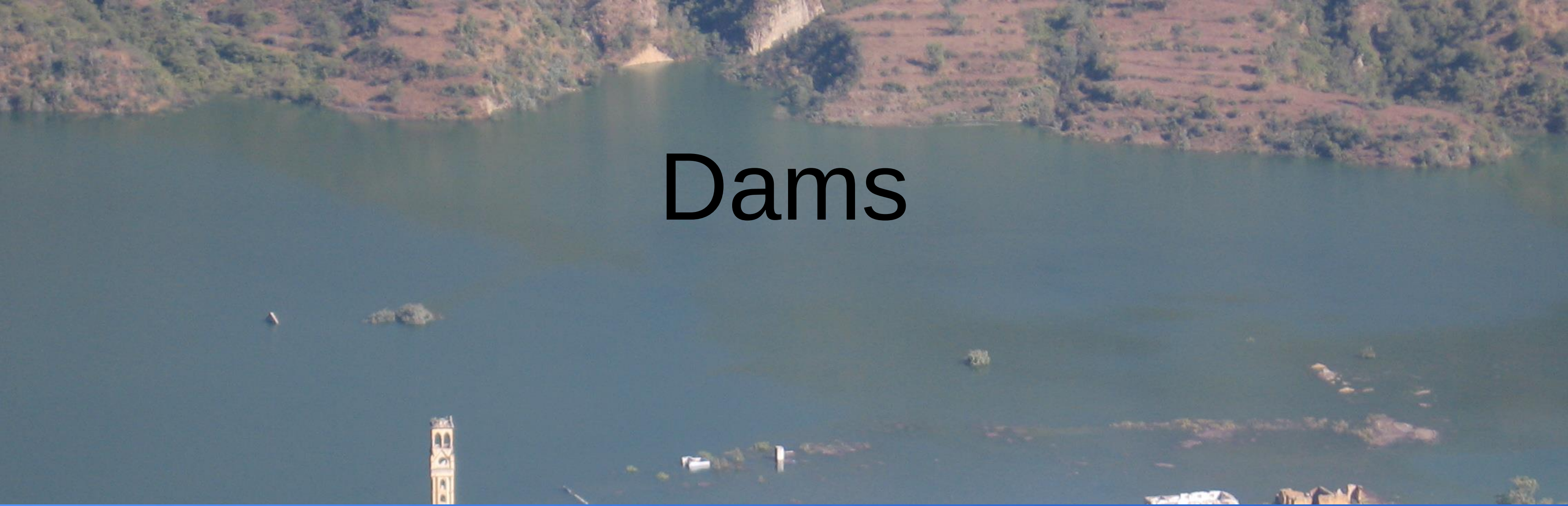
Dams



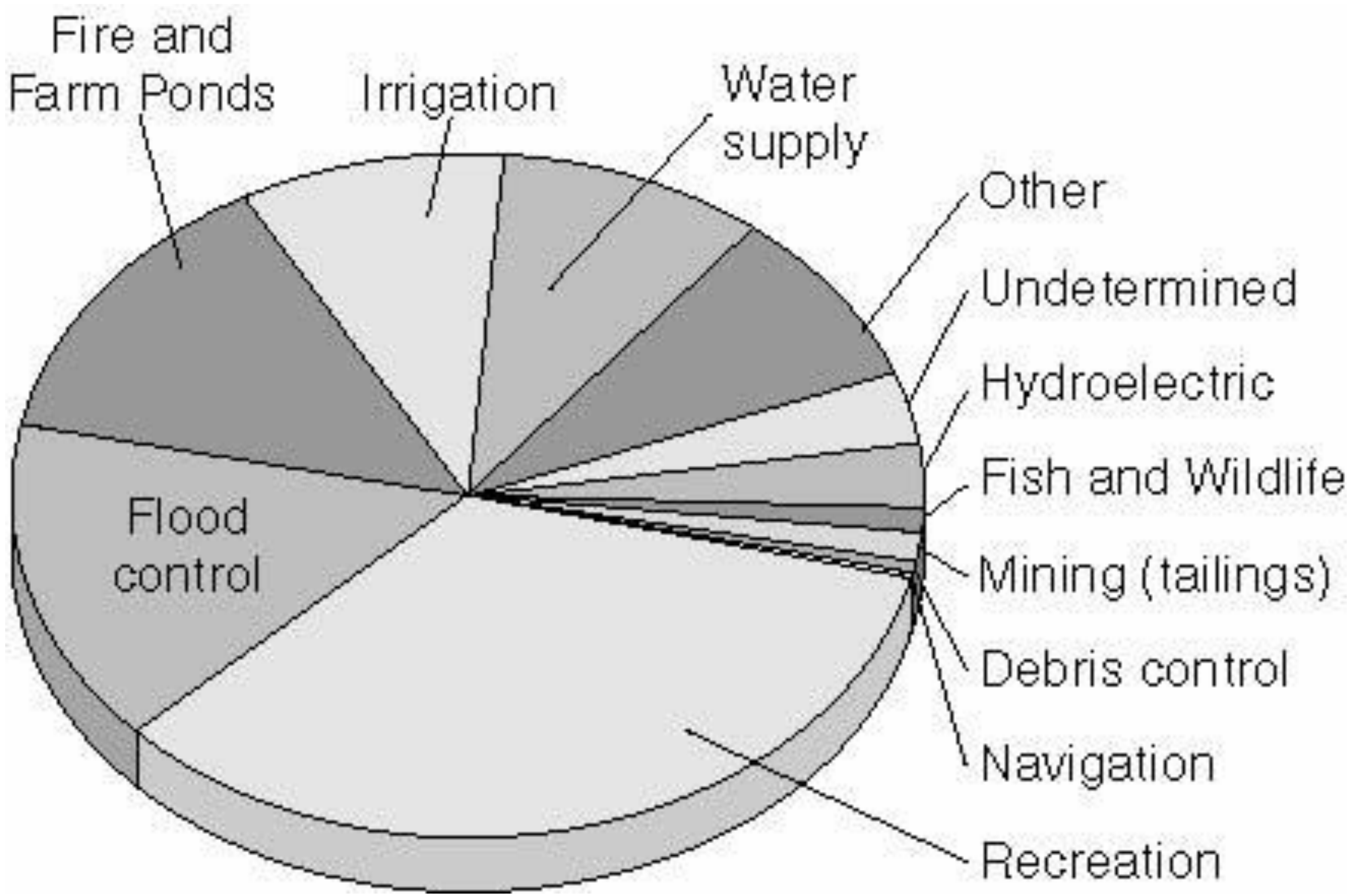
Dams: costs/benefits

Positive

- economic growth
- food production
- surface water enhancement
- recreation enhancement

Negative

- loss of wildlife habitat
- destruction of river corridors
- displaced peoples
- methyl mercury

