

Athabasca River Basin: from Glacier to Delta

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Science Outreach – Athabasca

Athabasca University



20 April 2011



Objectives of Talk

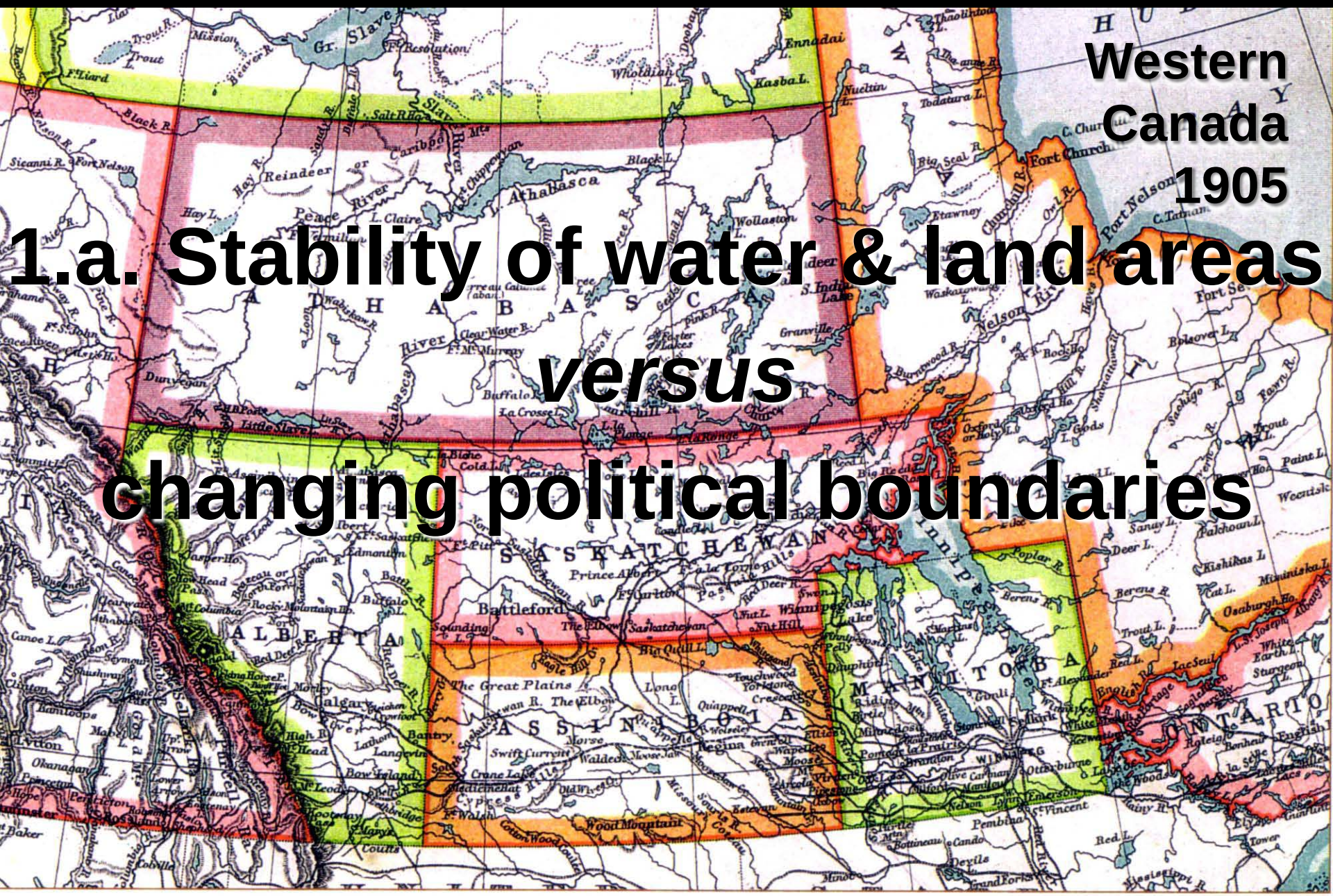
- Why work with a river basin?
- What is the Athabasca River Basin
 - Physical features of the ARB
 - Why the ARB is important
 - Concerns about the ARB

Near the headwaters of the Athabasca River, 2007

Why work with a river basin?

Western
Canada
1905

**1.a. Stability of water & land areas
versus
changing political boundaries**



1.b. Fort McMurray Boundaries

- Fort McMurray (Hudson Bay Company) 1870
- Village of McMurray (with Waterways) 1947
- Town of McMurray 1948
- Town of Fort McMurray 1962
- City of Fort McMurray 1980
- Regional Municipality of Wood Buffalo (with Improvement District 143) 1995

Photo: 2005

Data: Wikipedia, 30 Dec. 2009

Why work with a river basin?

**2. Integration & accumulation
of impacts on water, soil &
organisms
(but not atmosphere)**

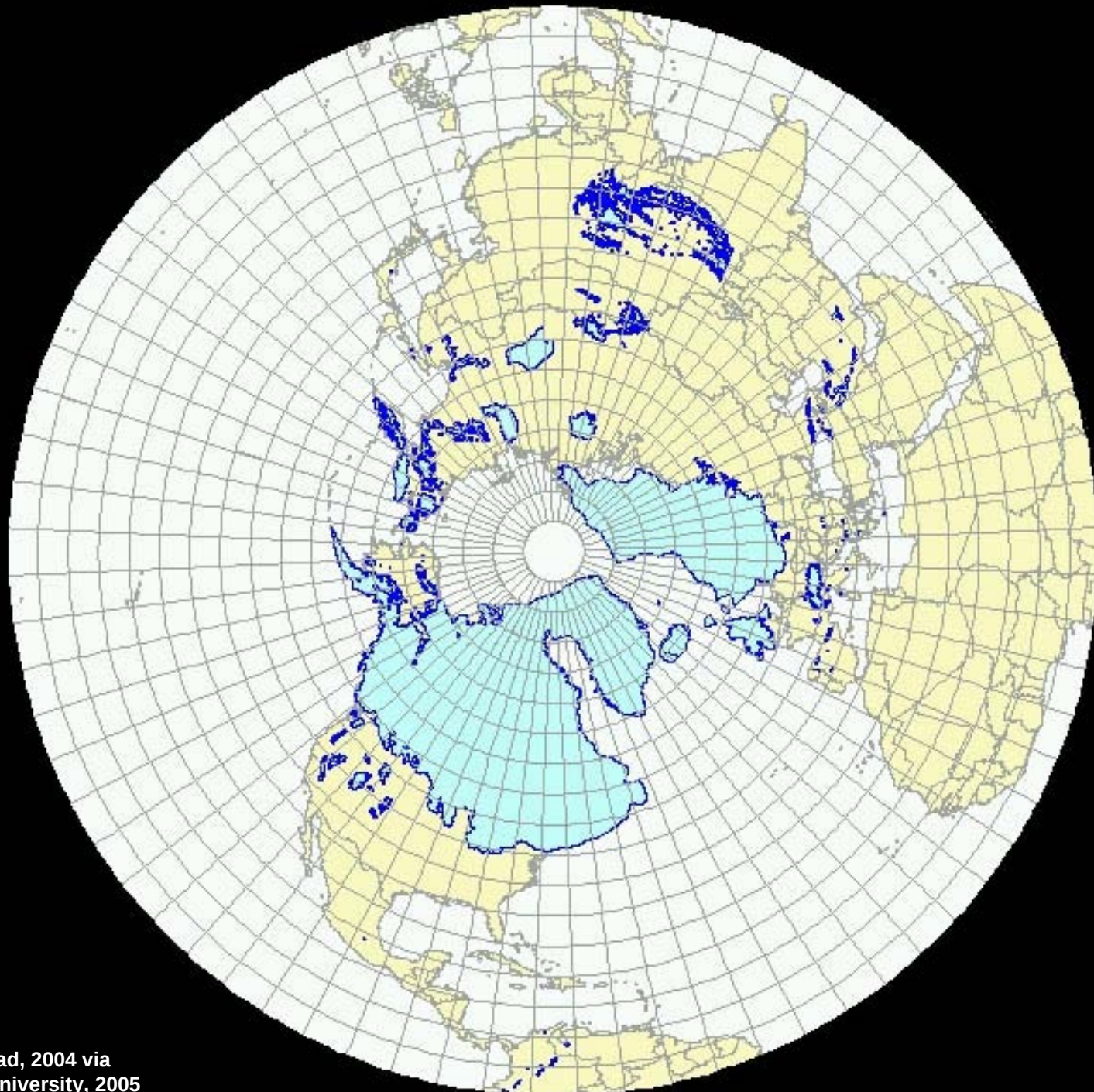
Athabasca River near Athabasca, 2007

Why work with a river basin?

3. Implications for humans:

- ecological sustainability**
- health**
- water, food, fibre, minerals & energy**
- economic sustainability**

**Maximum
extent of
last
glaciation
(21,000-14,000
years bp)**



Source: Jürger Ehlers and Philip Gibad, 2004 via
Cambridge Quaternary, Cambridge University, 2005

Alberta River Basins

- 7 basins
- 5 sub-basins of the Saskatchewan



What is the Athabasca River Basin (ARB)?

- ~1,230 km long
- ~133,000 km²
- >101 tributary rivers
- >307 named creeks
- >328 named lakes
- no dams or reservoirs

