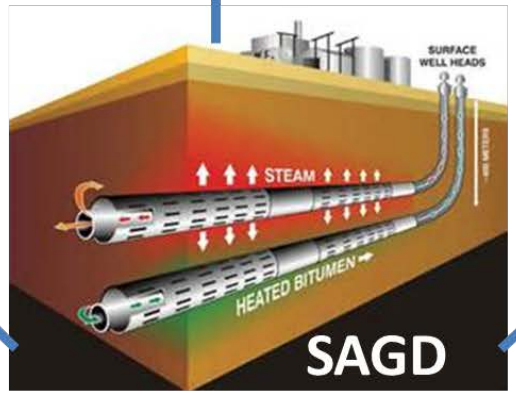
CSP



Low GHG Recovery Technologies



Energy Efficiency



Carbon Capture & Utilization

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CCEMC Climate Change & Emissions Management Corporation

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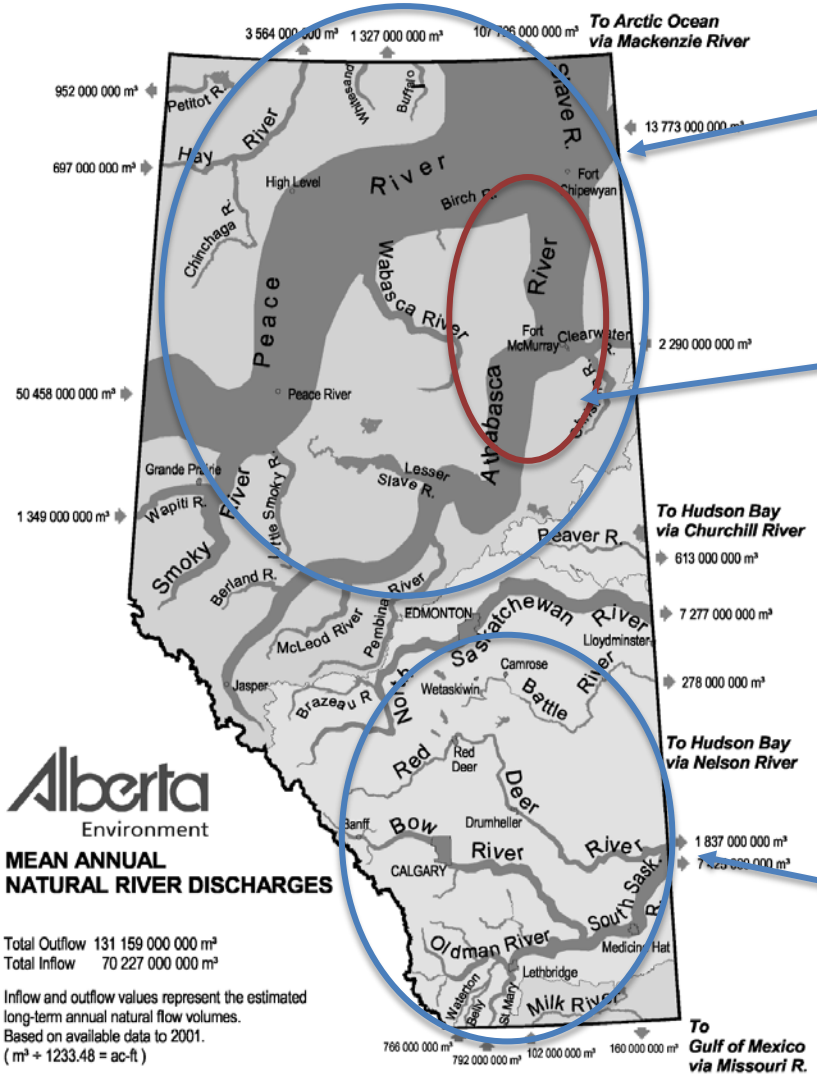
Mine water use (fresh water)