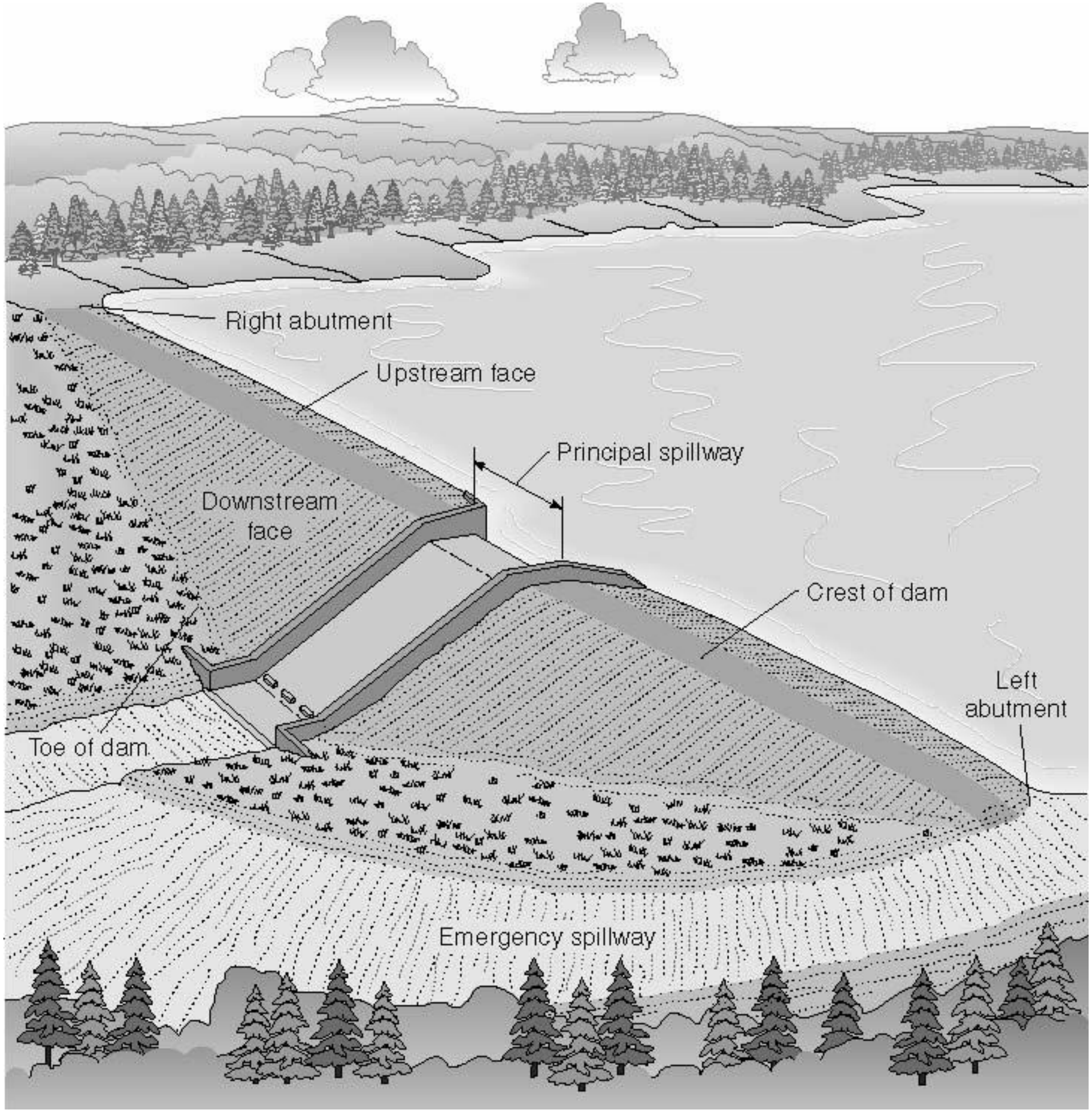

Fire and
Farm Ponds
Irrigation
Water
supply
Other
Undetermined
Hydroelectric
Fish and Wildlife
Mining (tailings)
Debris control
Navigation
Recreation
Flood
control

Primary Purposes of Dams in the United States, 2001

Primary Purpose	% of Total	Number of Dams
Recreation	33.8	26,152
Flood control	15.6	12,088
Fire and farm ponds	13.7	10,589
Irrigation	9.5	7,392
Water supply	9.4	7,297
Other	8.1	6,279
Undetermined	3.5	2,647
Hydroelectric	2.9	2,280
Fish and wildlife	1.4	1,046
Mining (tailings)	1.3	991
Debris control	0.5	396
Navigation	0.3	250
Total	100%	77,407

Source: U.S. National Inventory of Dams, U.S. Army Corps of Engineers, January 2001.

PRINCIPAL PARTS OF A DAM



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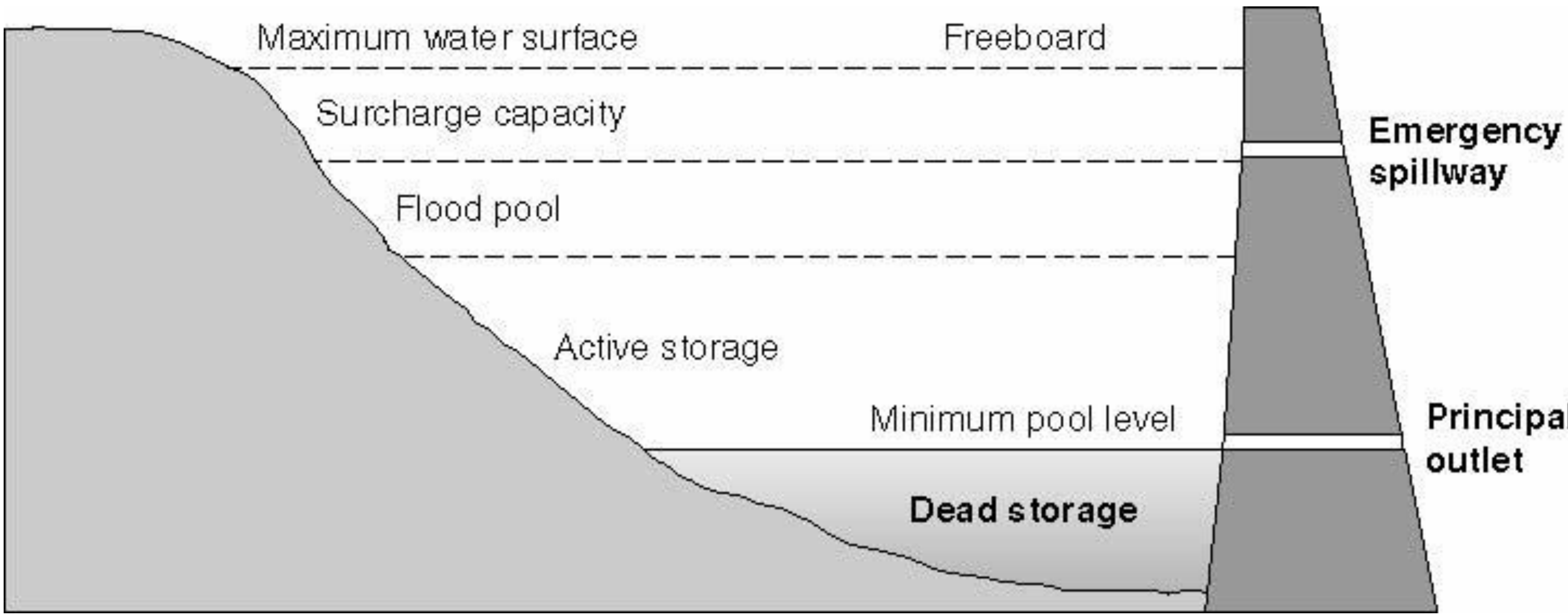
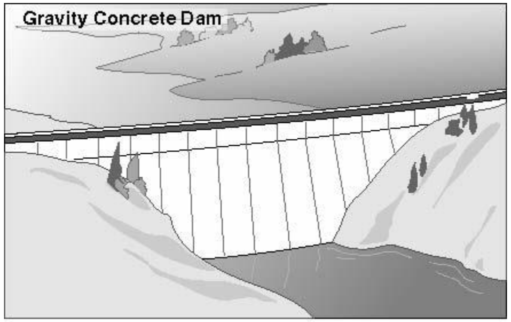
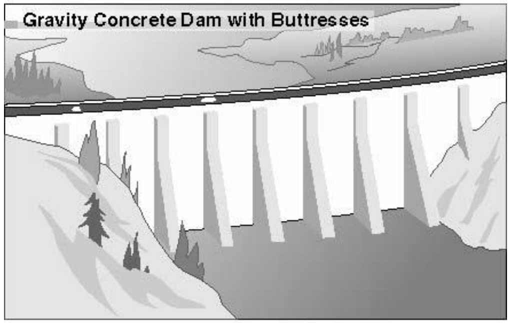
CLASSIFICATION OF PRINCIPAL STORAGE ZONES IN A CROSS SECTION OF A MULTI-PURPOSE RESERVOUR