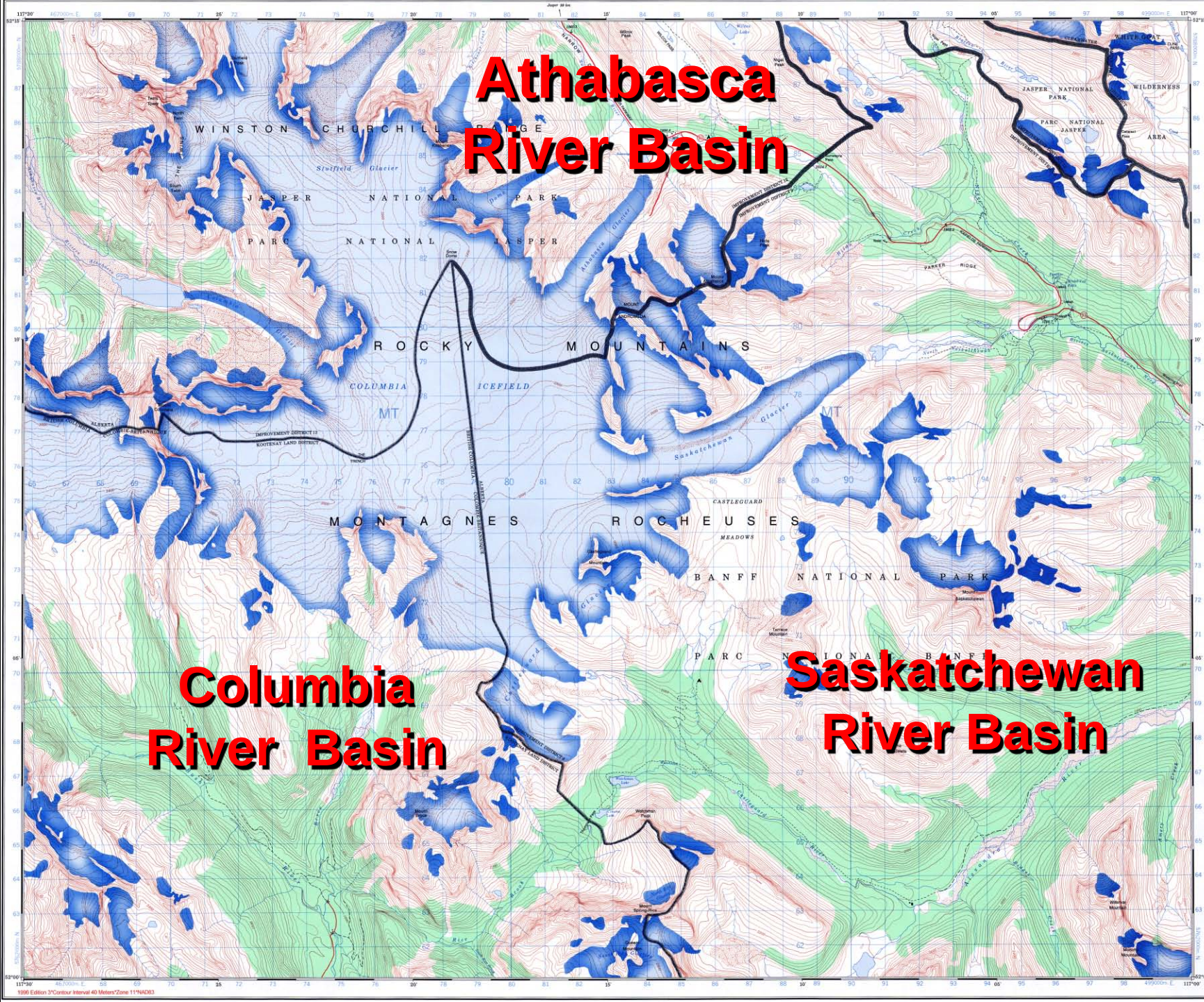


Columbia Ice Field

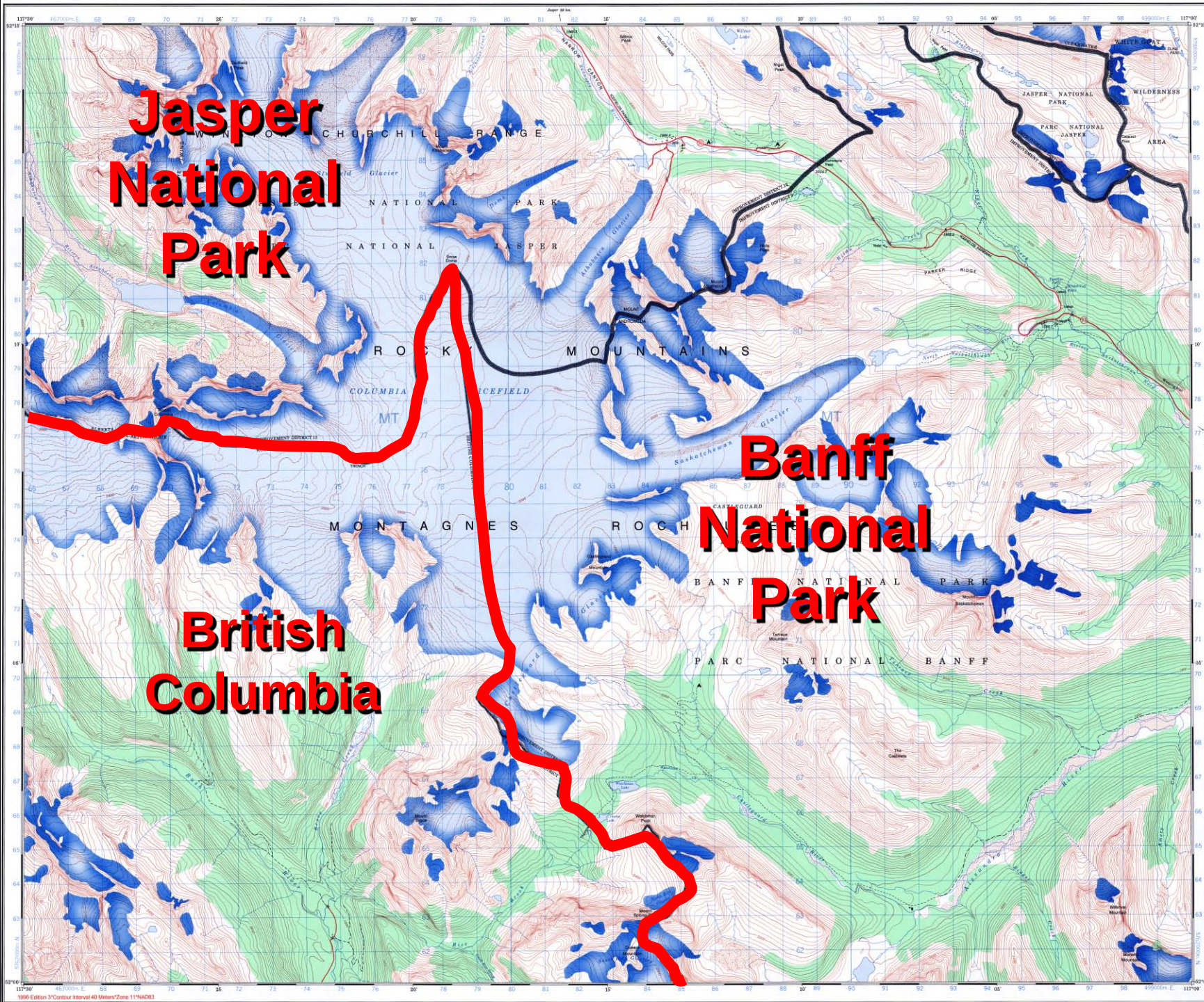
**Athabasca
River Basin**

**Columbia
River Basin**

**Saskatchewan
River Basin**

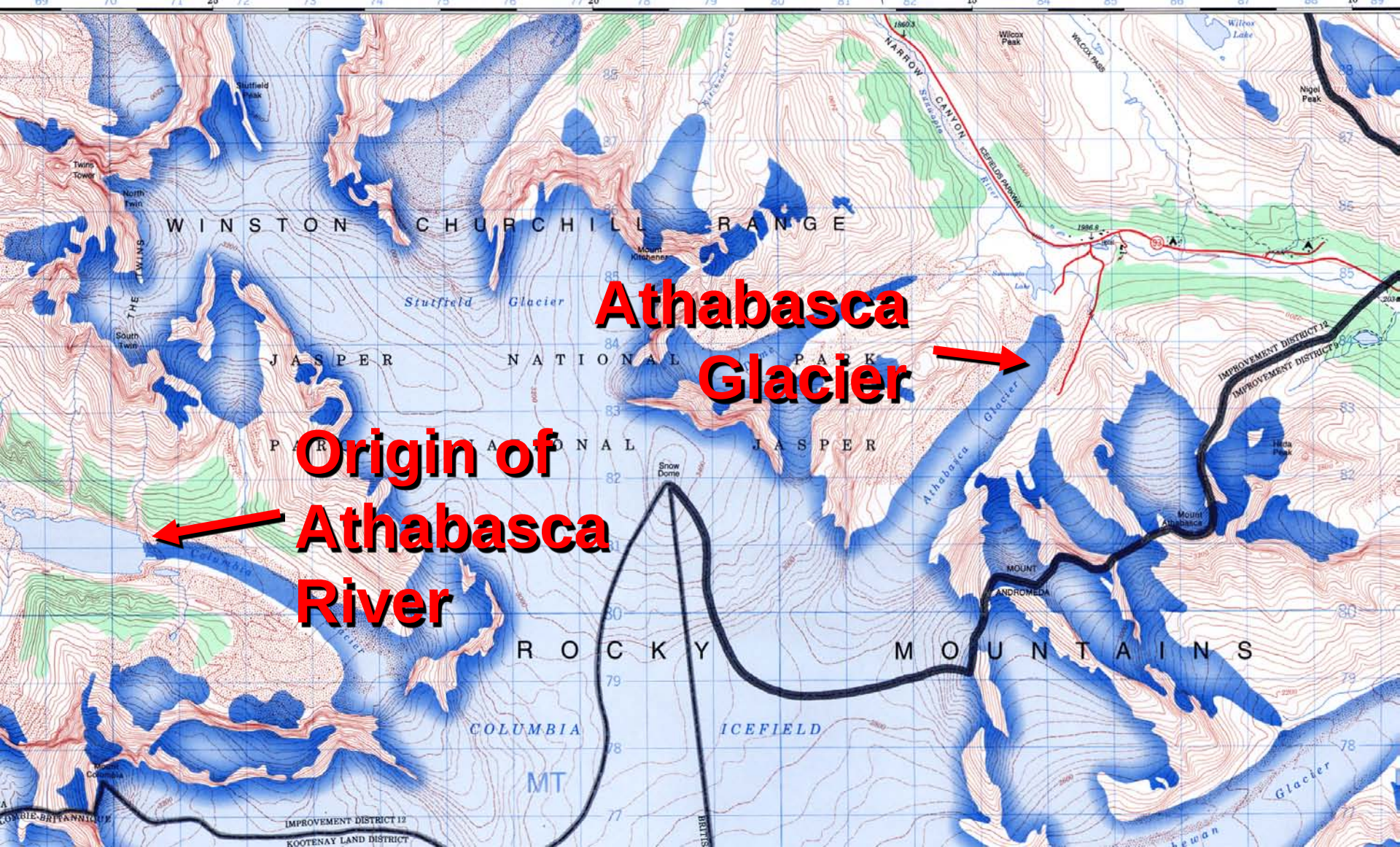


Columbia Ice Field





Athabasca Glacier 2002



Columbia Ice Field

Upper Portion of the Athabasca River Basin

Snake Indian River

Brûlé Lake

Snarling River

Jasper Lake

Rocky River

Miette River

• Jasper

Maligne River

Whirlpool River

Sunwapta
River

Athabasca
River

Columbia Ice Field



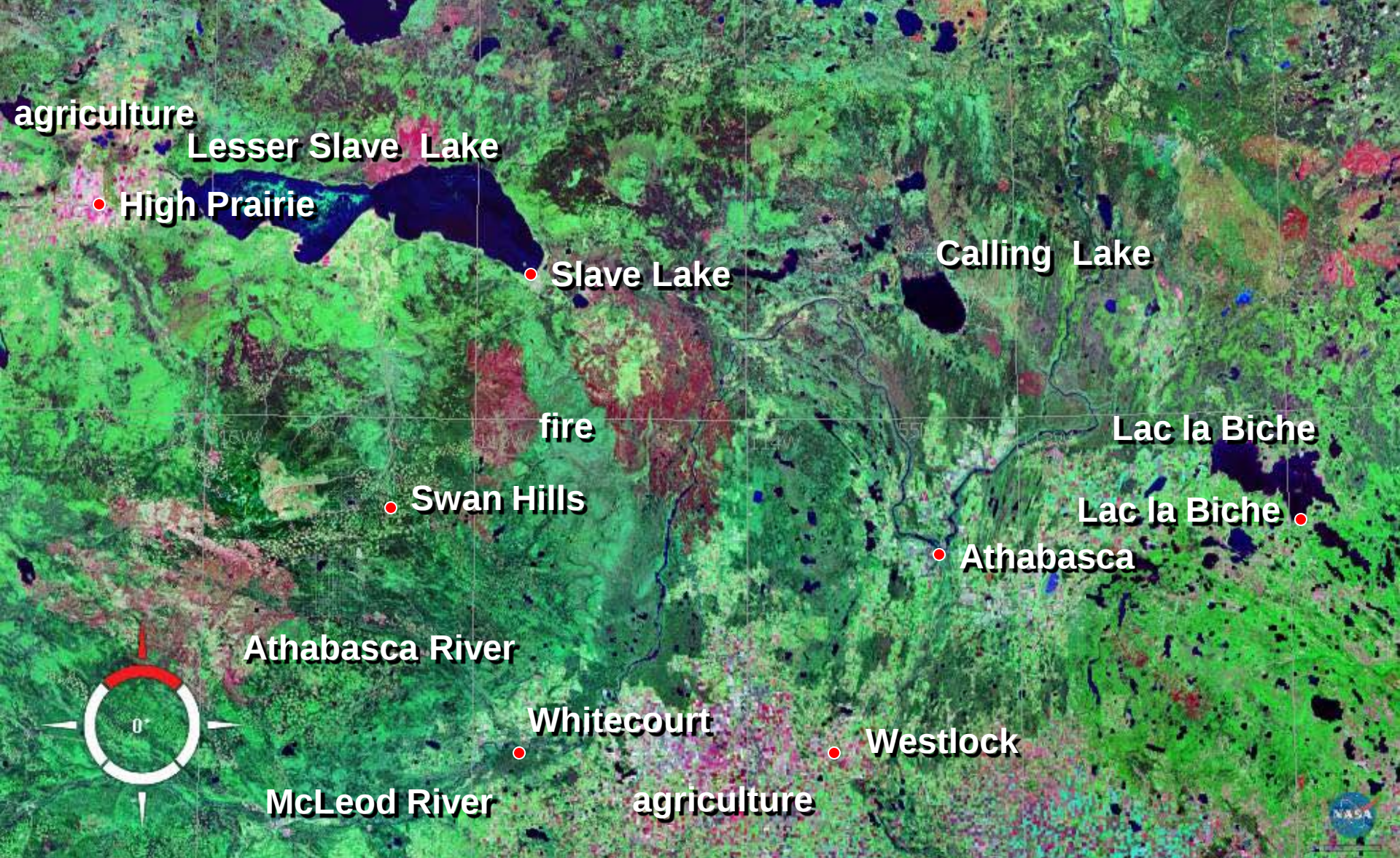


Athabasca Falls, 2004

Photo: Derek Ross,
http://en.wikipedia.org/wiki/Image:Athabasca_Falls_2005-06-11.jpeg

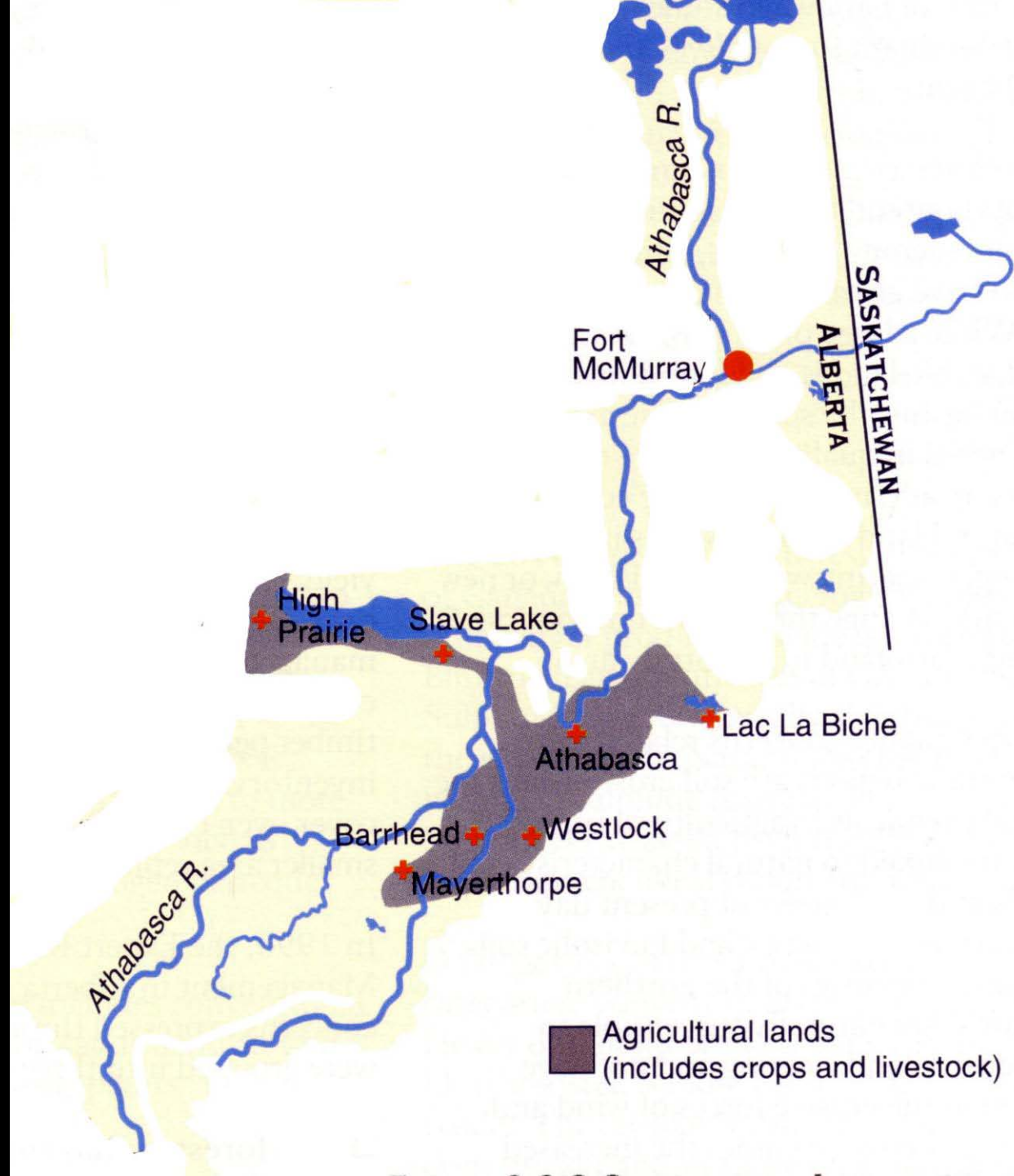


Athabasca River near Jasper, 2005



Central Part of Athabasca River Basin

Agriculture in the Athabasca River Basin



Source: Northern River Basins Study,
Report to the Ministers, 1996



Town of Athabasca from Athabasca River, 1991



Athabasca River downstream from Athabasca, 1987



Portaging foot of Grand Rapids (1.6 km), Athabasca River, circa 1903-06

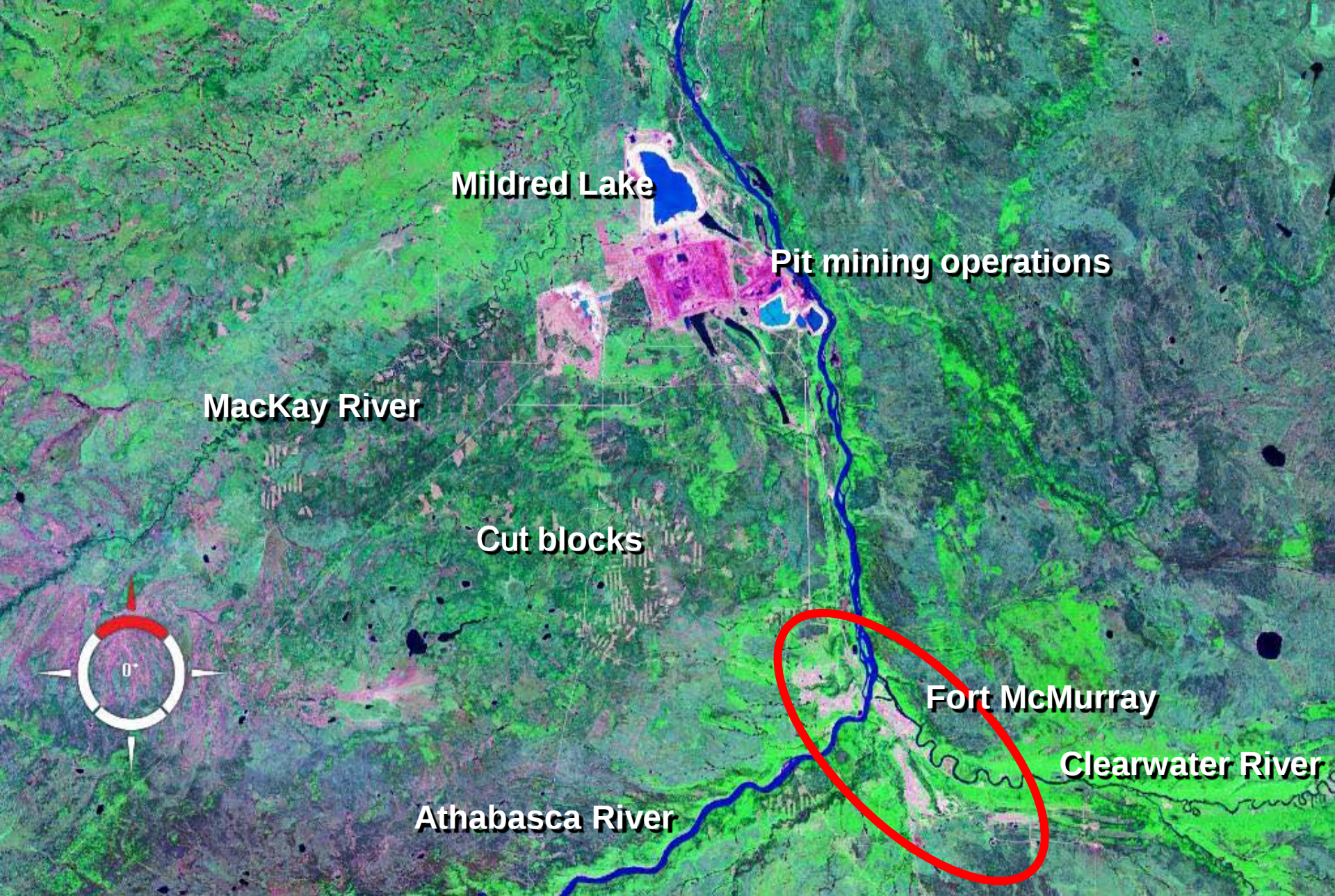


Big Cascade, Athabasca River, circa 1910

Photo: Canadian Department of the Interior, Library and Archives Canada PA-169585,
http://www.collectionscanada.ca/archivianet/020115_e.html