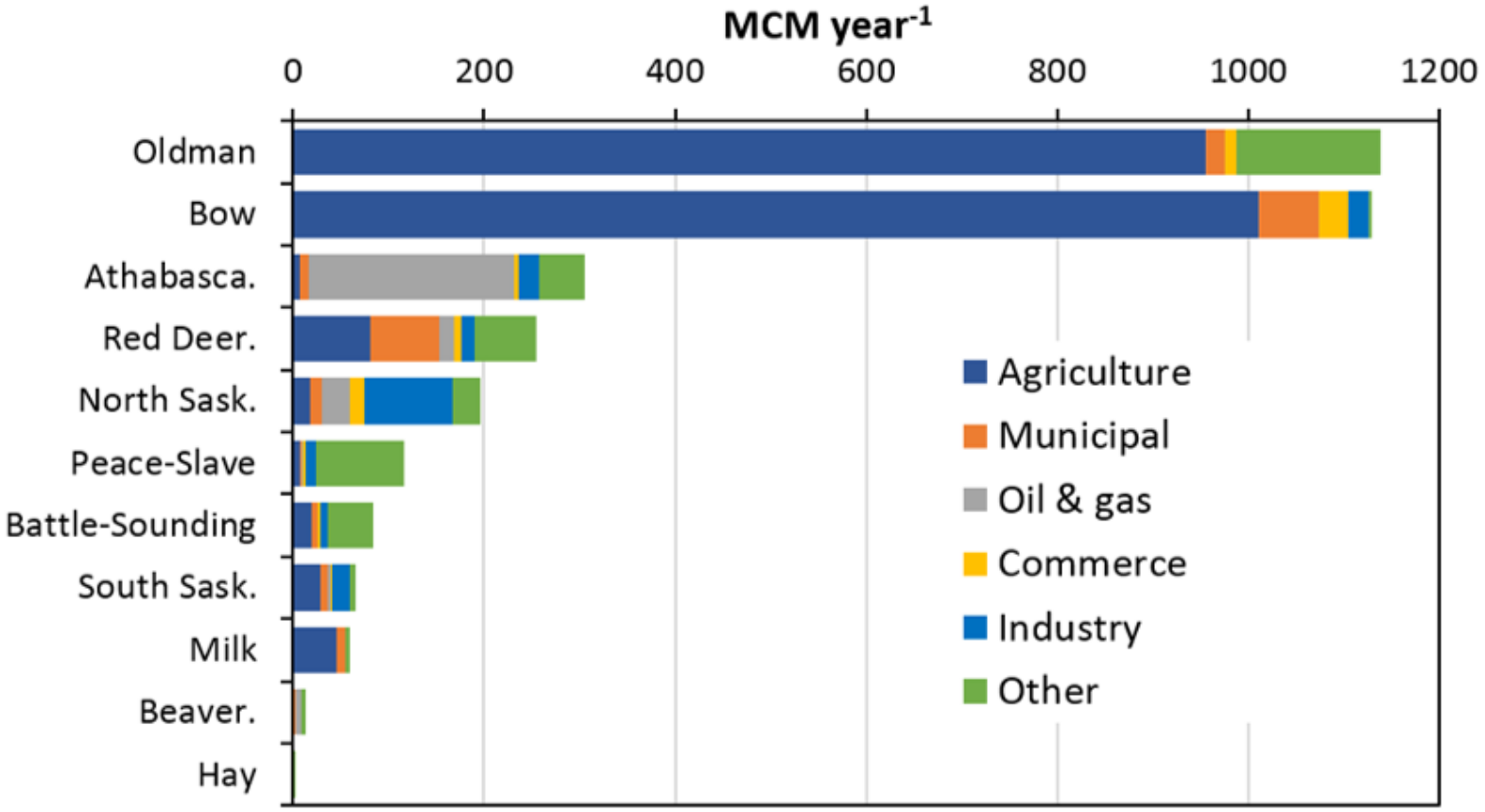
- 87% of water, 13% of demand

Oil sands Athabasca River Use:

- 0.6% annual flow
- 3.5% of low flow
- *Water use risk in winter low flow months*