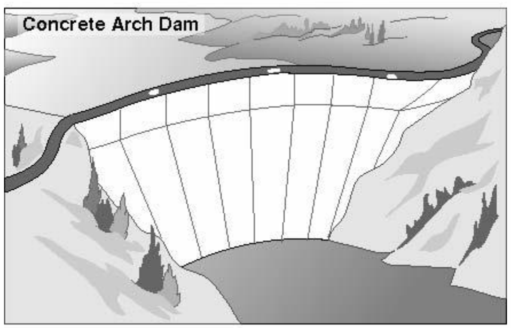


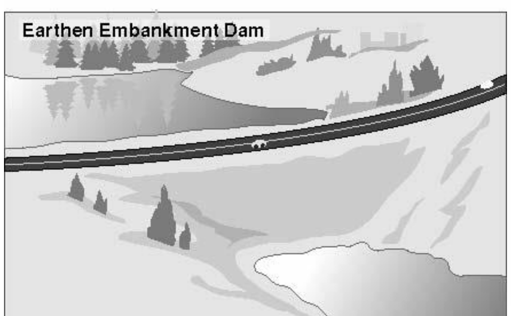
F07_05

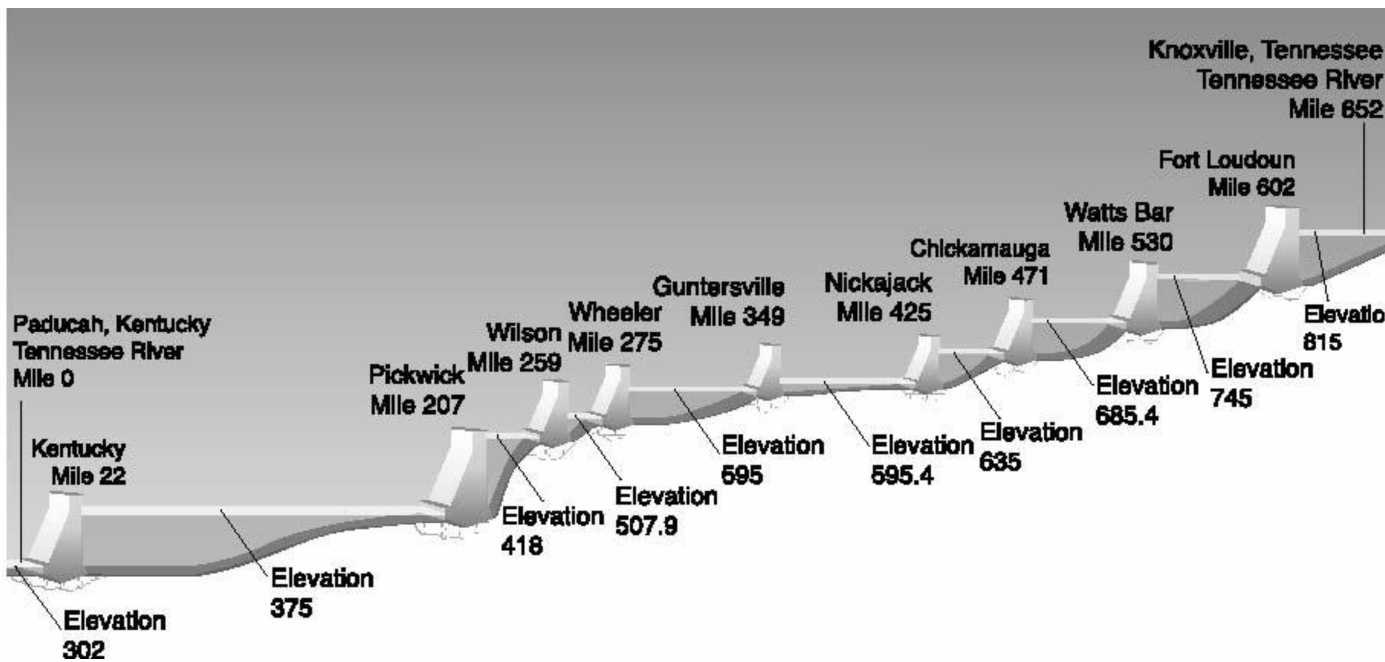
River dams (locks, levees) form a staircase of reservoirs that stretch the entire length of the Tennessee River









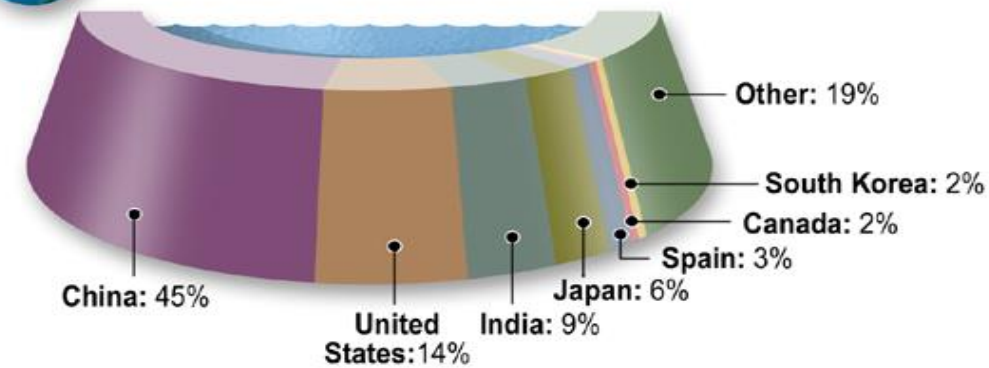


Dam builders have been busy beavers

In 2000, there were over 45 000 large dams* worldwide. Half of the world's existing large dams are built strictly for irrigation, while the remainder are built for hydro generation, water supply and flood control.

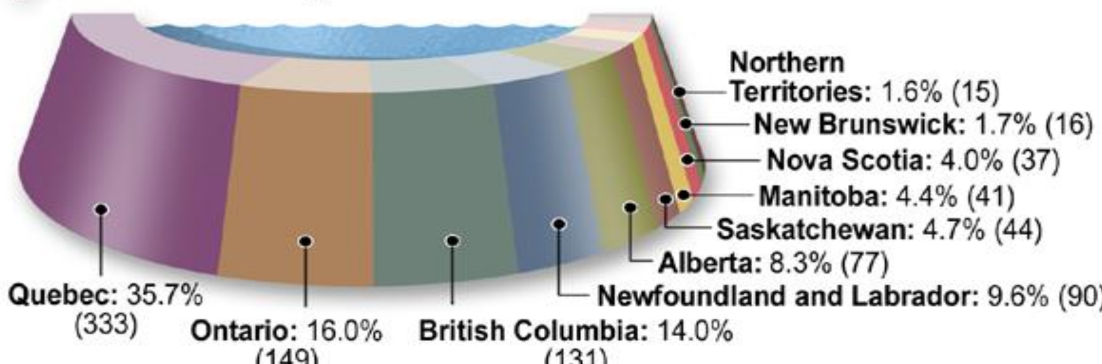
Distribution of large dams worldwide

Shown as a percentage of total large dams worldwide



Distribution of large dams in Canada

Shown as a percentage of total large dams in Canada. Actual numbers appear in brackets.