Fort McMurray – Athabasca and Clearwater Rivers, 2005



Mildred Lake

Pit mining operations

Mackay River

Cut blocks

Fort McMurray

Clearwater River

Athabasca River

Fort McMurray Area



Athabasca River at Fort MacKay, 1996



Fishing lodge at Namur Lake, 2004



Peace-Athabasca Delta Area



Sand Dunes near Athabasca River, 1998

Peace- Athabasca Delta





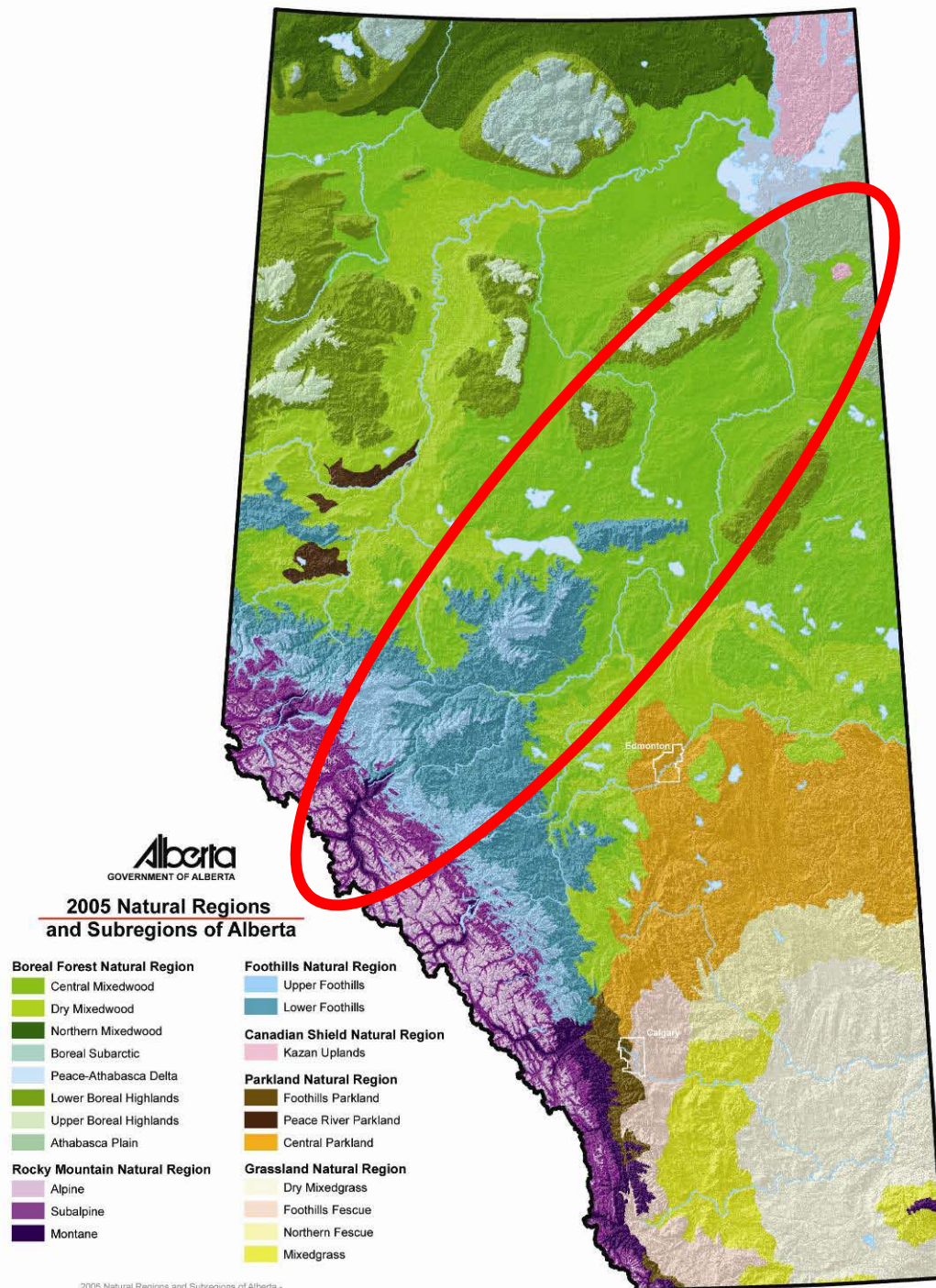
Peace- Athabasca Delta

- 4,100 km²
- >1,000 lakes
- sensitive to water levels
- all 4 major N.A. bird flyways converge here

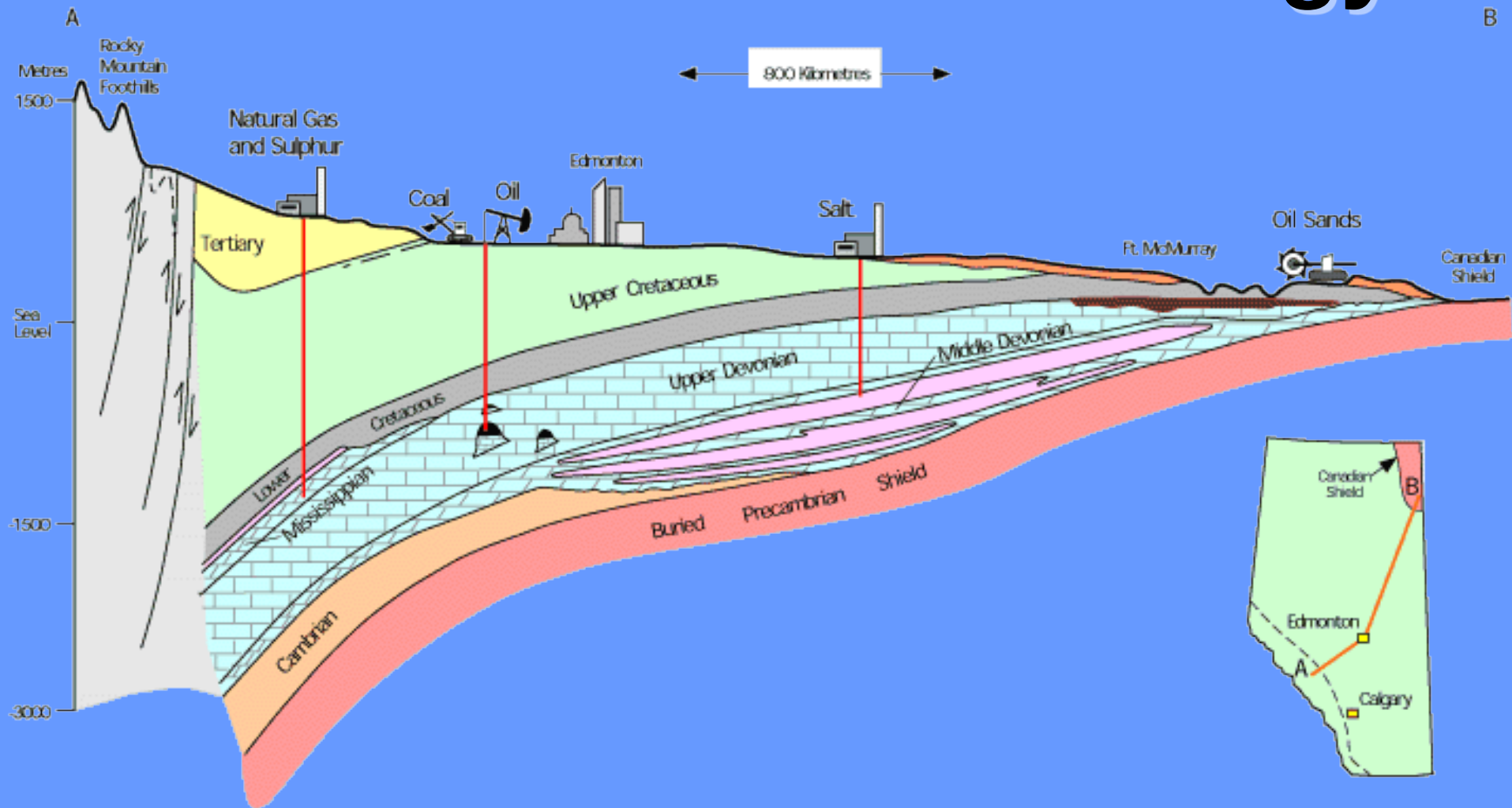
Peace-Athabasca Delta, 1998

What is the ARB?

- 3 natural regions and 11 sub-regions



What is the ARB? Geology



Athabasca River elevation at origin 1,231 m (foot of glacier), at mouth 205 m

Source: www.abheritage.ca/abnature/geological/photos/... via Royal Alberta Museum; Mussieux, R. and M. Nelson. A Traveller's Guide to Geological Wonders in Alberta; artist Dan Magee

What is the ARB?

- ~150,000 people
(1 city, 12 towns,
>75 villages, etc.)





Regional Municipality of Wood Buffalo

51,496 people
(Fort McMurray 47,705)

Fort McMurray 2004

Source Statistics Canada, 2006



Towns of the ARB

Hinton	9738
Whitecourt	8971
Edson	8098
Slave Lake	6703
Westlock	5008
Jasper	4265
Barrhead	4209
Lac la Biche	2758
High Prairie	2750
Athabasca	2575
Swan Hills	1645
Mayerthorpe	1474
Total	58194

What is known about the ARB?



Major Research Studies - **completed**

- Agriculture Canada: black flies, methoxychlor
- AOSERP¹ for Syncrude
- EIAs² for AlPac and other pulp mills
- Northern Rivers Basins Study³
- Northern Rivers Ecosystems Initiative⁴

¹ Alberta Oil Sands Environmental Research Program, 1970s

² Environmental Impact Assessments, 1990s

³ Athabasca, Peace and Slave River basins, ended 1996

⁴ Environment Canada: offshoot of Northern River Basins Study, 1996-2003



Major Research Studies – **on going**

- **Foothills Research Institute (formerly Foothills Model Forest, 1992)**
- **EMAN⁵ ecological monitoring**
- **EMEND⁶ studies logging and fire**
- **Alberta Biodiversity Monitoring Institute**

⁵ Environment Canada: Ecological Monitoring and Assessment Network, 1994-

⁶ Ecosystem Management Emulating Natural Disturbance, 1997-



Major Research Studies – on going

- RAMP⁷ monitors water
- CONRAD⁸ studies (industries, government & universities)
- WBEA⁹ monitors air
- CEMA¹⁰ recommendations

⁷ Regional Aquatics Monitoring Program, 1997-

⁸ Canadian Oil Sands Network for Research and Development

⁹ Wood Buffalo Environmental Association

¹⁰ Cumulative Environmental Management Association



Why is the ARB important?

1. Human survival
2. Resources
3. Ecological problems
4. Political
5. Intellectual interest



Why is the ARB important?

1. Human Survival

- Oxygen, $\text{CO}_2 \rightarrow \text{O}_2$
- Water for drinking, washing
- Food – wild and agriculture
- Fiber – wild, silviculture & agriculture

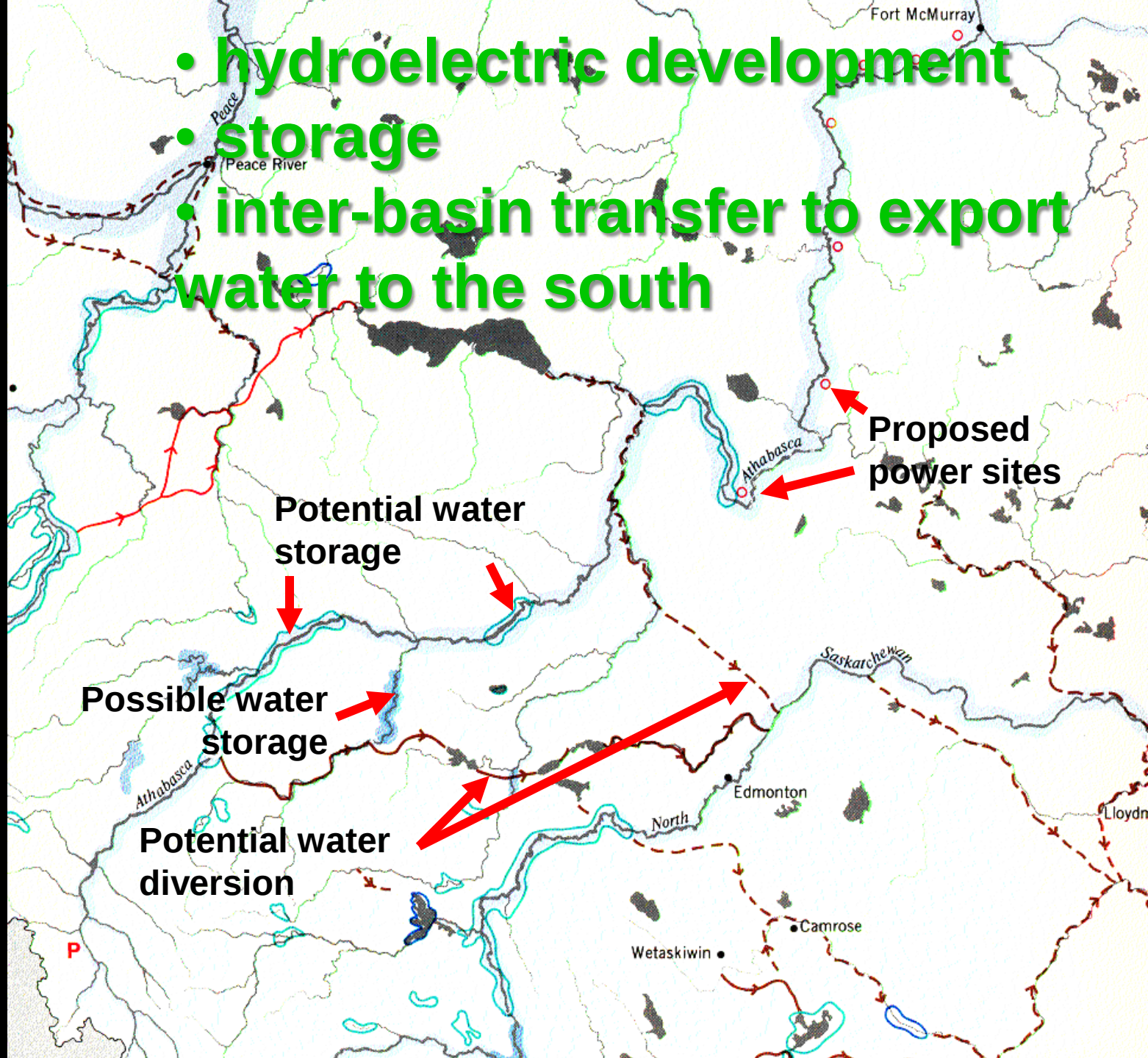
Why is the ARB important?

2. Resources – renewable

- Air, water & soil as “free” raw materials for agriculture, forestry & industry**
- Air and water for waste “treatment” (= dilution)**
- Hydroelectricity (potential)**

Potential Water Use

- hydroelectric development
- storage
- inter-basin transfer to export water to the south



Why is the ARB important?

2. Resources – renewable – wood

- Wood for lumber and plywood
- >12 mills in ARB

Sundance Forest Products, near Edson, May 2007

Why is the ARB important?

2. Resources – renewable - pulp

1. Hinton, Weldwood of Canada, 1957, bleached kraft

2. Whitecourt, Millar Western Pulp, 1988, bleached chemi-thermo-mechanical

3. Whitecourt, Alberta Newsprint Co., 1990, thermo-mechanical + paper mill

4. Slave Lake, Slave Lake Pulp, 1991, bleached chemi-thermo-mechanical

5. Athabasca, Alberta-Pacific Forest Industries, 1992, bleached kraft

Why is the ARB important?

2. Resources - renewable

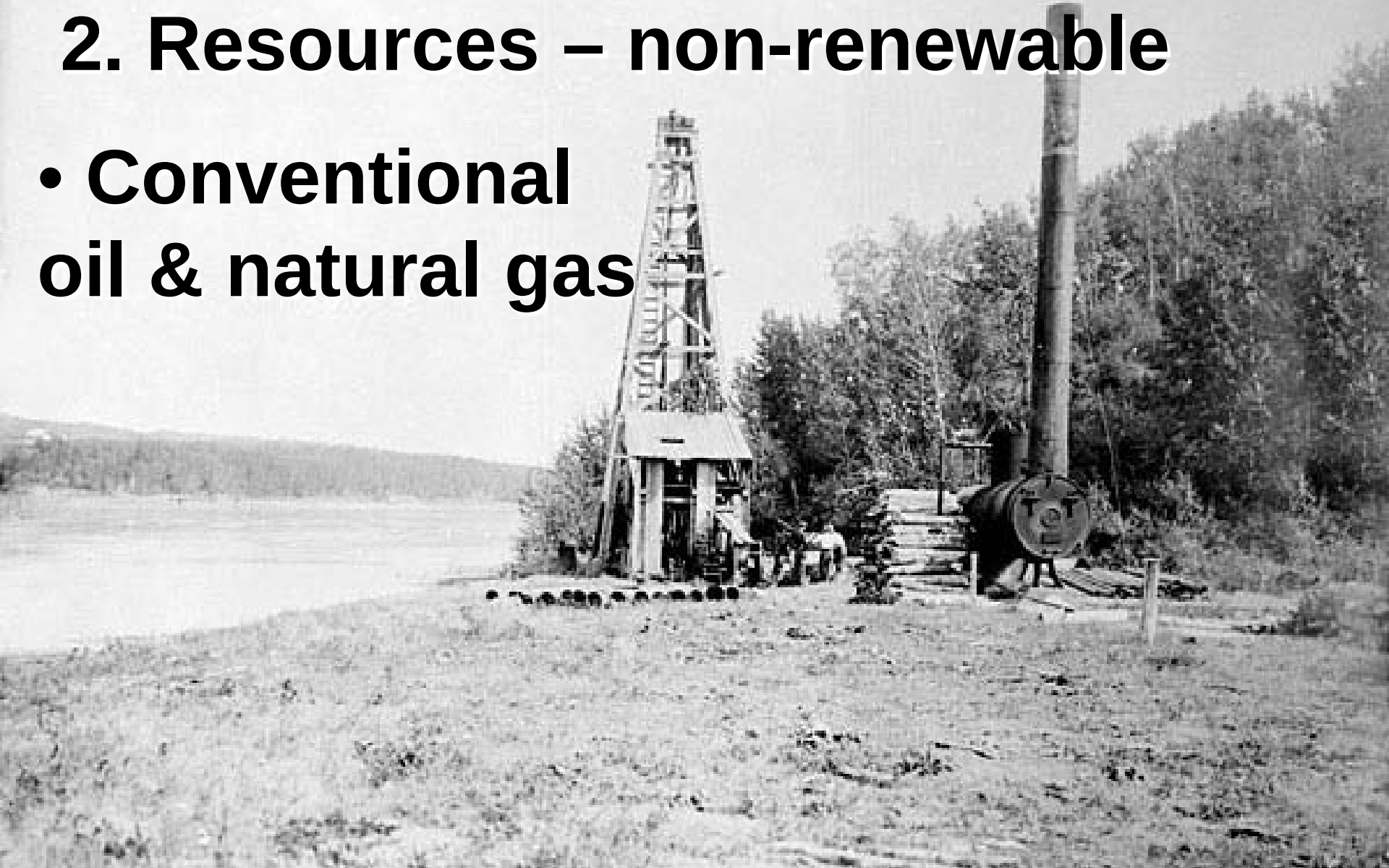
- Large mammals and fish for food
- Hunting and fishing guides
- Tourism



Why is the ARB important?