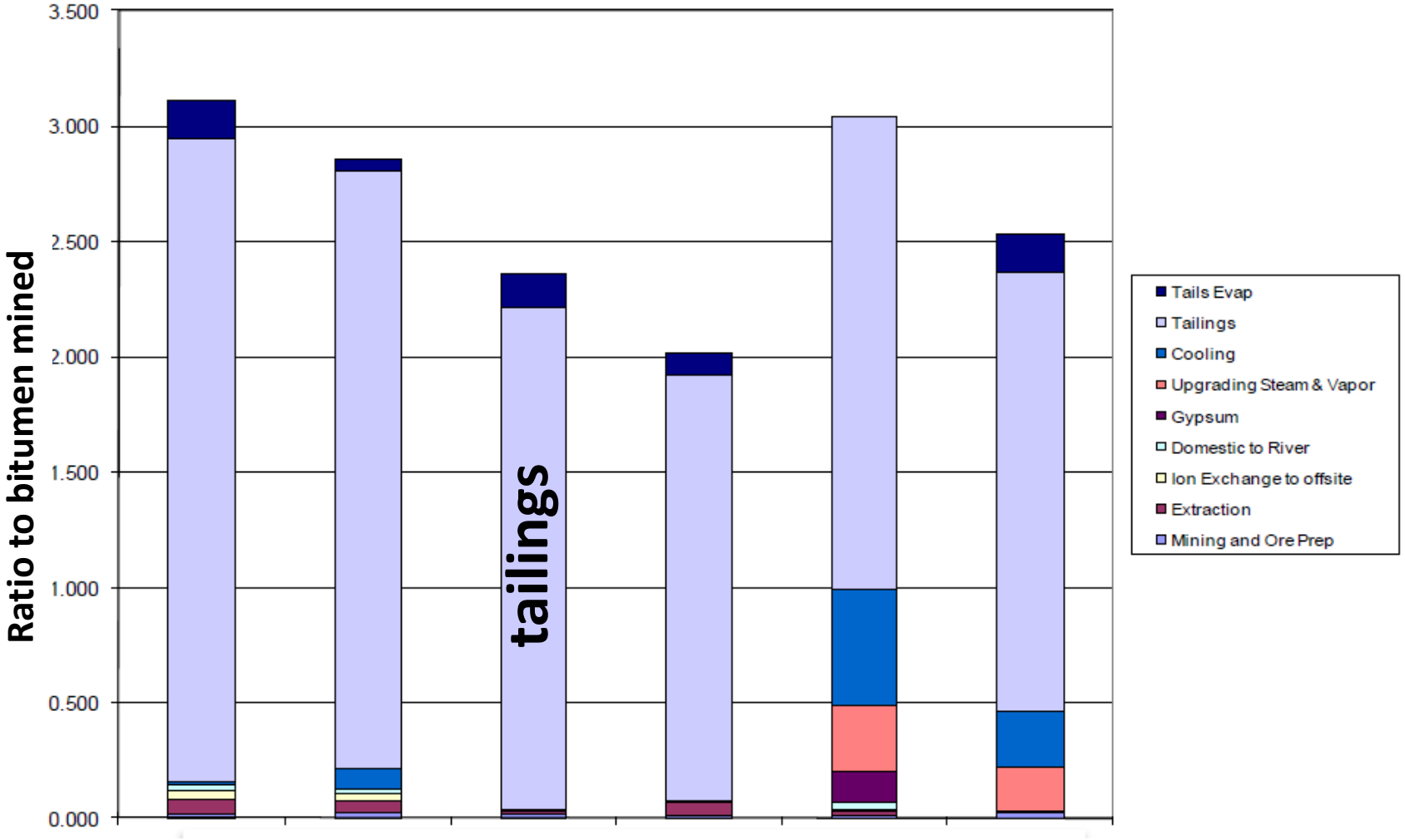
- 13% of water, 87% of demand

Water Use Conservation, Efficiency, & Productivity



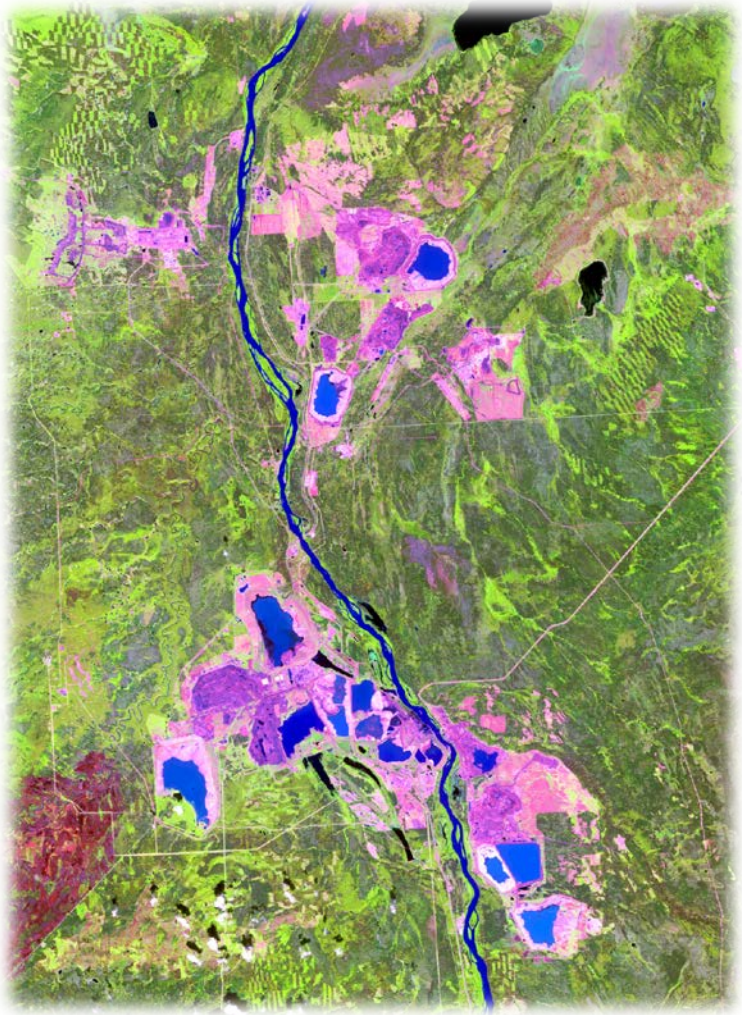
Vic Adamowicz, Greg Goss, Monireh Faramarzi , U of Alberta

Mine water consumption



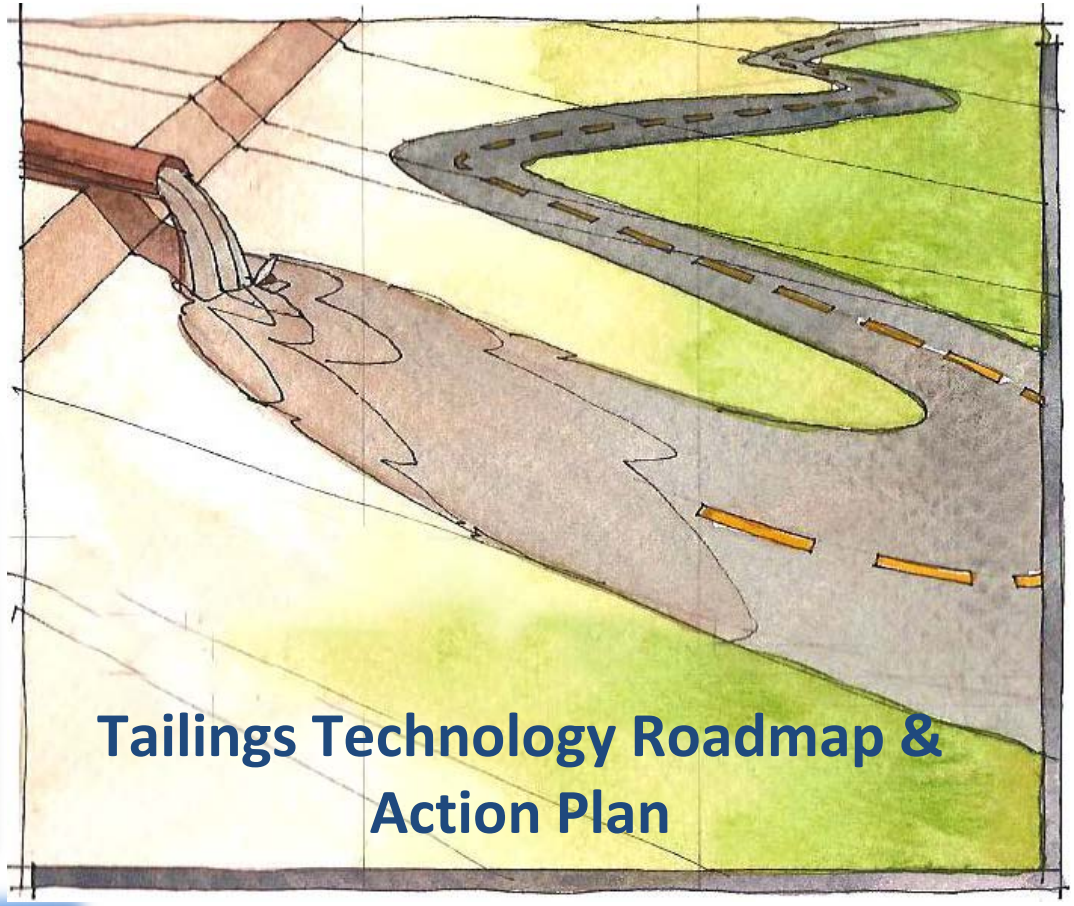
Tailings today...