Powering the world with water

In 2000, one-third of the world's countries relied on hydropower for more than half their electricity supply and large dams generated 19% of electricity overall. About 70% of hydroelectric power generation potential has already been tapped in the developed world; only about 10% in the developing world.

The world's largest hydroelectric plants

Numbers indicate megawatts of installed generating capacity

1. Three Gorges	China	18 200 MW
2. Itaipu	Brazil/Paraguay	12 600
3. Grand Coulee	United States	10 100
4. Guri	Venezuela	10 100
5. Tucuruii	Brazil	7 500
6. Sayano-Shushensk	Russia	6 400
7. Krasnoyarsk	Russia	6 100
8. Corpus-Posadas	Argentina/Paraguay	6 000
9. La Grande 2	Canada	5 300*
10. Churchill Falls	Canada	5 200

** The combined output of all eight dams at James Bay is 15 237 MW*

How much electricity is that?

La Grande 2 on James Bay, Canada's largest hydroelectric plant, produces enough hydro to constantly light a 60-watt light bulb for more than 10 000 years.**

*** Assuming the plant is run at maximum capacity around the clock.*

- Ratio of the present value of project benefits to the present value of the costs
    - Benefits and costs assigned a dollar value (yr accrued)
    - Develop a ratio (I.e. 2:1)
    - Ration better than 1:1 means positive ratio

Determine the present value of the following costs of dam construction. Consider Year 1 as the present year. All values are in the thousands, and the interest is 8% simple interest compounded annually.

Year 1	**Year 2**	**Year 3**	**TOTAL**
$100 000	$150 000	$200 000	$450 000

The present value cost of Year 1 = $100 000

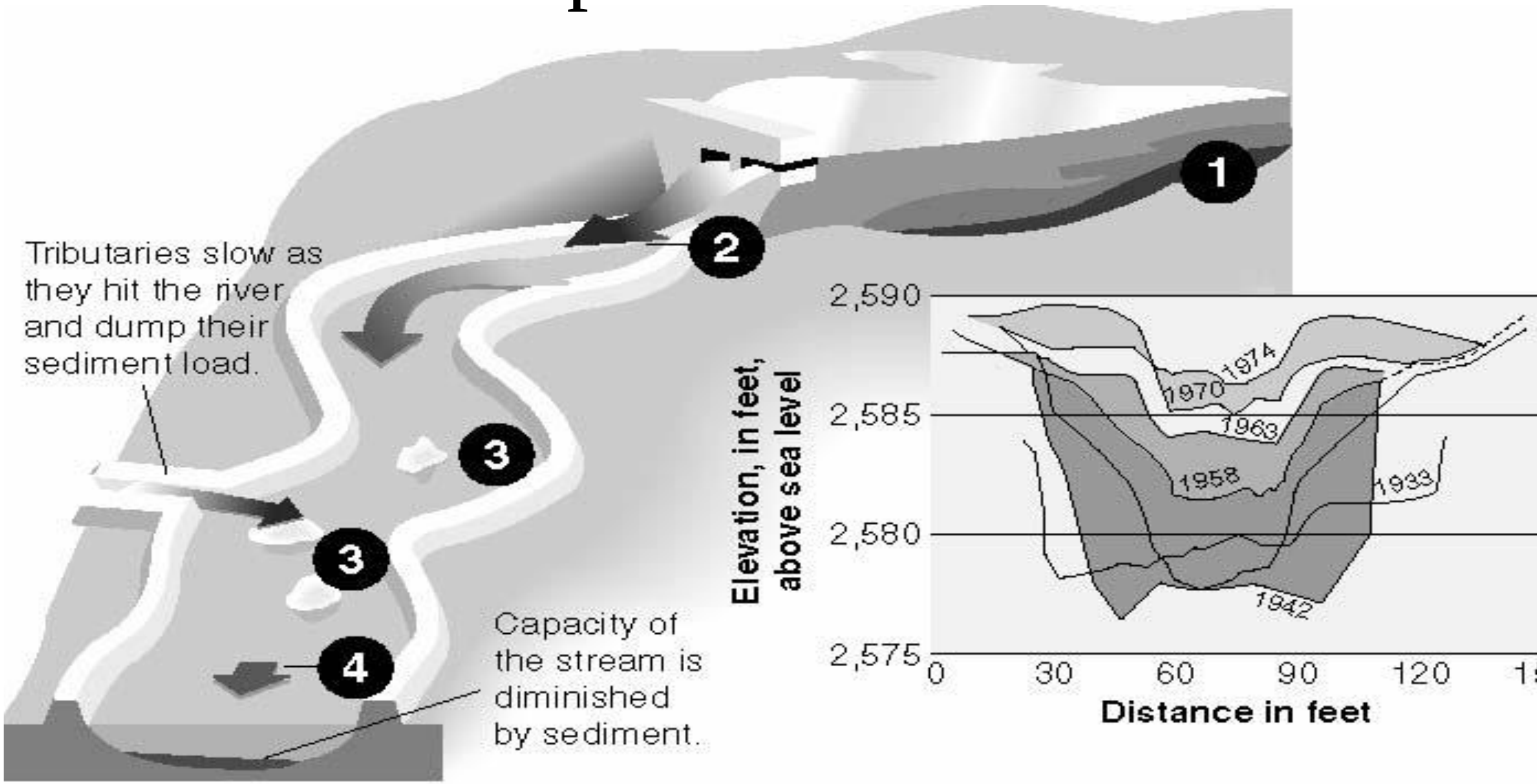
The present value cost of Year 2 = $150 000 divided by 1.08% = $138 889 ($138 889 invested 8% simple interest for one year = $150 000)

The present cost of Year 3 = $200 000 divided twice by 1.08% = $ 171 468 (This means that $171 468 invested at 8% simple interest will be worth $200 000 after two years)

Therefore, the present value cost of $450 000 in this example is $410 357

$100 000 + $138 889 +$171 468 = $410 357

Impacts of Dams



Dams change behaviour of rivers- sediment load settles behind a dam.

Downstream, water released through outlet pipes causes channel erosion

Farther downstream, the opposite can occur with silt forming islands and sandbars.