2. Resources – non-renewable

- Conventional oil & natural gas



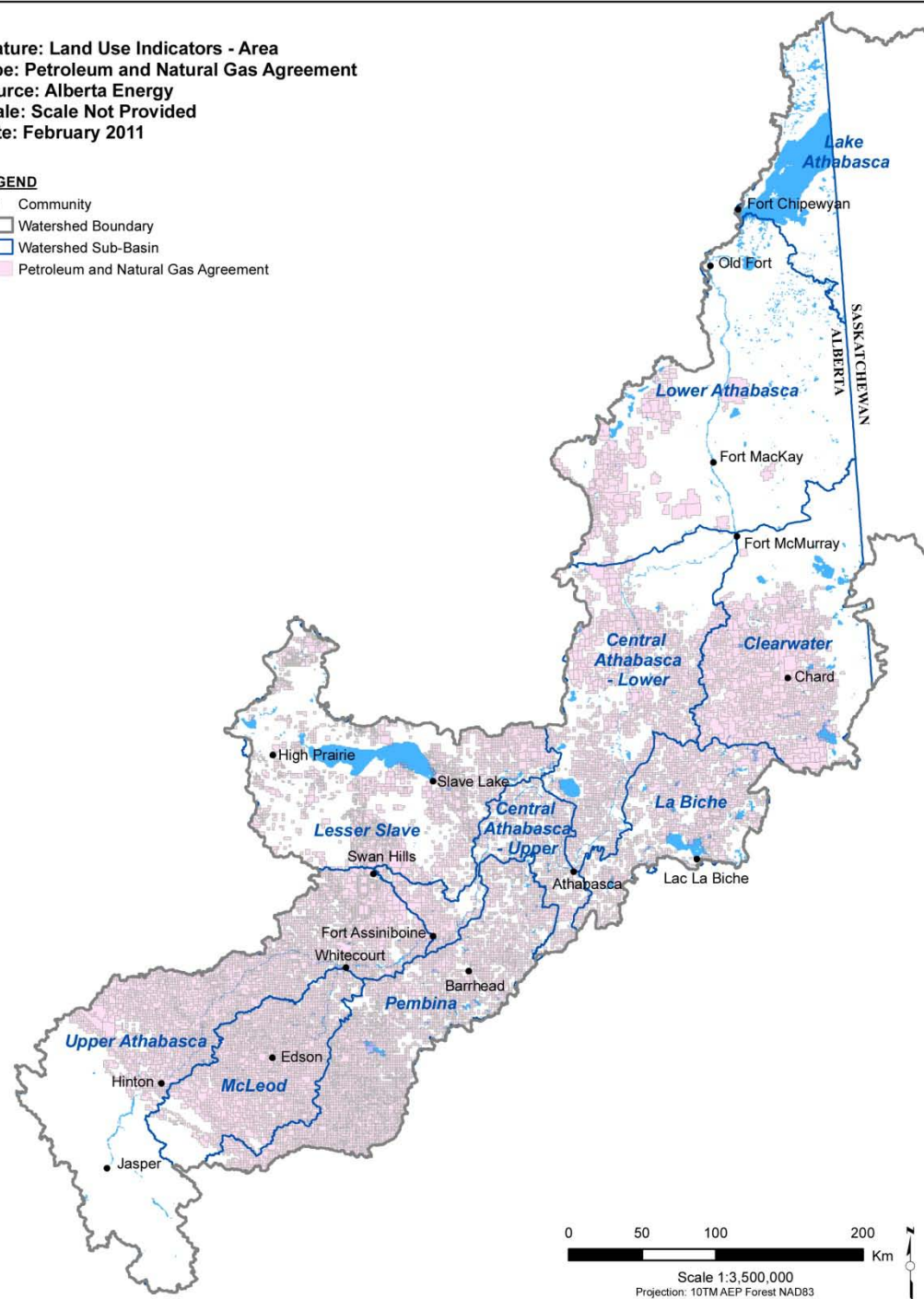
Conventional Oil & Natural Gas Agreements / Leases in the ARB, 2011

Source: Athabasca Watershed Council, State
of the Watershed Report, Phase 1, Appendix
A2: Maps from the Preliminary Atlas, 2011

Feature: Land Use Indicators - Area
Type: Petroleum and Natural Gas Agreement
Source: Alberta Energy
Scale: Scale Not Provided
Date: February 2011

LEGEND

- Community
- ▭ Watershed Boundary
- ▭ Watershed Sub-Basin
- ▭ Petroleum and Natural Gas Agreement



Landscape fragmentation by seismic lines, roads, wells, pipelines and processing plants



Alberta 2003

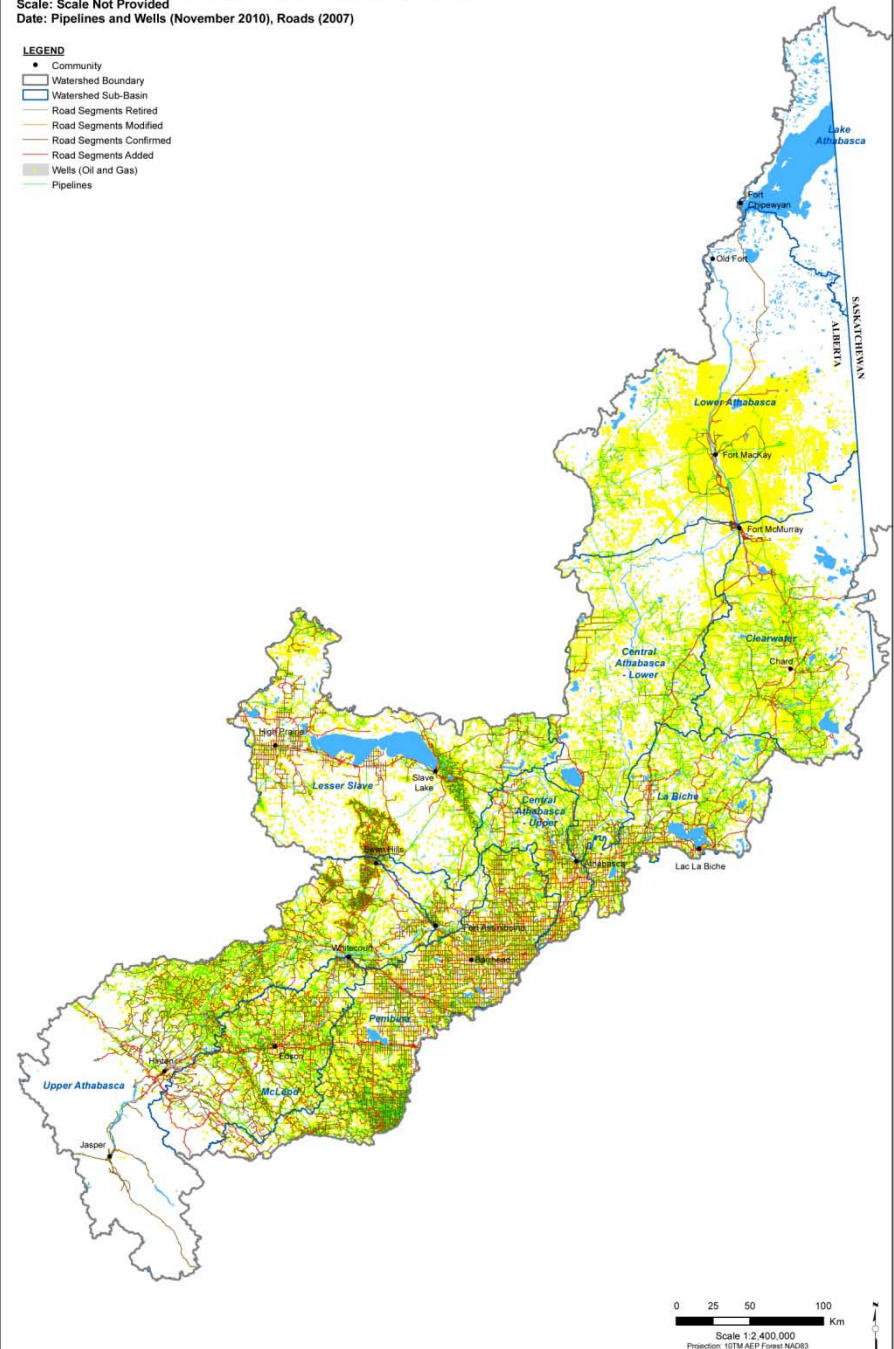
Pipelines, Oil Wells & Roads in the Athabasca River Basin, 2007/2010

Source: Athabasca Watershed Council, State
of the Watershed Report, Phase 1, Appendix
A2: Maps from the Preliminary Atlas, 2011

Feature: Land Use Indices - Linear
Type: Pipelines, Wells, and Roads
Source: Energy Resources Conservation Board and Natural Resources Canada
Scale: Scale Not Provided
Date: Pipelines and Wells (November 2010), Roads (2007)

LEGEND

- Community
- Watershed Boundary
- Watershed Sub-Basin
- Road Segments Retired
- Road Segments Modified
- Road Segments Confirmed
- Road Segments Added
- Wells (Oil and Gas)
- Pipelines



Why is the ARB important?

2. Resources – non-renewable

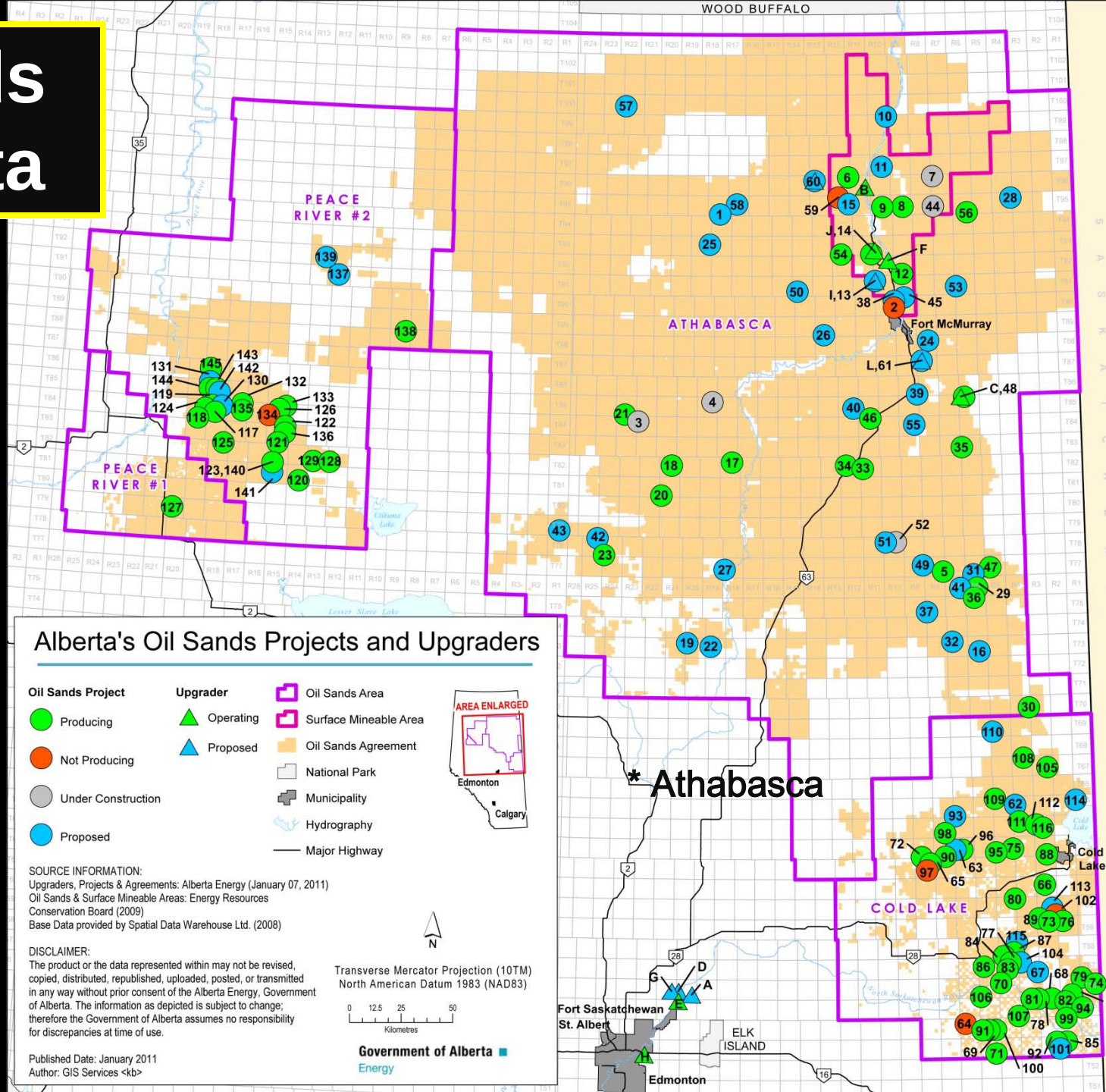
- Oil/tar sands or bitumen



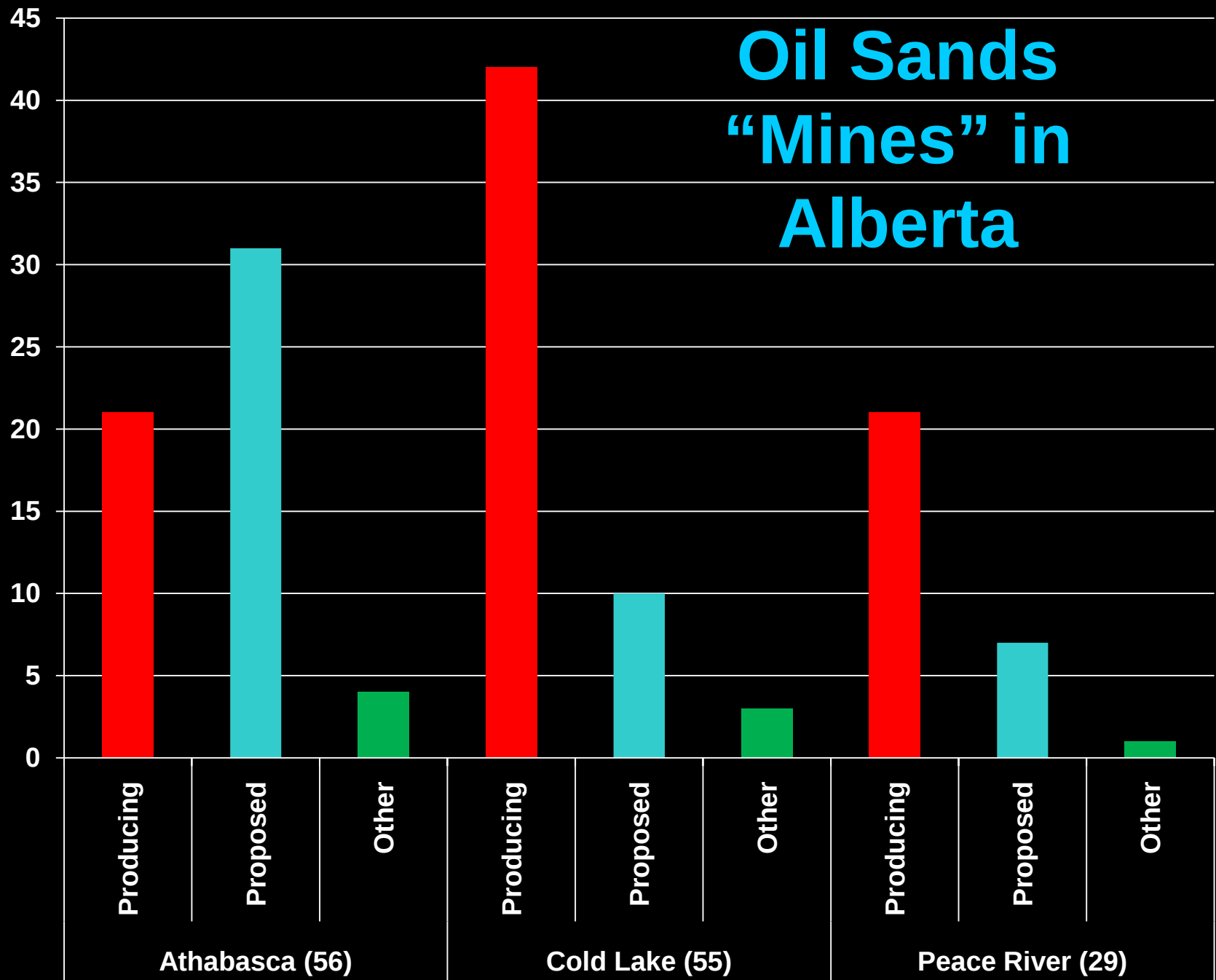
Oil Sands in Alberta



Oil Sands in Alberta



Oil Sands “Mines” in Alberta



Surface / Pit Mining

An aerial photograph showing a vast industrial mining complex. In the foreground, a large, dark, circular open-pit mine is visible, with a red crane positioned on its rim. The surrounding area is filled with extensive conveyor belt systems, large piles of material, and several large, irregularly shaped bodies of water, likely used for processing or storage. The landscape is heavily disturbed by the mining activities, with a mix of dark earth, light-colored material, and green vegetation in the background.