- 1 billion m^3 of Mature Fine Tails (MFT) in tailings ponds
- >200 km^2 of tailings
- ~ 88 km^2 pond area
- tailings reclamation is bigger than you think



Lower Athabasca Region

Tailings Management Framework for the Mineable Athabasca Oil Sands



Tailings Technology Roadmap & Action Plan

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OSTC

TOTAL

Canadian Natural

Syncrude

Teck

SUNCOR ENERGY

Esso Imperial Oil

Alberta Innovates Energy and Environment Solutions

Thin Lift Drying

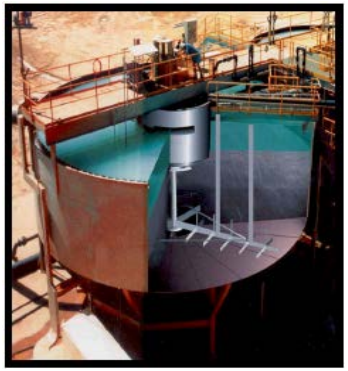
Suncor (TRO™)

Water-Capped MFT (BML)

Syncrude: Commercial demonstration being monitored and assessed (not yet approved).

Thickeners

Shell (CNRL and IOL)



Centrifuge Process

Syncrude: commercial facilities constructed

Innovation Gap: Inconsistent performance of commercial systems, soft deposits and high costs

Reducing tailings production …

Inline de-watering

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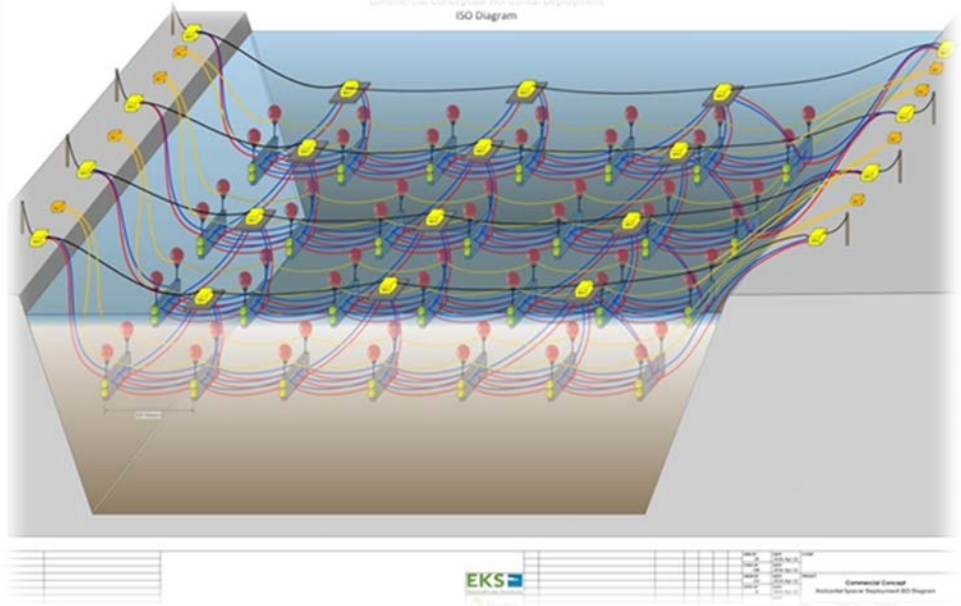
Remediating legacy tailings …