Hydroelectricity And
The James Bay Project

<u>The "Quiet Revolution" Resulted in Four Major Events:</u>

- Resurgence of ethnic nationalism (Quebecois)
- Quebec's joining the urban/industrial world of North America and expansion in the size of its industrial labour force and business class
- Removal of the old elite
- State's aggressive role in the province's affairs

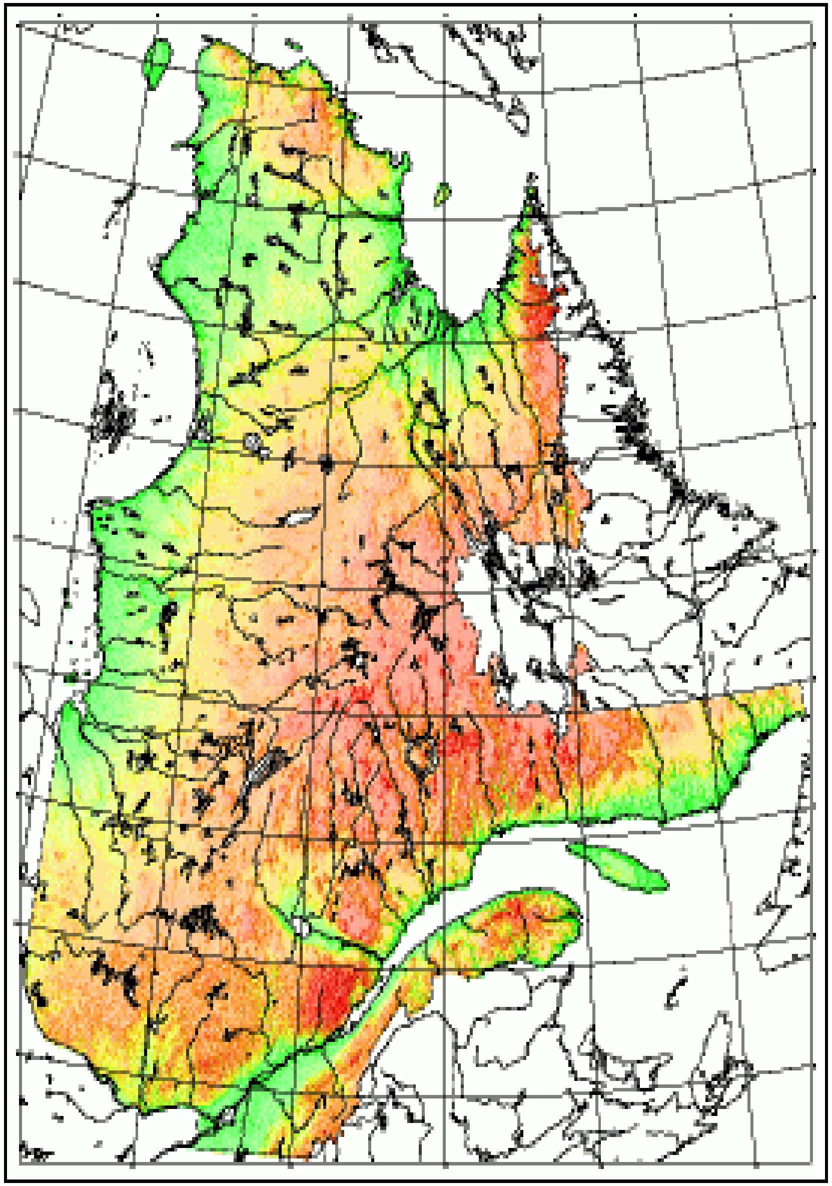
Hydroelectric Power in Quebec

<u>strong physical feature</u>

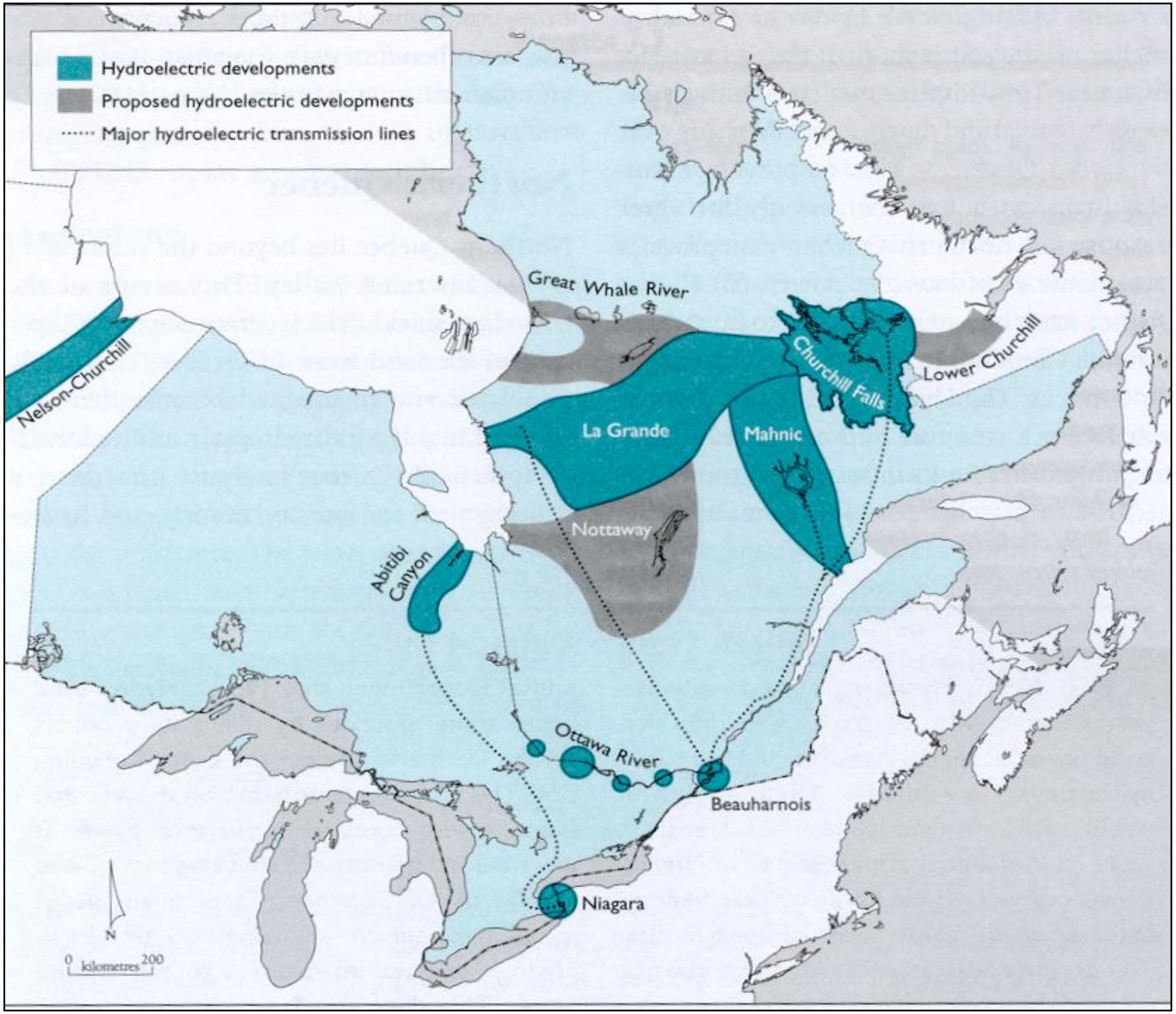
i. heavy annual precipitation

ii. high elevations of Can. Shield

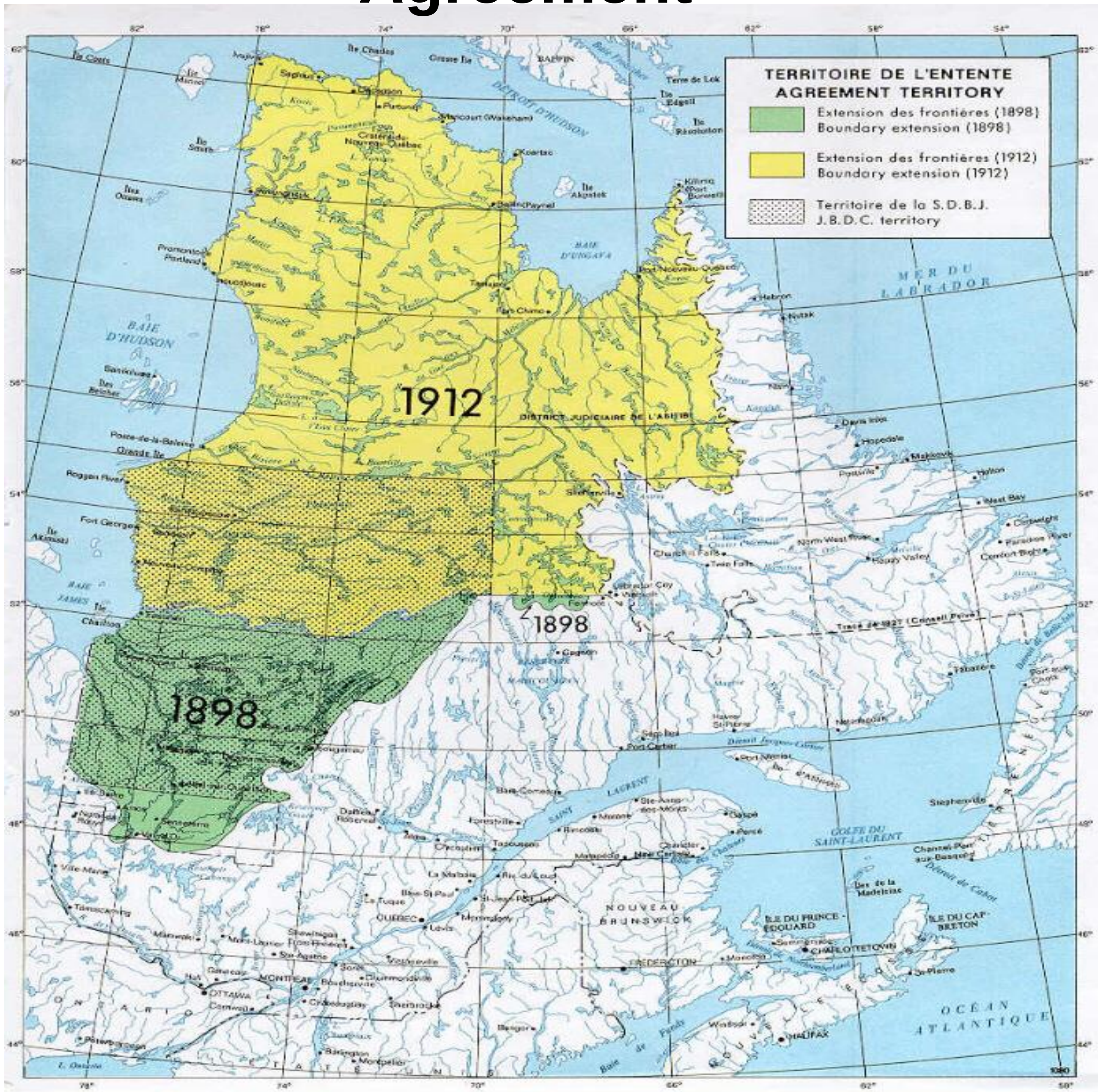
- Huge hydroelectric plants
- Technology



The James Bay Project



The James Bay and Northern Quebec Agreement



The Nipigon River

The Nipigon Basin

History of the Area

1000-1600

Aboriginals are well established in the area.

1650
Europeans arrive and are in awe at the limitless supply of beavers, otters and muskrats. Became huge center for fur trade.

1850
Ojibway sign the Robinson Superior Treaty

Late 1800s