Fort McMurray area, 2004



**Pit mining
restricted
to bitumen
less than
70 m deep**

Fort McMurray area, 2004

Tailings Ponds: 720 million m³ in 130 km²



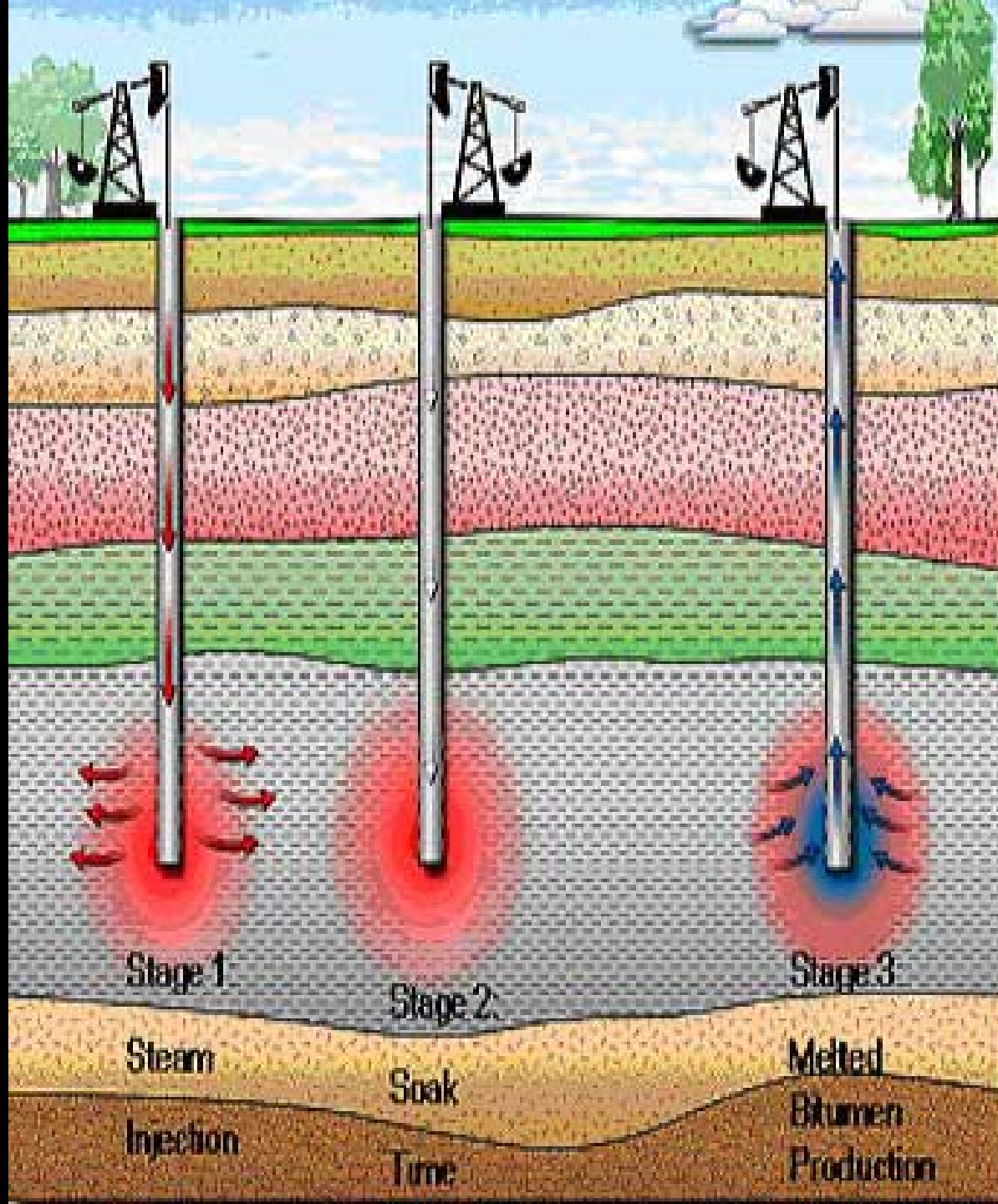
In situ Oil “Mines”

- 15% land disturbance but much fragmentation
- Uses lots of natural gas (13% of Canadian total in 2007, 60% by 2030?)
- Uses considerable amounts of water

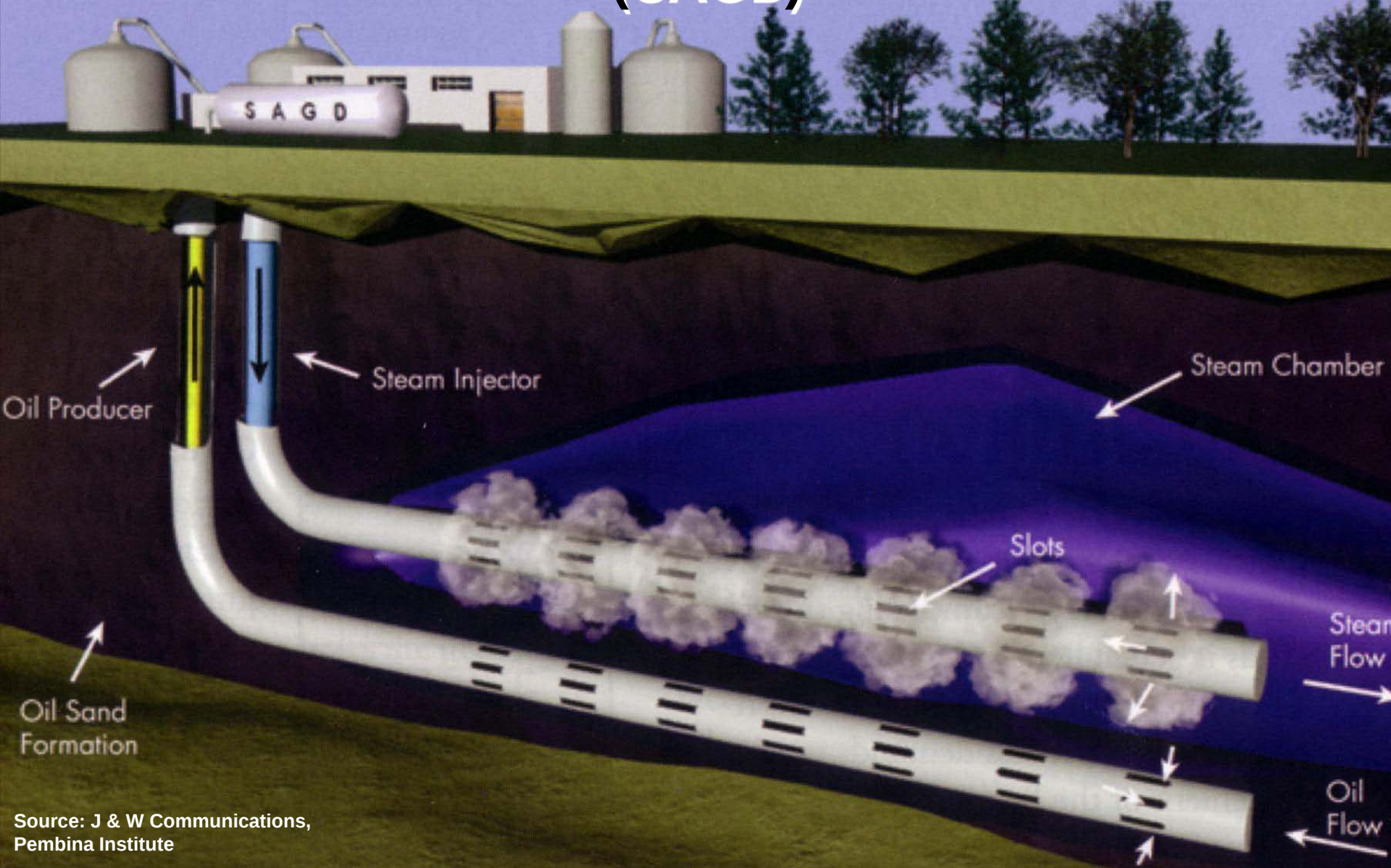
Near Fort McMurray, 2005

***In Situ* Mining: Cyclic Steam Stimulation (CSS) = Primary**

**6-8 month
cycles**

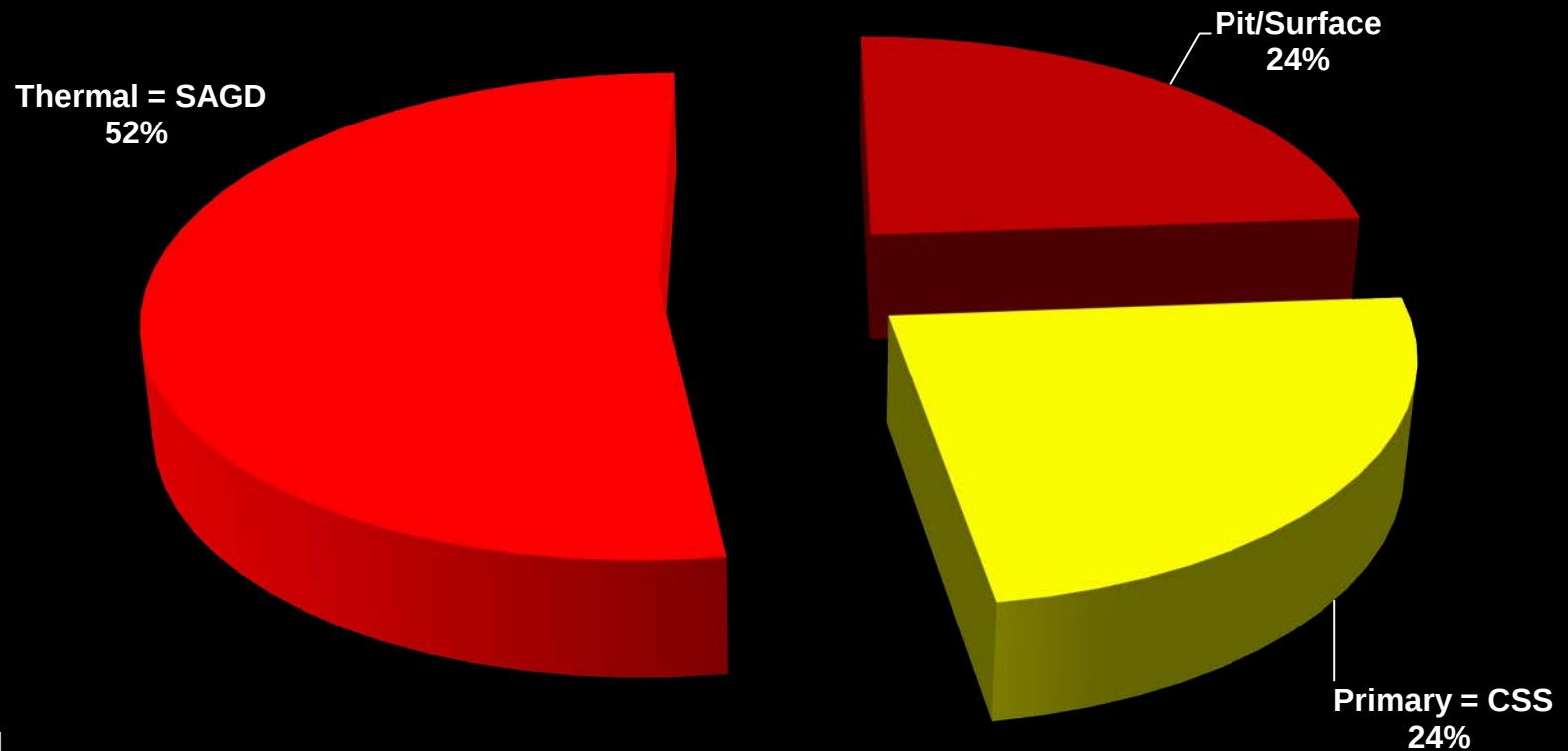


***In Situ* Mining: Steam Assisted Gravity Drainage (SAGD)**



Source: J & W Communications,
Pembina Institute

Types of Oil Sands “Mines” in ARB



n = 21

+ 31 proposed

+ 4 other

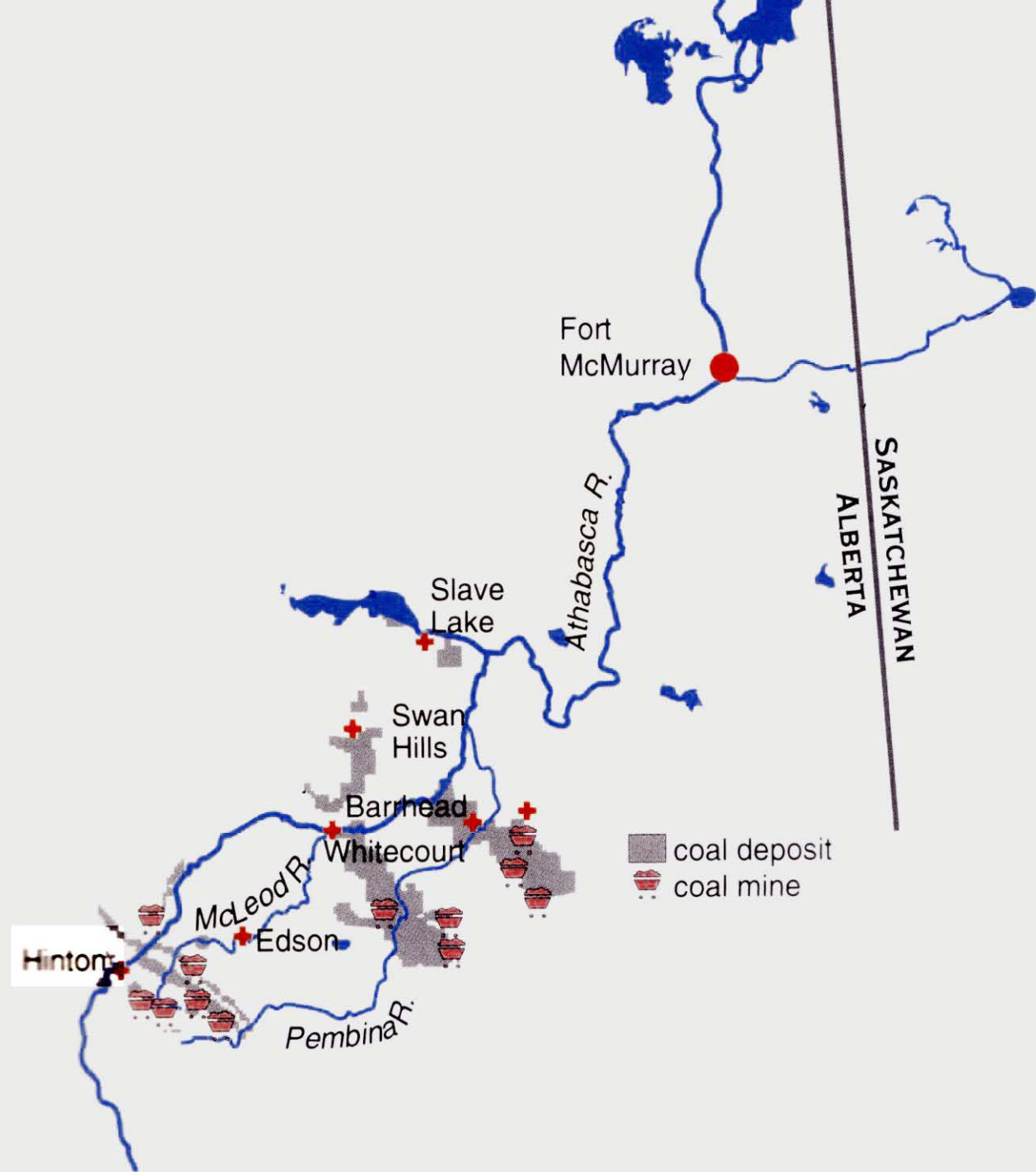
+ 5 experimental

Source: Alberta Energy,
January 2011

Why is the ARB important?