Electrokinetic Reclamation Field Demonstration

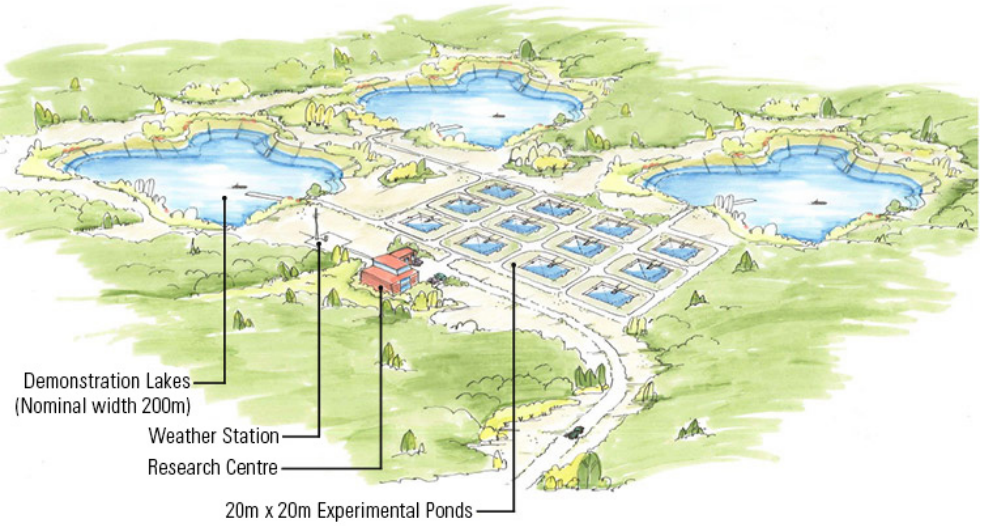


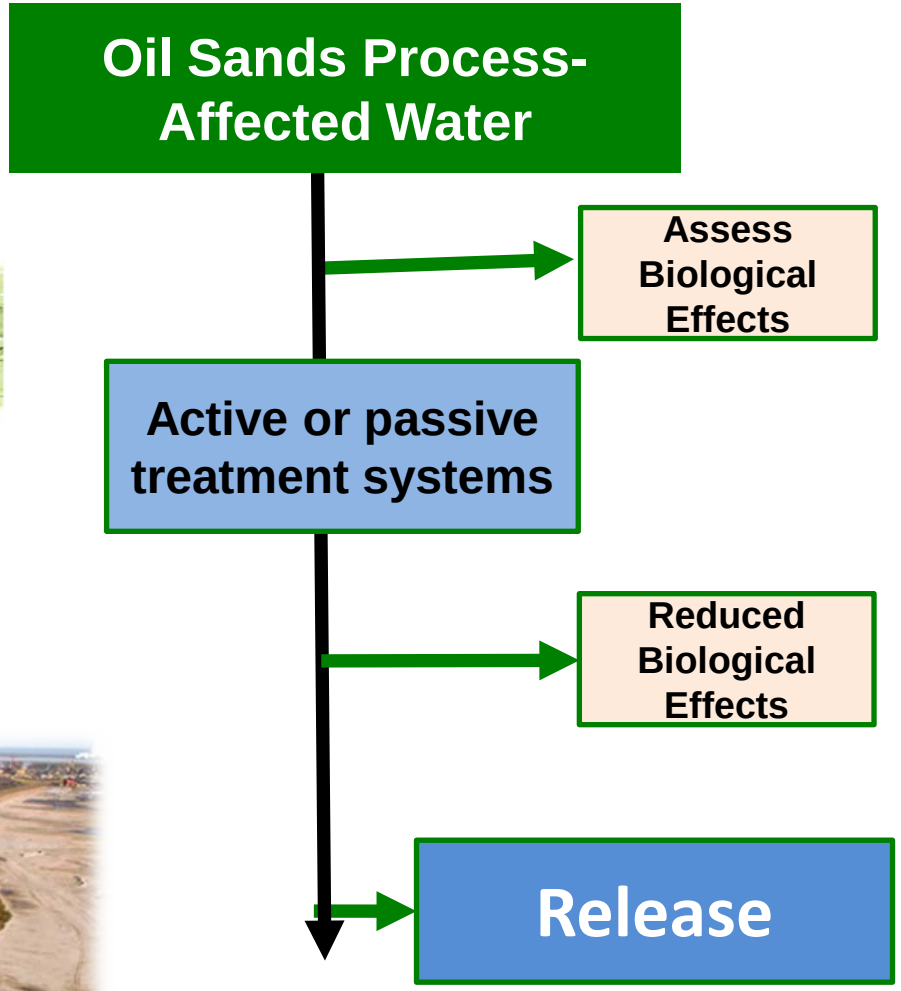
EKS
ElectroKinetic Solutions

SUNCOR ENERGY

Remediating process-affected water

- pit lakes





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Resilient communities & sustainable water supplies

… my city's nightmare is the **climate change wake-up Alberta,** and Canada, **needs** (Andrew Nikiforuk 2013).

…it is **El Niño supercharged** with **climate change** (Naomi Klein 2016)

Blair King Become a fan

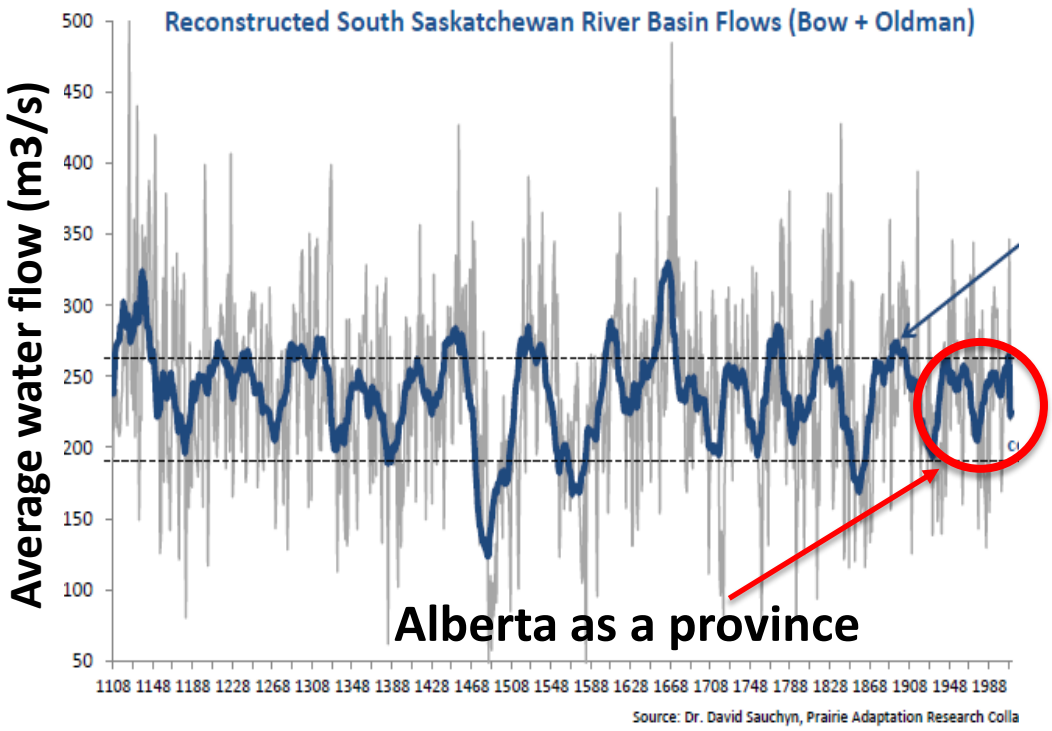
Environmental Scientist, Husband, Father

We Can't Blame Climate Change For The Fort McMurray Fires

Posted: 05/10/2016 9:04 am EDT | Updated: 05/10/2016 9:59 am EDT

Climate variability and water supply – a lens into the past

1100 AD to present



Oilsands may face severe water shortages, Athabasca River study suggests

'The river is much more variable than you would think based on measurements since 1950s'

By Emily Chung, CBC News Posted: Sep 21, 2015 3:19 PM ET | Last Updated: Sep 25, 2015 4:00 PM ET

Resilient communities, forest disturbance & source water protection

Disturbance – water quality – drinking water

GoA, Spray Lake Sawmill, City of Calgary, FRi Research Institute, AI-Bio, U of A, U Waterloo, Brock U

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Watershed Management:
South Saskatchewan River Basin (SSRB)

- stakeholder engagement
- impact on issues
  - current (basin management & allocation)
  - emerging (flooding)
  - long-term (climate change)

ALBERTA watersSMART
Water Management Solutions

CCEMC
Funding climate change innovation.