The Nipigon Region begins to be identified as a beautiful area internationally. CPR is built through Nipigon. The region is now connected to the rest of the country.

Theodore Roosevelt

1900s
First log drive attempted down the Nipigon river. Full log drives occurred from 1923-73.

WW1
Commercial fishing begins. Construction of hydro dams begin along the Nipigon R. Hydro dams were constructed until the 1950s.

1916
World Record Brook Trout Caught (14.5 lbs)

1940
Ogoki river diversion begins. Increased flow of Nipigon R. by 50%

2001
Nipigon places a special focus on sustaining bald eagle population in area.

Long Lake and Ogoki Diversions

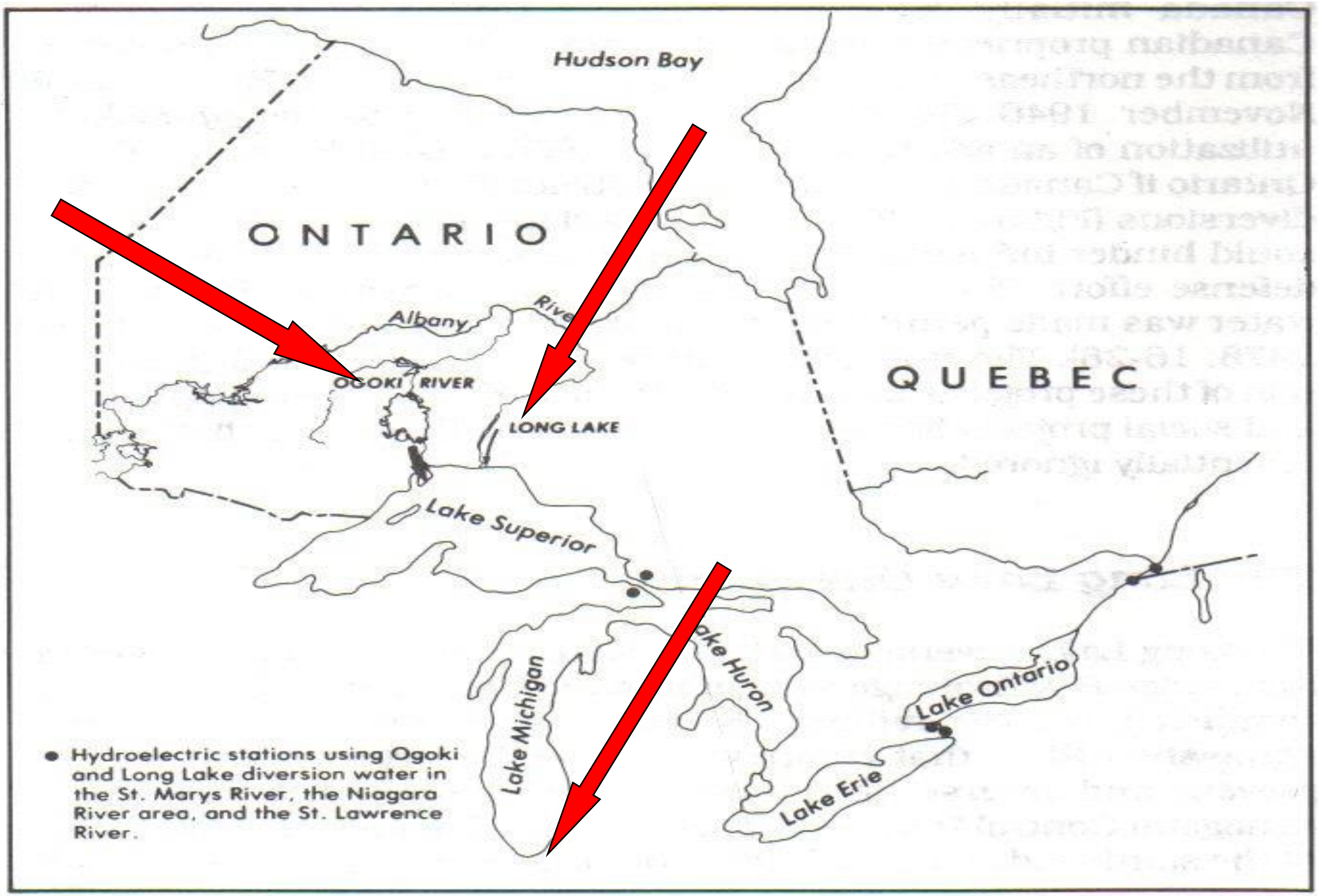


Figure 9: Hydroelectric Stations Using Ogoki and Long Lake Diversion Water

Purpose of the Project

→ To ease fears that energy shortages in the United States would hinder industrial production of material for the World War II defense effort.

a) Long Lake Diversion

→ To move water from the Albany River in the James Bay drainage system into the Great Lakes.