2. Resources – non-renewable

- **Coal**



Source: Northern River Basins Study,
Report to the Ministers, 1996

Why is the ARB important ?

2. Resources – non-renewable

- Peat



Why is the ARB important ?

2. Resources – non-renewable

- Gravel, limestone and other minerals



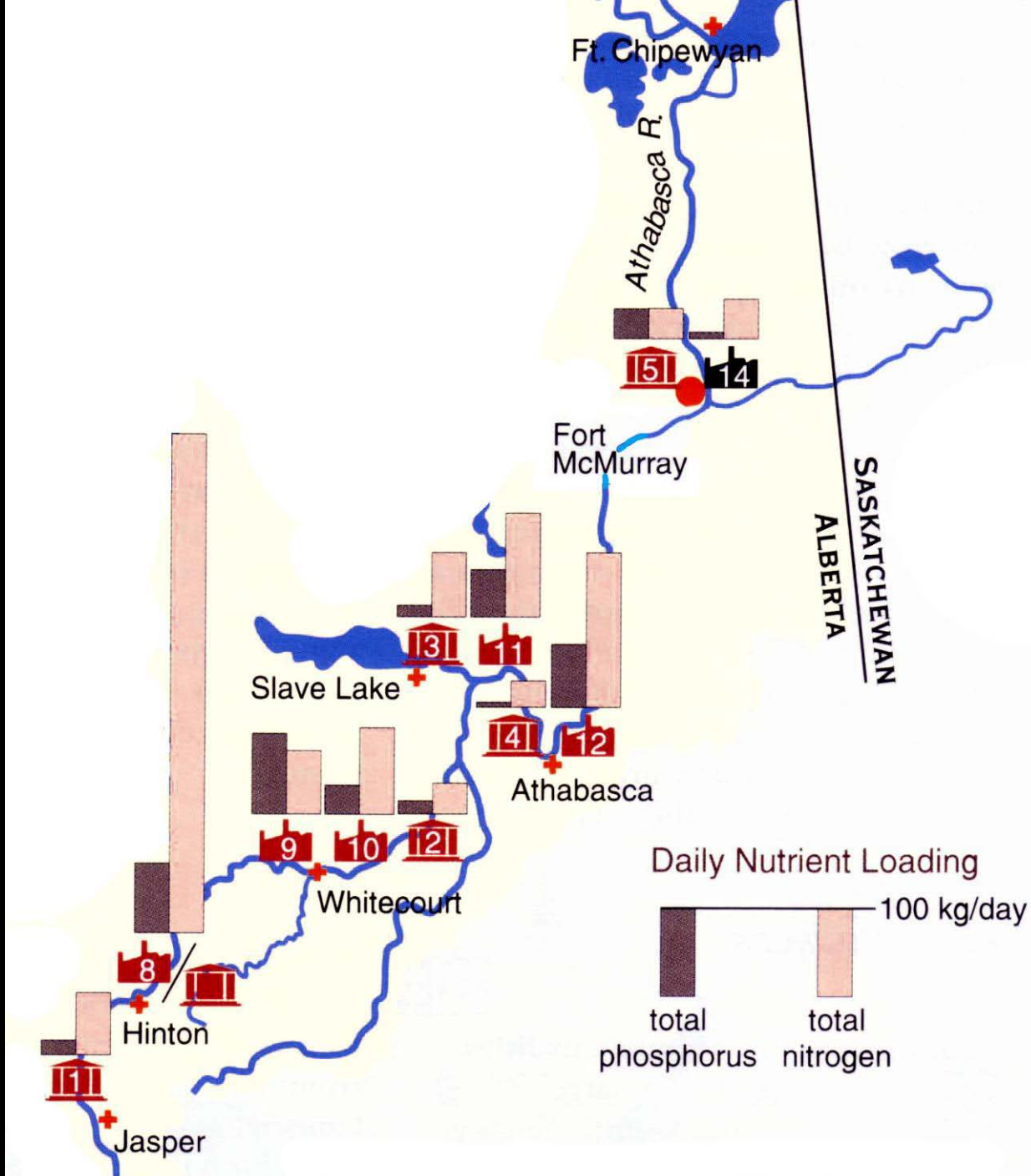
Why is the ARB important?

3. Environmental Problems

- Water quality, especially toxic chemicals and disease-causing organisms
 - natural e.g. mercury, polycyclic aromatic hydrocarbons (PAHs), cyanobacterial toxins
 - industrial wastes e.g. chlorinated organics
 - erosion from logging
 - agricultural run-off and wastes
 - municipal wastes



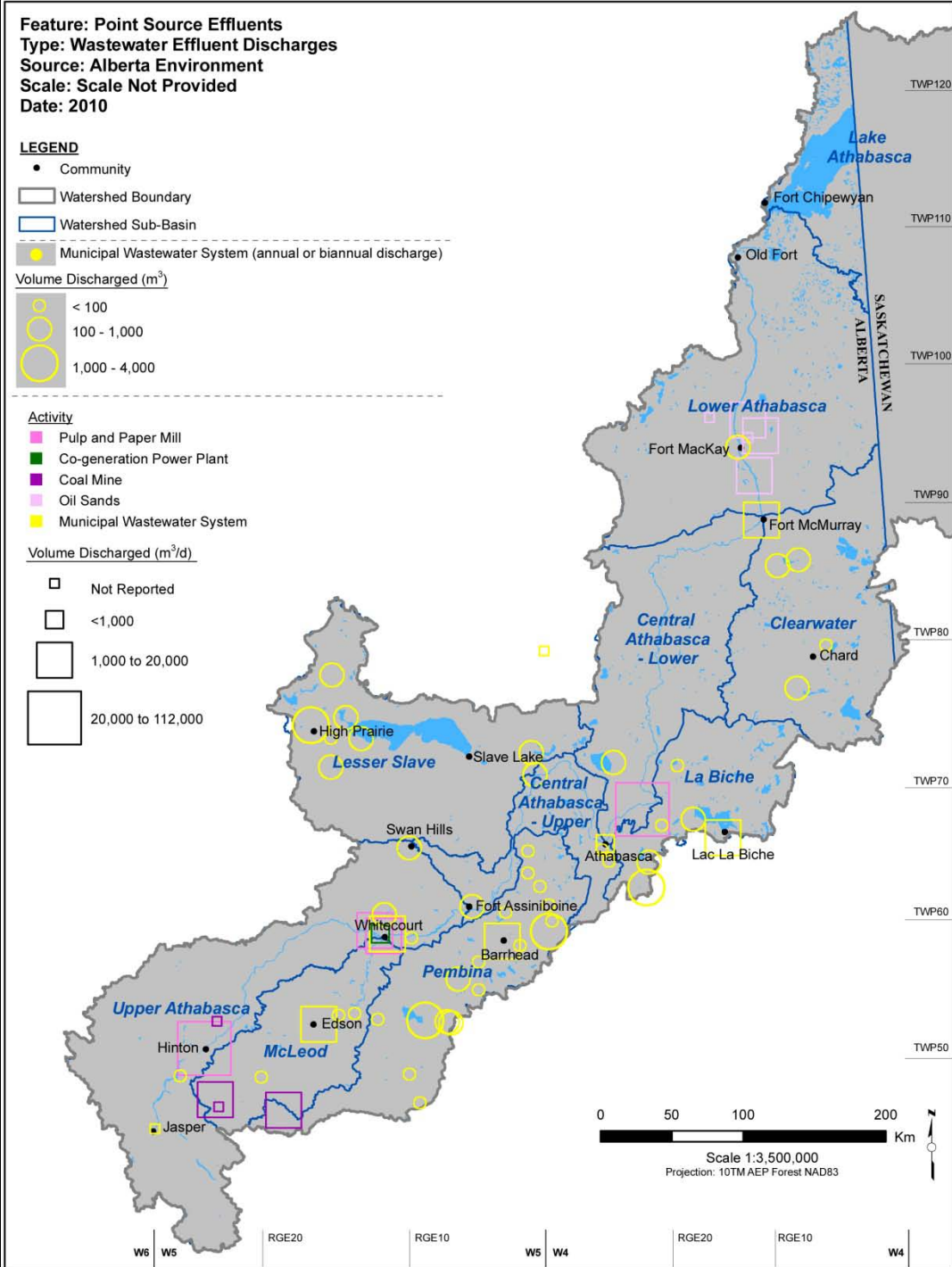
Point Sources of Nutrient Inputs in the Athabasca River Basin, <1996



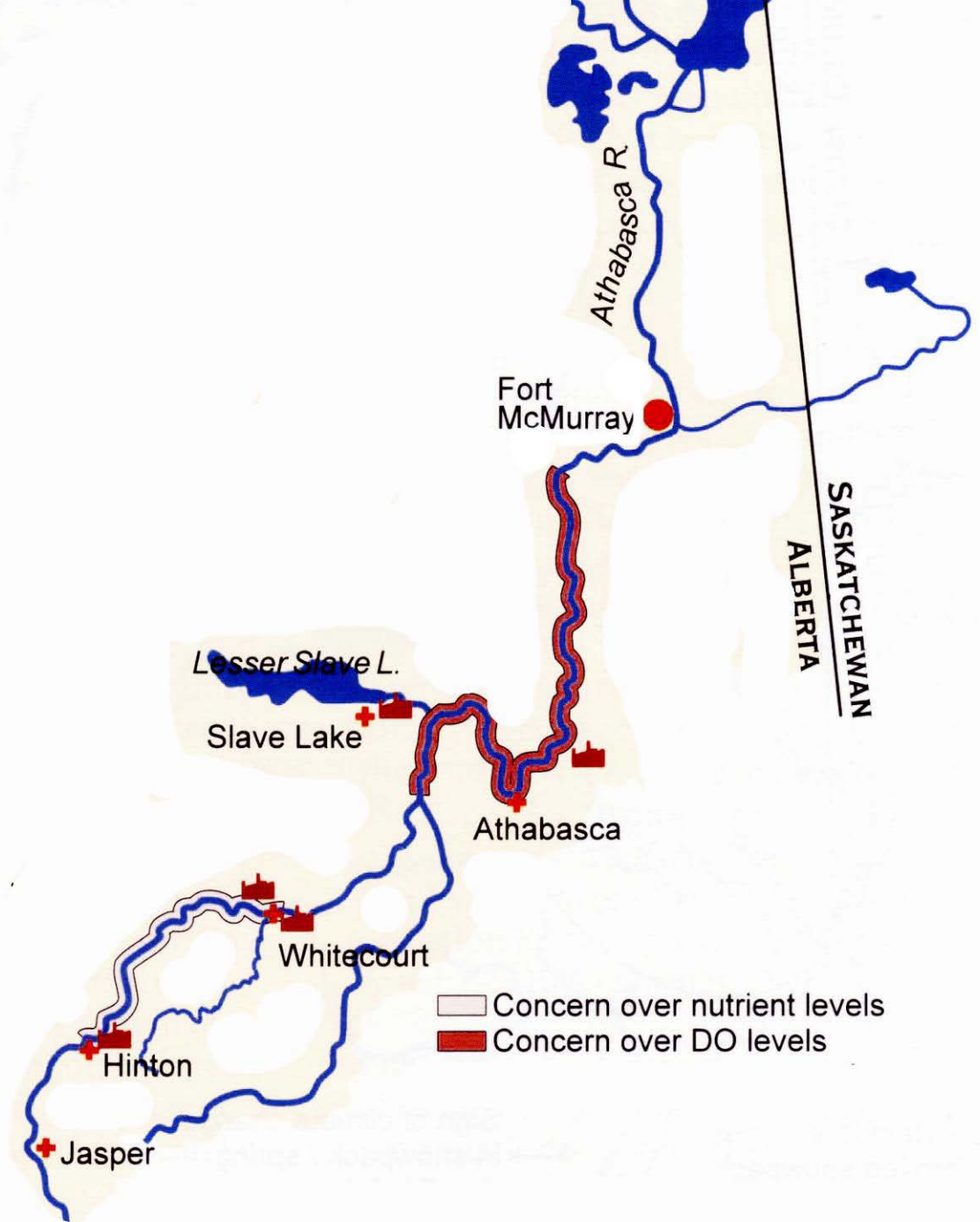
Source: Northern River Basins Study,
Report to the Ministers, 1996

Point Sources of Wastewater Effluents in the Athabasca River Basin, 2010

Source: Athabasca Watershed Council, State of the Watershed Report, Phase 1, Appendix A2: Maps from the Preliminary Atlas, 2011



Nutrient and Oxygen Concerns in the Athabasca River Basin



Source: Northern River Basins Study,
Report to the Ministers, 1996

Why is the ARB important?

4. Political

- Treaty 8 used Athabasca River as a boundary
- Export of rural resources to urban areas
- Distribution of government taxes and benefits



Why is the ARB important?

5. Intellectual Interest

- Archeology and pre-history
- History: early explorers, fur trade transportation
- Biology: many unknown or poorly understood organisms
- Geography: Athabasca flowed south via the Tawatinaw Valley



Legislative Protection: Federal

- **Fisheries Act**
- **Navigable Waters Act**
- **Environment Assessment Act**
- **Environmental Protection Act**



Legislative Protection: Provincial

- **Water Act**
- **Public Lands Act**
- **Wildlife Act**
- **Forests Act**
- **Wilderness Areas Act**
- **Wilderness Areas, Ecological Reserves and Natural Areas Act**
- **Oil Sands Conservation Act**



Legislative Protection

- **Regulations & reporting (= monitoring)**
- **Enforcement**



Conservation within ARB

CDN parks (Jasper & Wood Buffalo)	2
AB wildland parks	17
AB + SK (2,240 km²) parks	11 + 1
AB wilderness park (part of Willmore)	1
AB ecological reserves	6
AB natural areas	29
AB bird sanctuaries & wildlife area	4

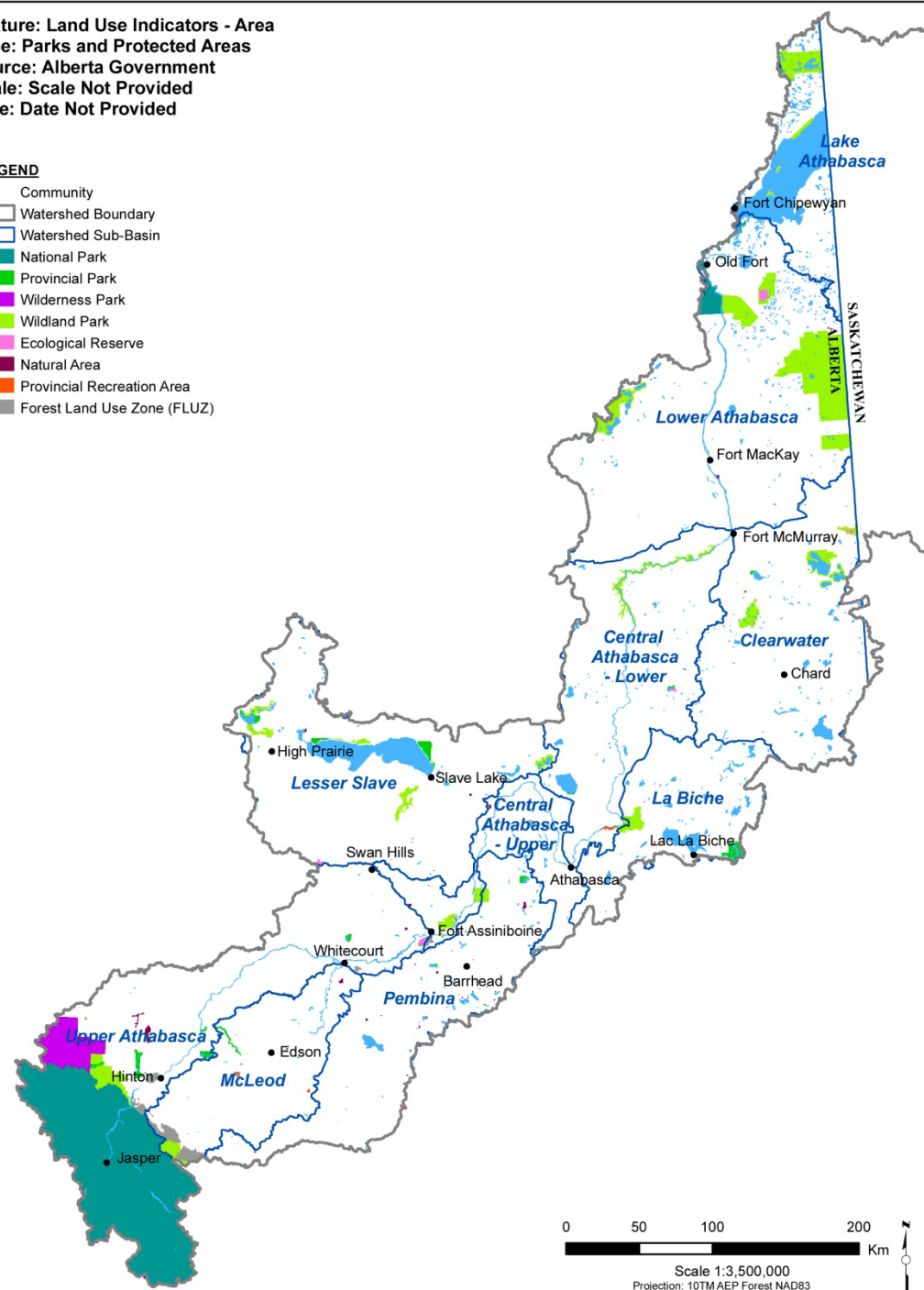
Parks & Protected Areas in the Athabasca River Basin