Alberta Innovates
Energy and Environment Solutions

Watershed Management: South Saskatchewan River Basin (moving to Athabasca River Basin)

Management strategies

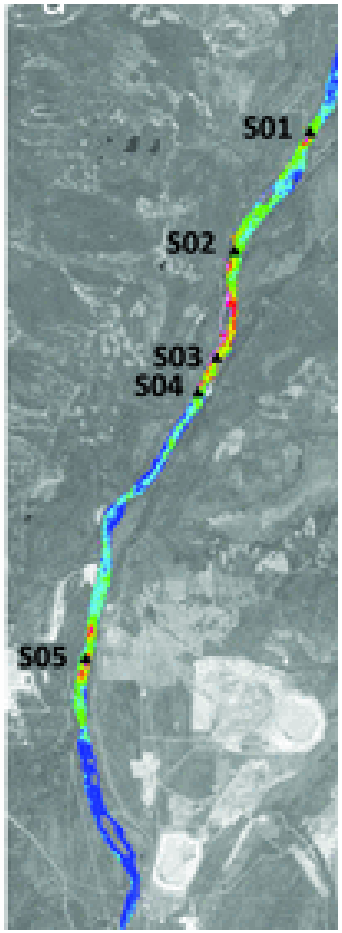
Solving emerging issues

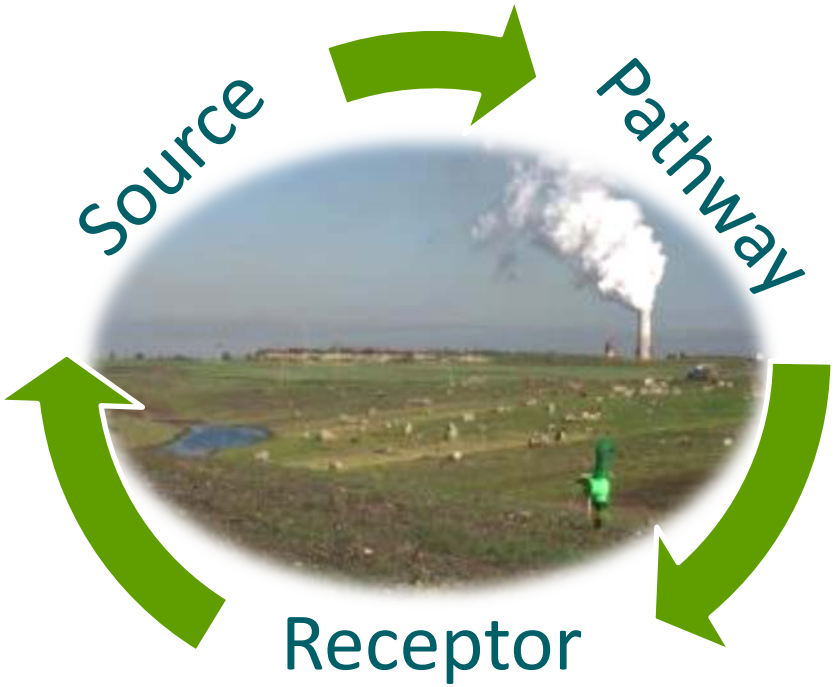
Water supply and water quality

ALBERTA waterSMART
Water Management Solutions

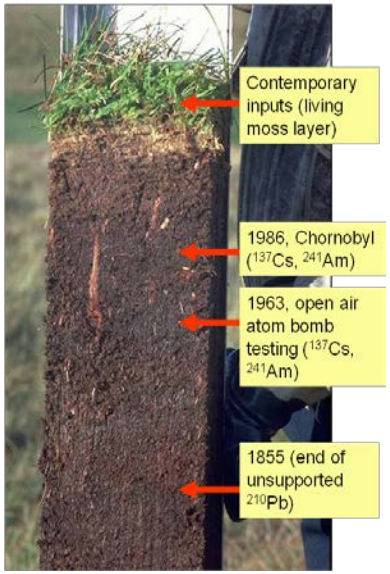
Environmental Monitoring

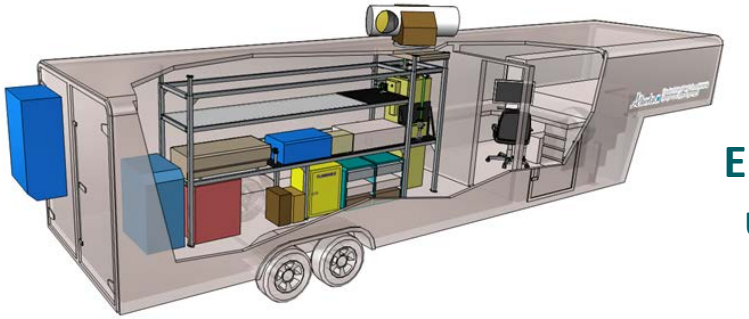
Contaminants in the Lower Athabasca





Historic and current deposition of metals / organics





Emission monitoring using DiAL (LIDAR)