→ To redirect Kenogami River flows south into the Aguasabon River that empties into Lake Superior.

→ Its two functions:

- Interbasin pulpwood transportation
- Power generation in the St. Mary's, Niagara and St. Lawrence rivers

b) Ogoki Diversion

→ To divert northeastward flowing Ogoki River southward through Lake Nipigon and into the Great Lakes system.

→ To provide an average 113 m^3 /s flow increment of water for power production at generating stations on the Nipigon, St. Mary's, Niagara and St. Lawrence rivers.

History of the projects

In 1940, the United States agreed to use 143 m^3/s of water at Niagara Falls in Ontario, if Canada would rapidly construct the Ogoki and Long Lake diversions.

The Process

Ogoki Diversion

- Construction of a diversion dam at Waboose Rapids.
- Caused water levels at Ogoki River to rise 12 m.
- Flooded the river valley and Mojikit Lake up to the height of the land.
- There, a 0.4 km diversion channel was excavated.
- The Summit Control Dam constructed to regulate southerly flows.
- The diverted water enlarges the Little Jackfish River which discharges into Ombabika Bay at the north end of Lake Nipigon.
- Trees were not cleared from the reservoir prior to inundation.

- The project became operational in July 1943.

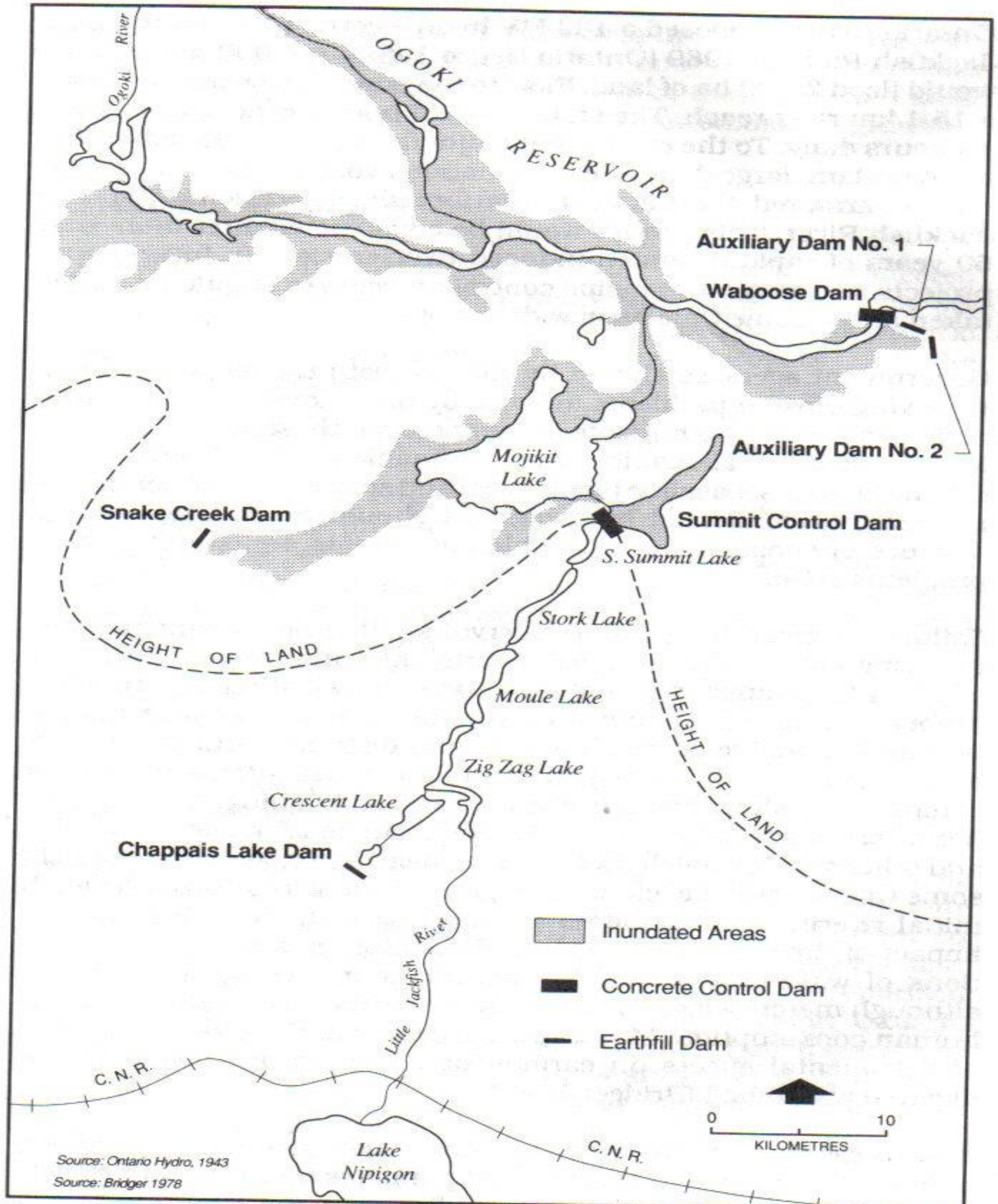
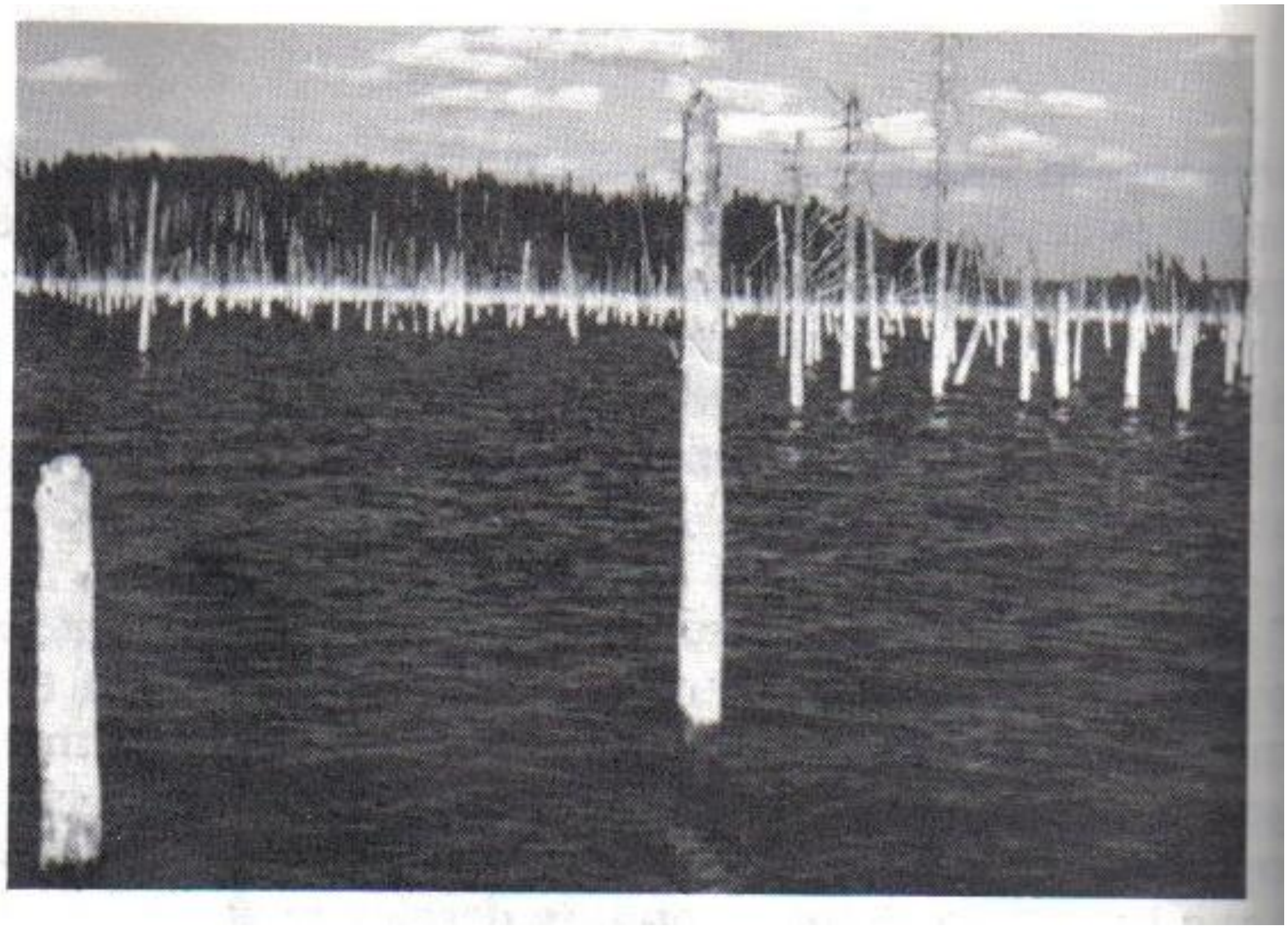