Source: Athabasca Watershed Council, State of the Watershed Report, Phase 1, Appendix A2: Maps from the Preliminary Atlas, 2011

Feature: Land Use Indicators - Area
Type: Parks and Protected Areas
Source: Alberta Government
Scale: Scale Not Provided
Date: Date Not Provided

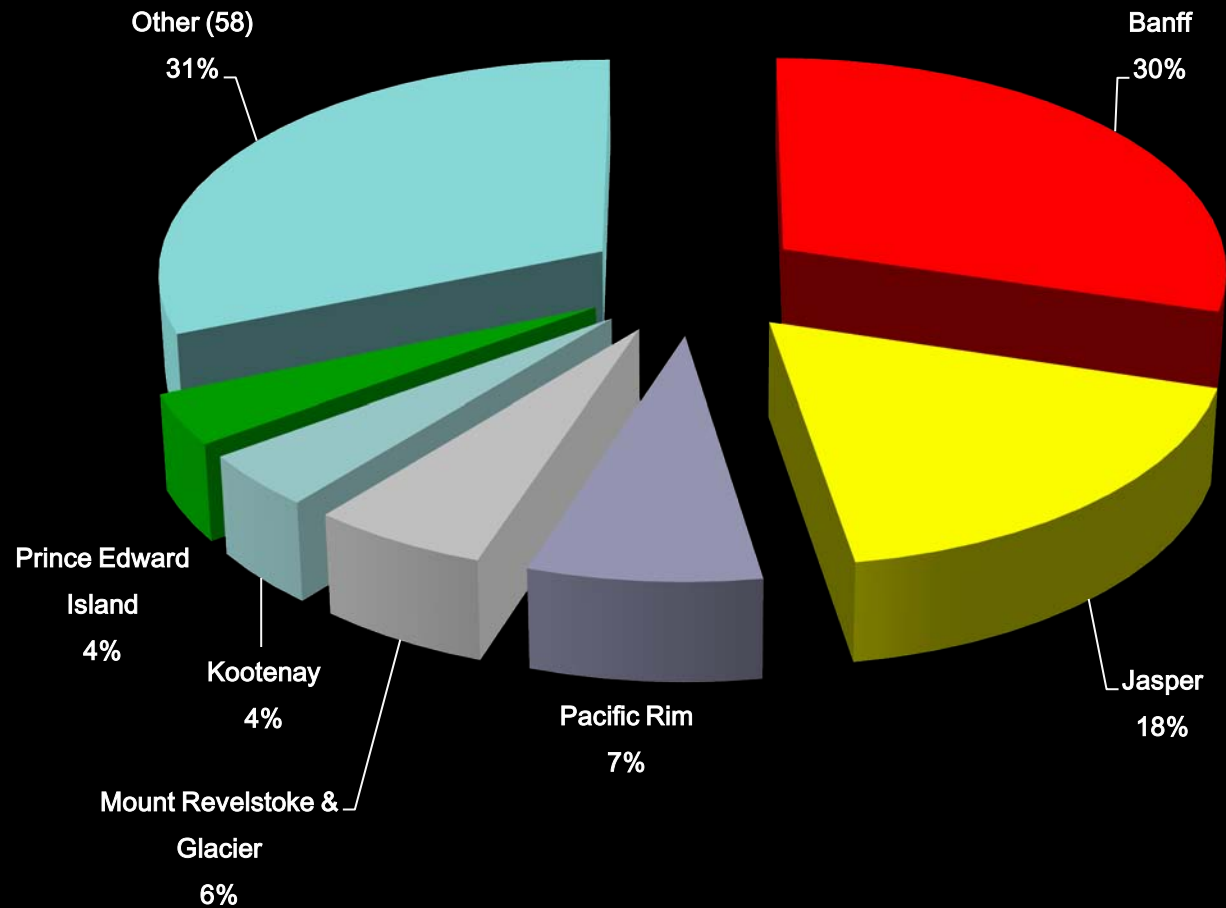
LEGEND

- Community
- Watershed Boundary
- Watershed Sub-Basin
- National Park
- Provincial Park
- Wilderness Park
- Wildland Park
- Ecological Reserve
- Natural Area
- Provincial Recreation Area
- Forest Land Use Zone (FLUZ)



Visitors to 64 Canadian National Parks

Jasper:
• 2nd most
visited
federal park
• 1,868,797
visitors in
2009-2010

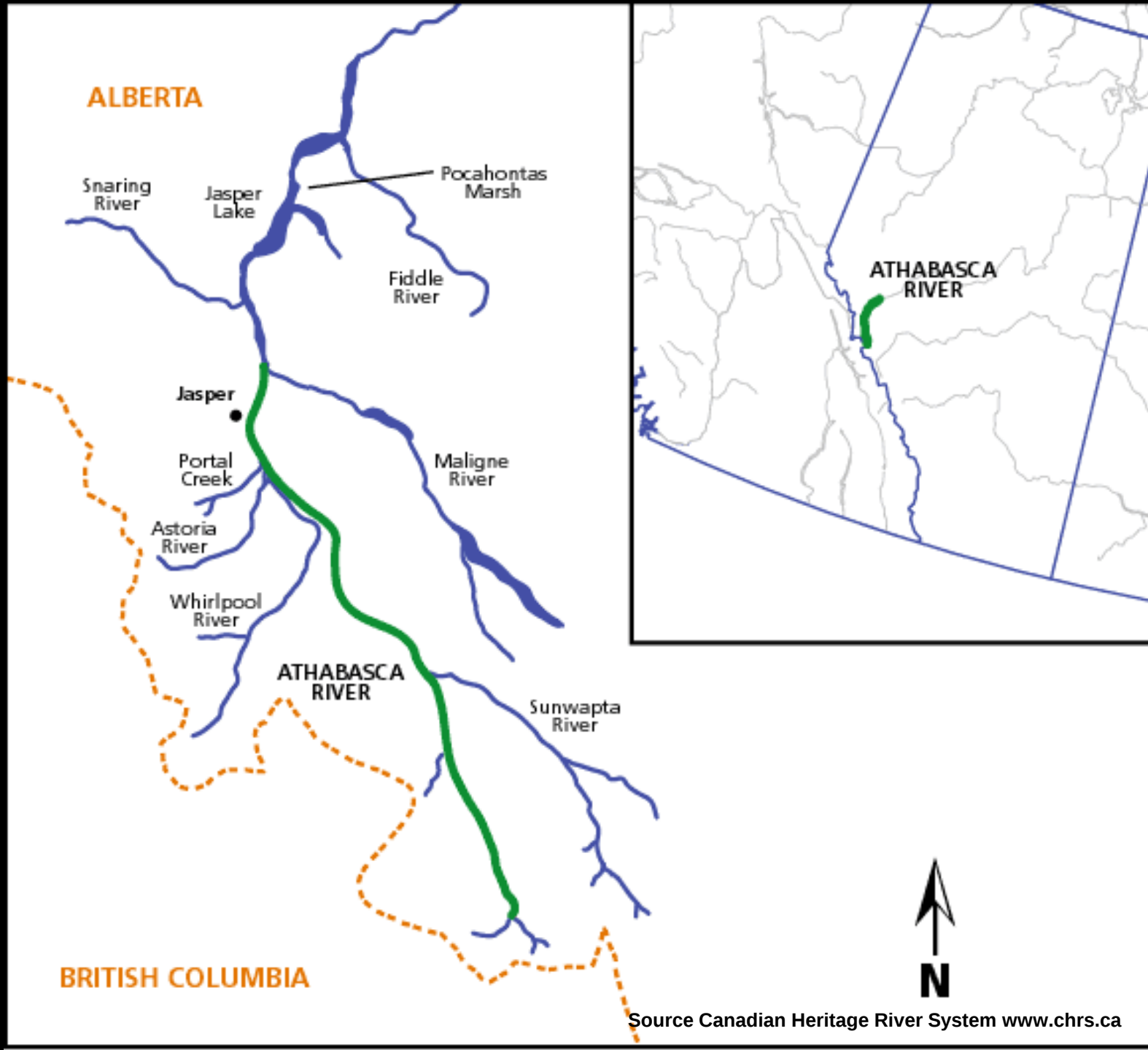


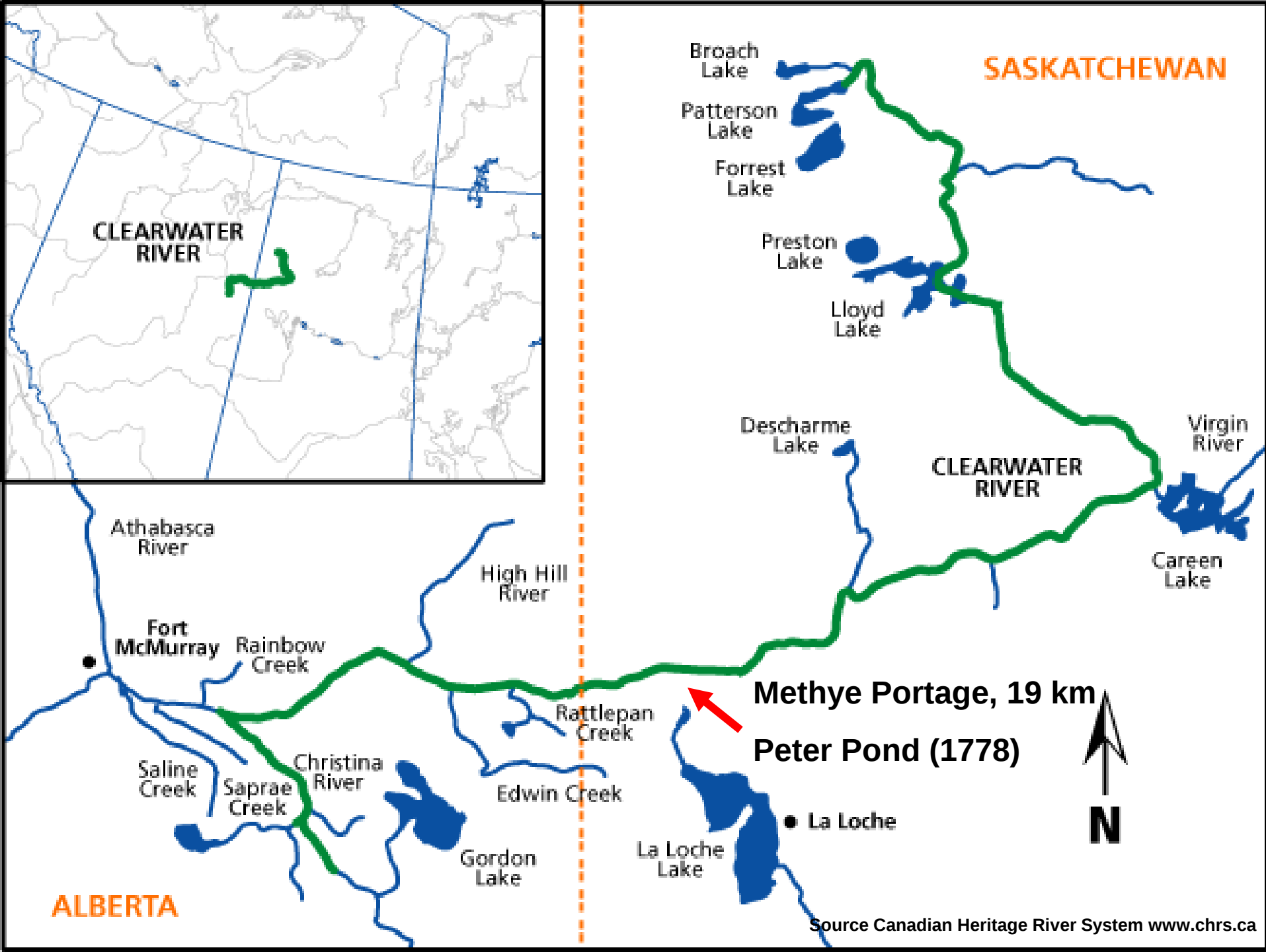
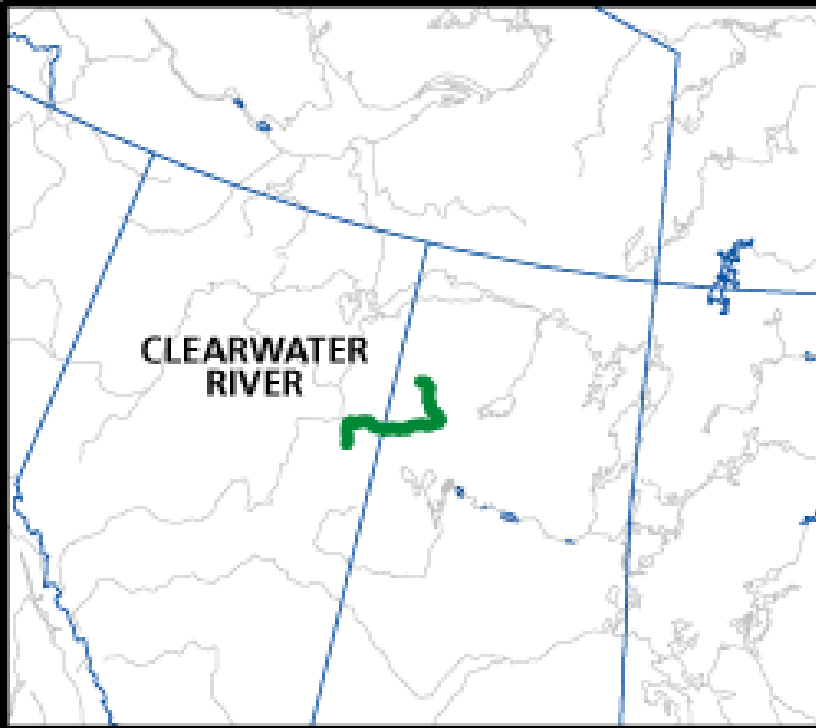
Athabasca River: a Canadian Heritage River

- nominated for natural features, historical significance & river recreation
- Jasper National Park (1989)
- Clearwater in Saskatchewan (1987) and Alberta (2004)



Heritage Rivers of Canada





Basic Concerns of Everyone

Can I drink the water?



Can I eat the fish?



Can I swim in the water?