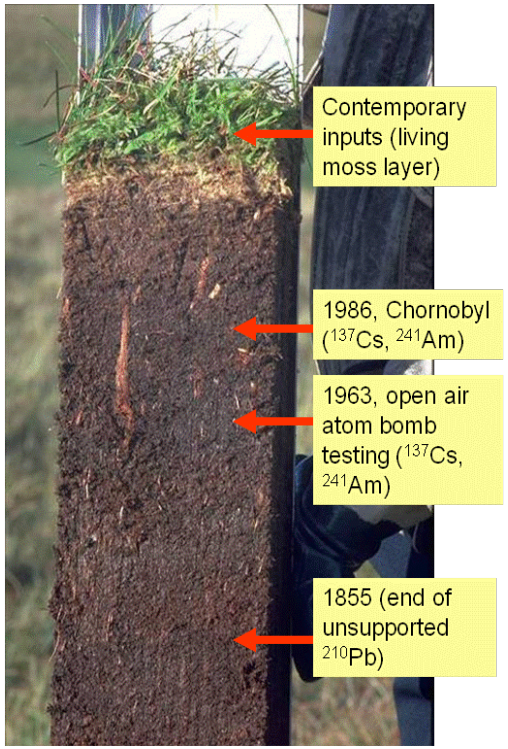
Water Quality Protection

- **water quality variation & sources of contamination in the Lower Athabasca**

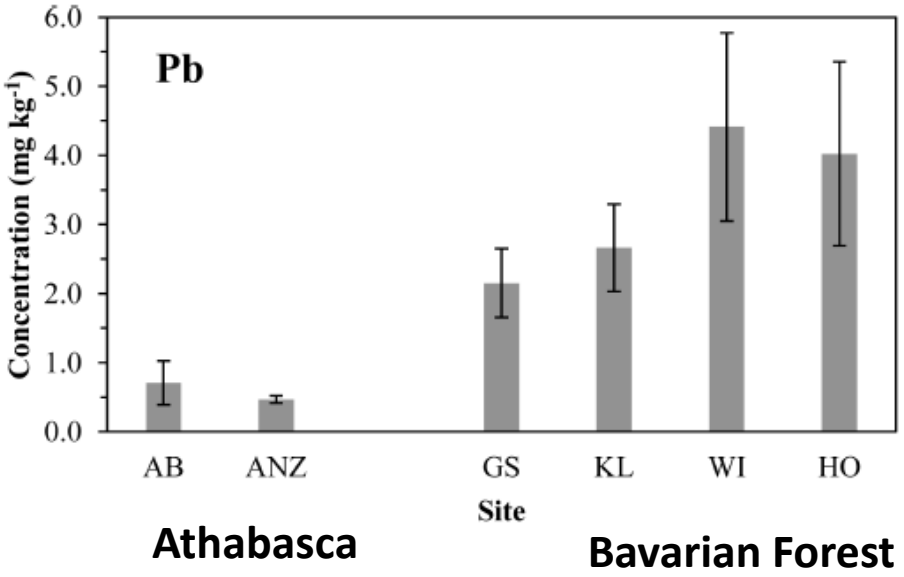
Trace metals in the lower AR:
Ag, Cd, Pb, Sb and Tl concentrations at or below those of bottled water

Water Quality Protection

- **Metal / organic contamination in the Lower Athabasca region**



Environ. Sci. Technol. 2014, 48, 12603−12611

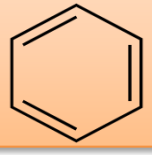


- Metal contamination is low in the oil sands region
- Peat cores suggest heavy metal precipitation peaked in the past
- Pet coke is a major source of organics

Effect of Diluted Bitumen on Freshwater Environment – Contributions to a civil discussion