Concerns - General

- Water supply: too much / too little & timing
- Seasonal vs. year-to-year
- Flooding (rainfall, snowpack and snowmelt, ice jams) , e.g. Pembina River sub-basin, Fort McMurray
- Drought
- Transport of suspended and dissolved materials
- Habitat maintenance

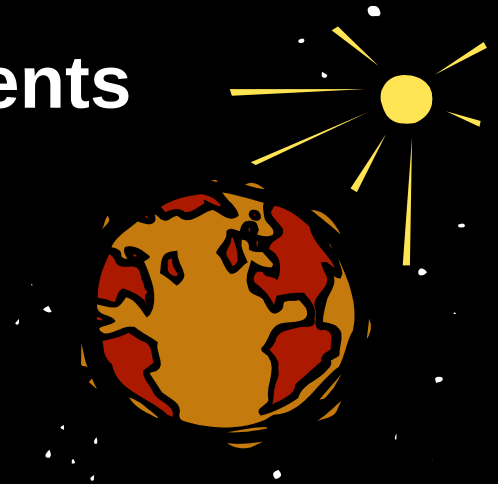
Concerns - General (continued)

- Over-exploitation of resources
 - renewable → non-renewable
 - non-renewable → exhausted too quickly



Concerns - General (continued)

- **Global warming → less water for:**
 - native and agricultural plant growth
 - water for municipalities and industries
 - dilution → increased concentrations of toxins
 - flooding of habitats with nutrients



Concerns – Specific Groups

- **Industry (pulp, oil)**
 - sufficient water for processes via licenses, tradable rights and performance standards
 - storage of water
 - water quality and water treatment (pre- / post-)
 - enough water for effluent dilution
 - spills
 - aquatic organisms

Millar Western Pulp,
Whitecourt, 2007

Concerns – Specific Groups

- **Forestry**
 - tree growth
 - drought
 - fire
 - tree-feeding insects
 - tree diseases
 - tree biodiversity



Concerns – Specific Groups

- Agriculture
 - precipitation for plant growth
 - water for livestock
 - nutrient run-off
 - crop and livestock diseases
 - insect pests / pollinators

Near Baptiste Lake, 2007

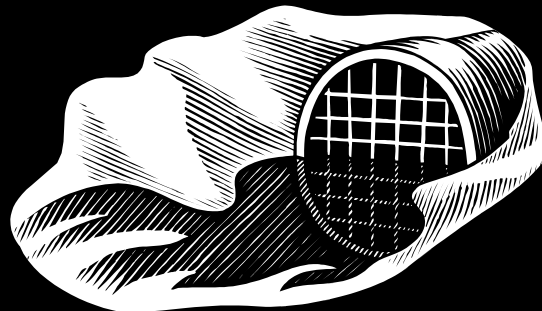
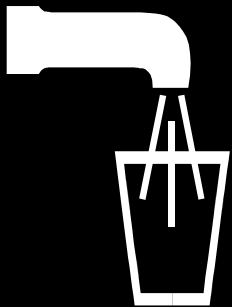
Concerns – Specific Groups

- Fisheries
 - water quantity and timing
 - water quality / toxicity
 - habitats
 - catch limits
 - exotics



Concerns – Specific Groups

- **Municipalities**
 - potable water
 - sewage treatment
 - flooding



An aerial photograph of a vast, green forested landscape. A river winds through the center of the image, surrounded by dense trees. Several small, irregularly shaped ponds are scattered throughout the forest, reflecting the sky. The terrain appears to be a mix of forest and open land, possibly a wetland or a managed forest area. The overall color palette is dominated by various shades of green, with some brown and tan areas indicating cleared land or different types of vegetation.

Concerns – Specific Groups

- **Conservationists**
 - **Water (in-stream flow needs) and land for organisms and their habitats**
 - **Toxins**
 - **Biological diversity**
 - **Habitat fragmentation**
 - **River morphology via wide variation of water flow**

Concerns – Specific Groups

- Tourism
 - water and land recreation
 - range of accessibilities (easy to difficult)



What is happening at the provincial level:

- **WPACs = Water Planning Advisory Councils for each Alberta river → state of the river reports → recommendations to government**
 - **Lesser Slave Watershed Council**
 - **Athabasca Watershed Council**



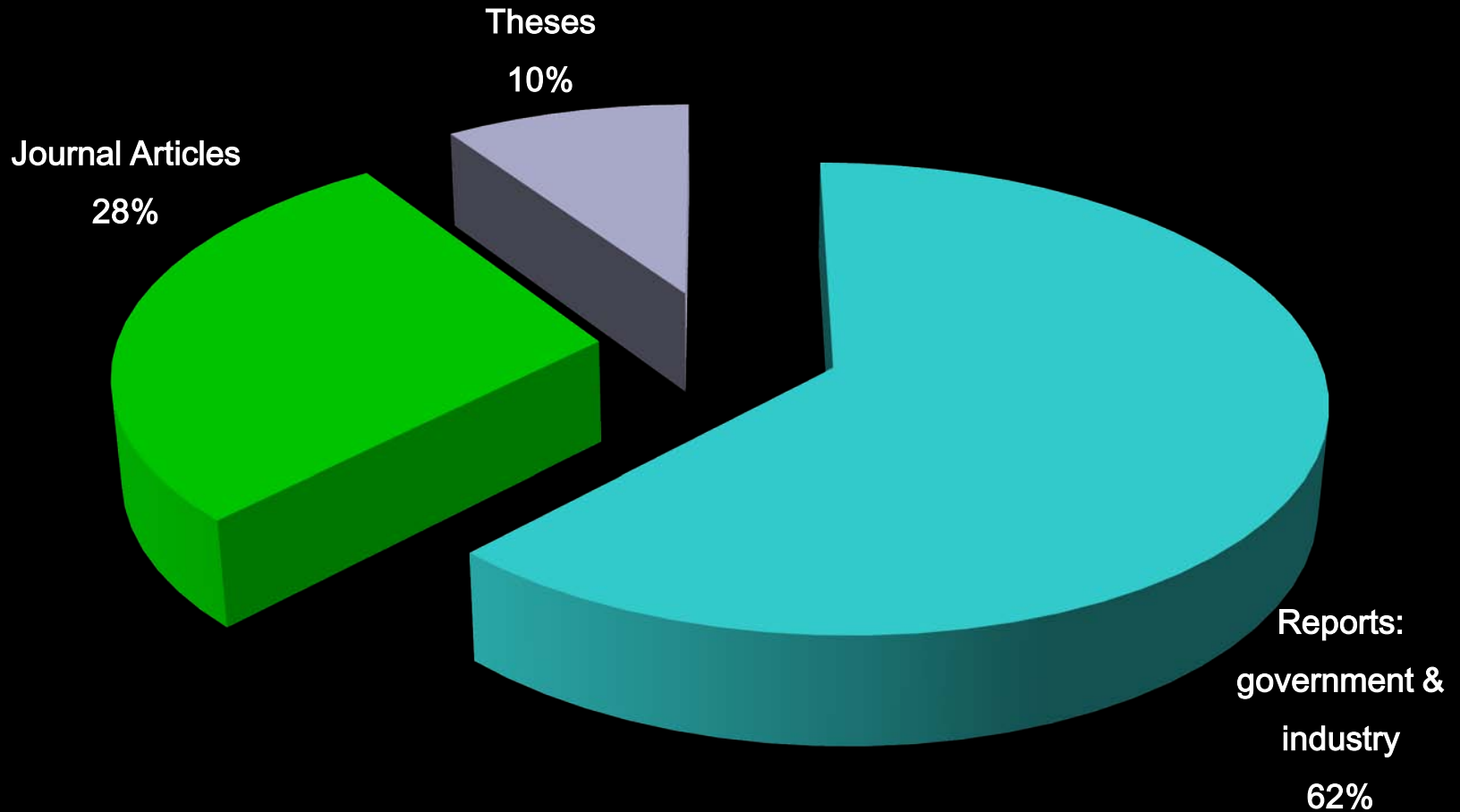
What is happening at Athabasca University:

- **BARB = Bibliography of the Athabasca River Basin***
- **BARB → free, on-line, searchable database**
- **Comprehensive:**
 - **>25,000 science references**
 - **+history, economics, sociology, etc. references**



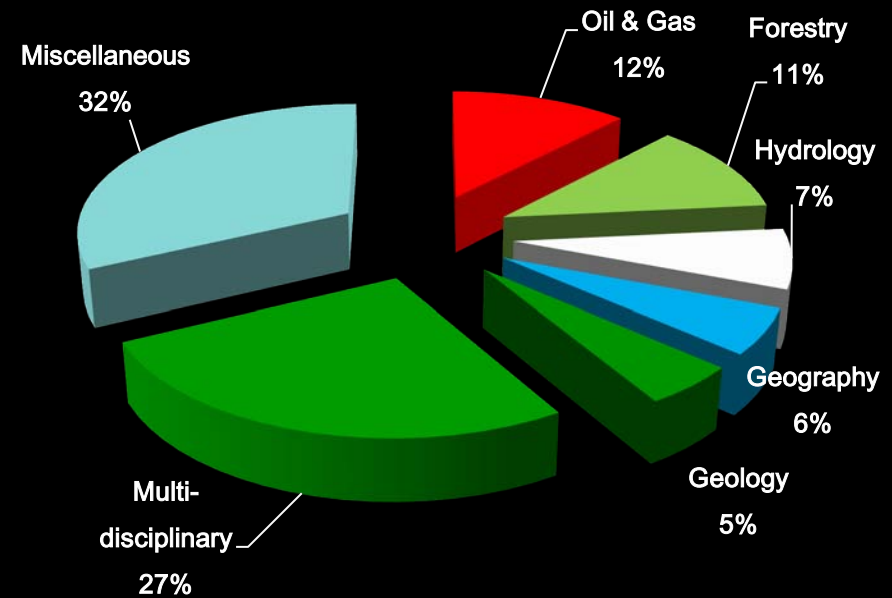
* Project of Athabasca River Basin Research Institute (ARBRI), Athabasca University Library, Science Outreach – Athabasca, AU faculty & staff

Science Publications Related to the ARB

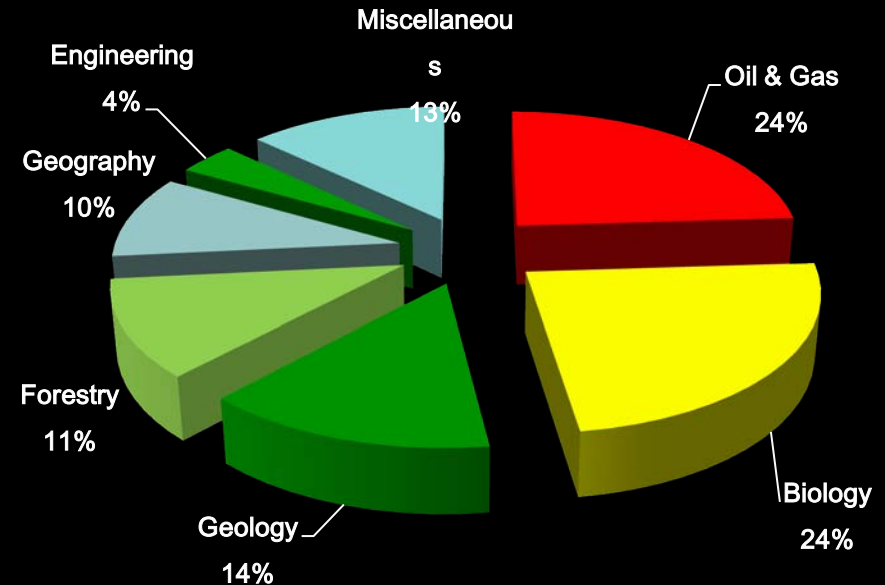
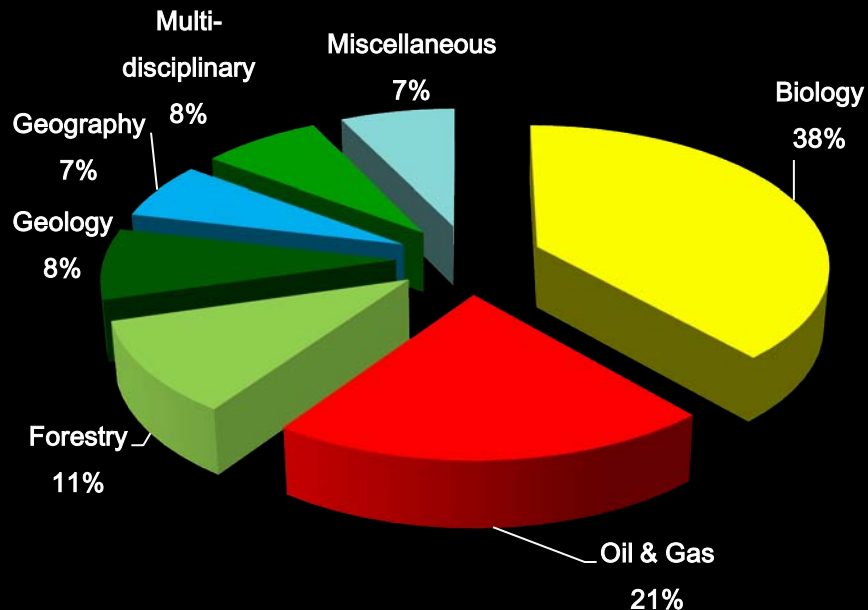


Data: Science Outreach – Athabasca, as of 31 August 2010, n = 25,530

Subject Matter of Science Publications



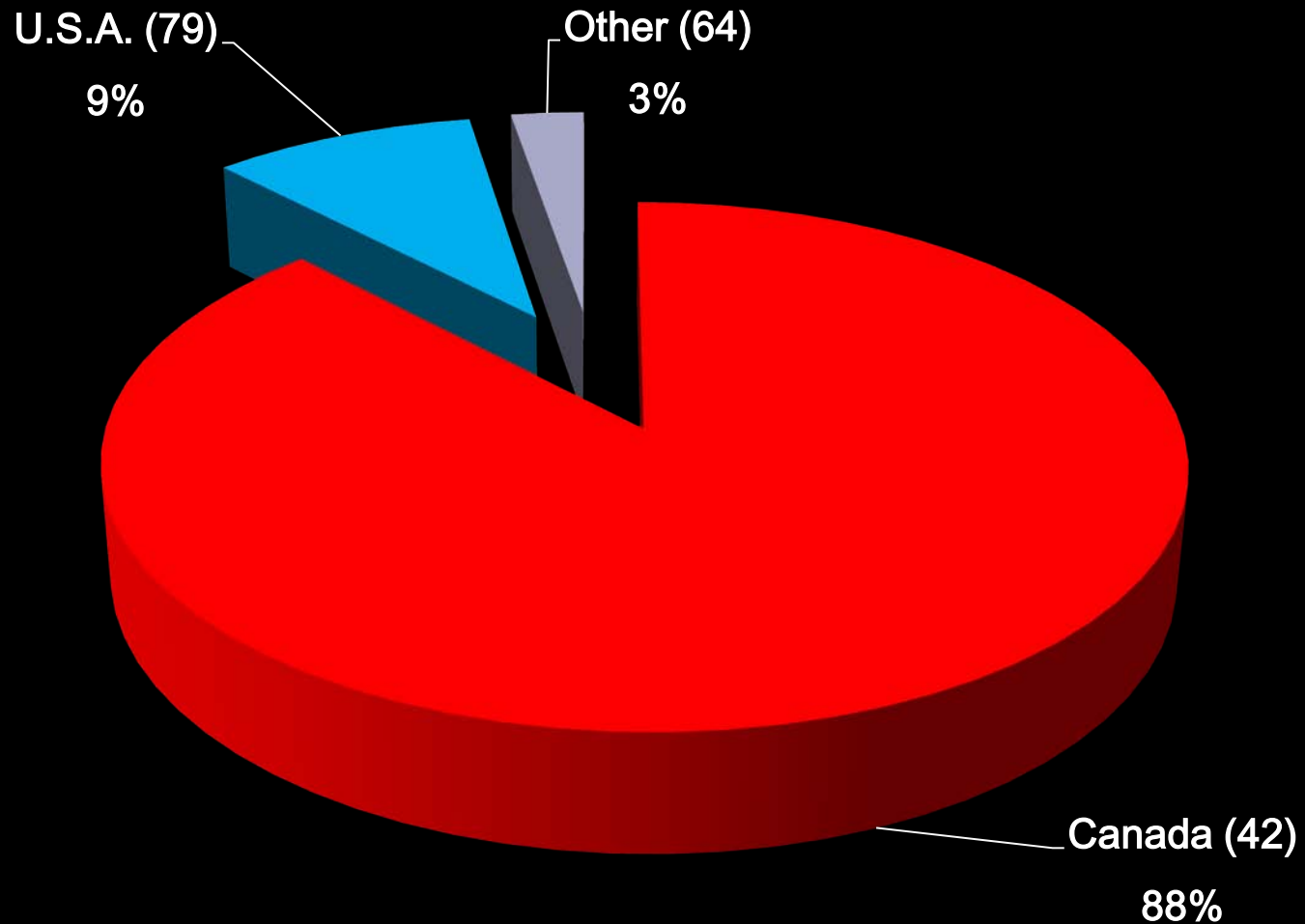
1. Reports: government & industry



2. Journal articles

3. Theses

Home Universities (n = 185) of ARB Theses



Of 2,123 Canadian theses, 57% = U of A, 12% = U of C

N = 2,417

Our hopes for BARB over next 5 years:

- **BARB with >50,000 references**
 - ~20% fully-searchable texts (URLs, electronic periodicals, pdf files)
- **AU Library with 3rd best collection of ARB materials**



My Hopes for the ARB

1. Integrated planning for accumulated impacts (e.g. interactions of pulp mill effluents with oil sand PAHs)
2. Monitoring – arms-length, long term and public access
3. Remediation money held in trust (i.e. outside of resource companies and loop holes closed)



My Hopes for the ARB

4. Research – primarily funded by resource consumers and effluent producers
5. Informed public – interested and active in their river basin
6. AU Library = central depository for all published materials related to the ARB



Questions?