……to answer the questions articulated by the National Academy of Sciences

1.Compositional Comparison



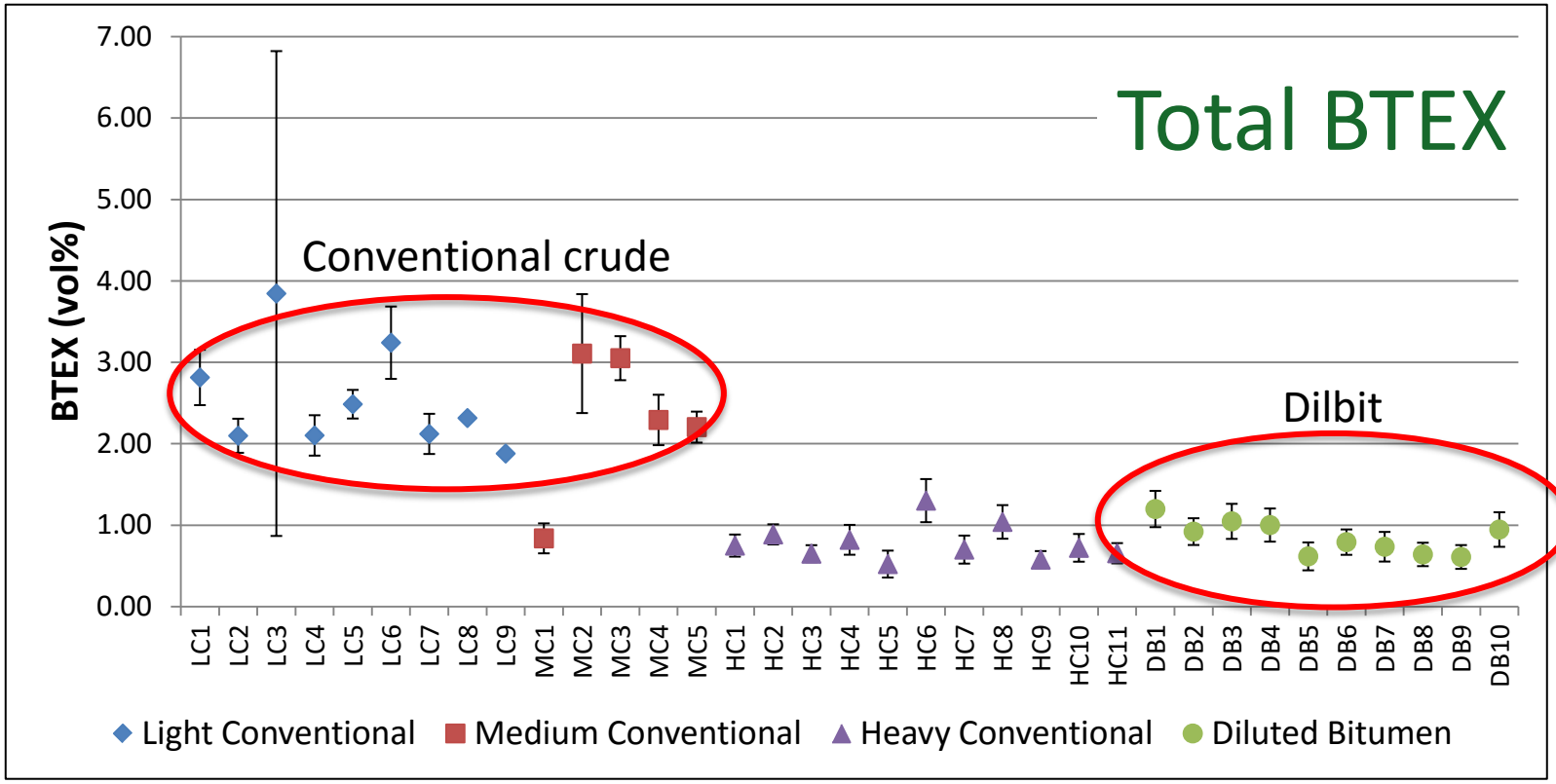
2. Lab Testing: Chemi-physical

Insight and Understanding

3. Lab Testing: Biological

4. Spill Case Comparisons

Chemical-Physical Properties: Benzene, Toluene, Ethyl Benzene, Xylene



Based on open data from www.CrudeMonitor.ca

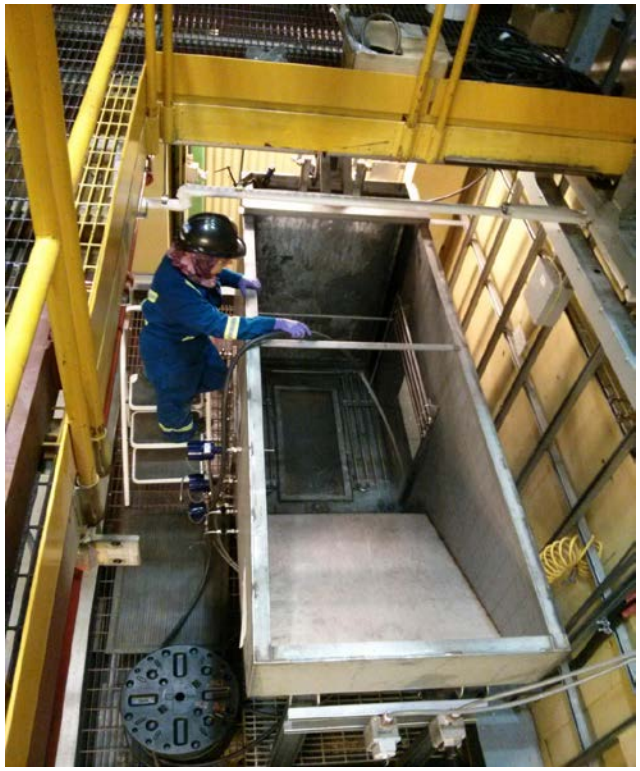
Biological impact

"…… mixed sweet blend crude was more toxic than dilbit, demonstrating that the risks associated with dilbit are less or no different from those of conventional crude."

Philibert and Tierney, 2015

Float or sink:
Impact of wave action and sediments

Dettman (2015)



Spill Case Comparison

Marshall, Michigan

July 25, 2010

Dilbit; 17+hours; 3,800 m^3

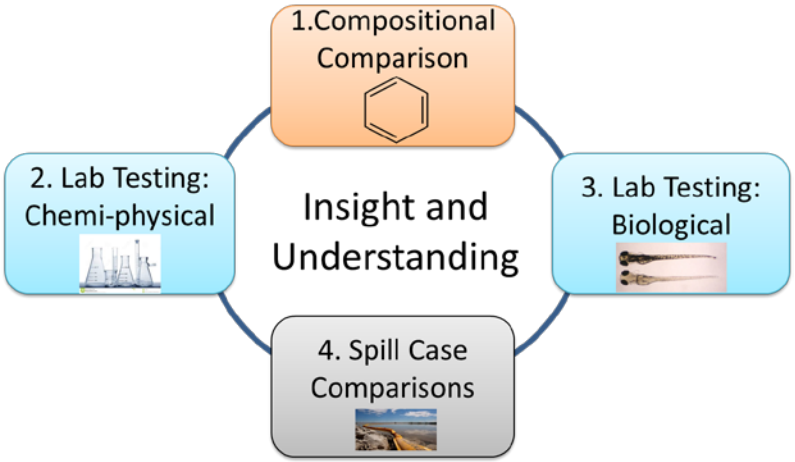
Sundre, Alberta

June 7, 2012

Light Crude; 2.5 hours; 463 m^3

The biggest lesson: no matter what type of oil spilled, prompt response action is the key

Summary - The fate, behavior, and environmental impact of dilbit spills



- How is dilbit different from conventional crude?
  - Similar to heavy oil, less acute toxicity than light oil
- Is such difference so great that we need different preparedness and response procedures for dilbit?
  - No. Be prepared. Act fast.

Land Reclamation:
Learning from International Experiences

Appalachian mountain top coal mining
> 8X mineable oil sands disturbance

Australian bauxite mines
Similar footprint to an oil sands mine

What can we learn from nature

Facility operated from the ‘20s to ‘50s

Upland forest vegetation with shallow soils over bitumen

Wetland on exposed bitumen

Wetland and terrestrial vegetation rooted into bitumen

Summary comments

Future Water Supply and Watershed Management

Water Quality Protection

Water Use Conservation, Efficiency, & Productivity

Healthy Aquatic Ecosystems

AI-EES Water Innovation Team

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Dr. Dallas Johnson
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Scientific Director of Water Resources
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Rick Nelson, M.Sc.
Senior Director, Oil Sands Tailings
Responsibility in WIP: Mine water treatment and end pit lakes

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Responsibility in WIP: Municipal and industrial water treatment and groundwater quality

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Alberta Innovates Energy and Environment Solutions


Thank you
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