Figure 11: The Ogoki Diversion

Summit Dam

Waboose Dam

Diversion Effects



Biophysical Change

- Erosion in Reservoirs, Diversion Channels & Receiving Water Bodies

  - Erosion has led to . . .
    - → Increased turbidity
    - → Degraded water quality
    - → Damaged private property & cultural artifacts
    - * Impaired habitats for fish

Biophysical Change

Trees are in or near reservoirs, Diversion Channels and Lake Nipigon

Failure to clear trees has led to . . .

❖ Excess debris

(Will take 100s of years to disappear by natural oxidation)

❖ Partially submerged standing trees

Causes navigation & shoreline access hazards.

❖ Degraded natural aesthetic beauty.

Biophysical Change

- Drowned vegetation

- Creates a hazard for commercial fishing

- Long term impact on fish habitats is unclear

- Still an abundant population of walleye and pike in Ogoki Reservoir

- Mercury levels in fish flesh are above acceptable levels for consumption

- No evidence of detrimental effects on moose, caribou or other animals living in the diverted watershed.

Socioeconomic Change

- Economic Benefits from Hydroelectricity of Long Lake & Ogoki Diversions

- 1943 to 1974

→profits exceeded 220 million dollars.

Socioeconomic Change

- Credit for Diverted Water

- Canada's right to the diverted water was made permanent by the 1950 Niagara River Treaty.

- 1943 to 1972 → diversions averaged 18.7 m^3 /s more than expected.

- Under the treaty, Canada can use only half of the surplus (9.3 m3 /s).

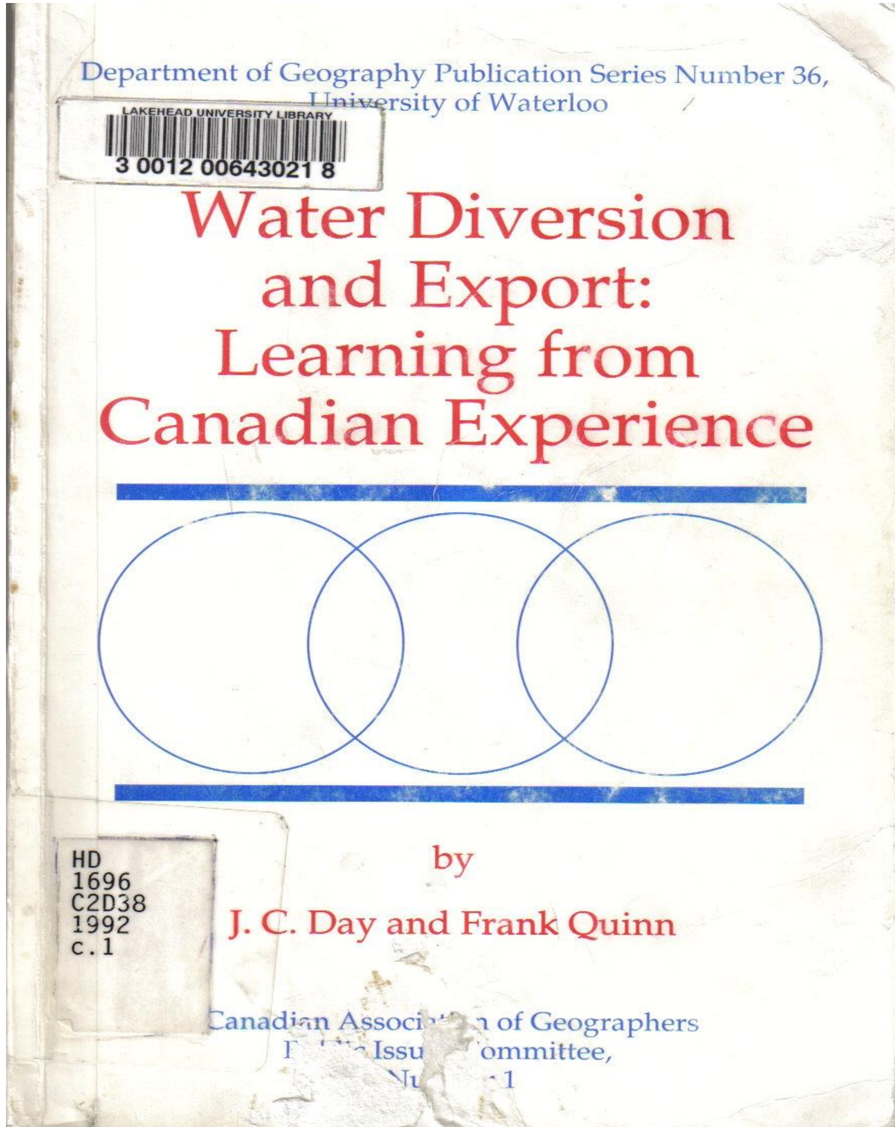
- The United States agreed in principal that the rights of water diverted into the Great Lakes should be vested in the country from whose territory it comes.

- This agreement was not approved by the U.S. Senate.

- Canada does not receive credit for about 9.3 m3 /s of water at Niagara and for half of the diverted water in the St. Mary's and St. Lawrence rivers.

(The result of failing to create an international Great Lakes Basin water agreement)

Source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Cultural Conflicts

- History of the Aboriginals
- Robinson-Superior Treaty
- Conflicts

The Aboriginals

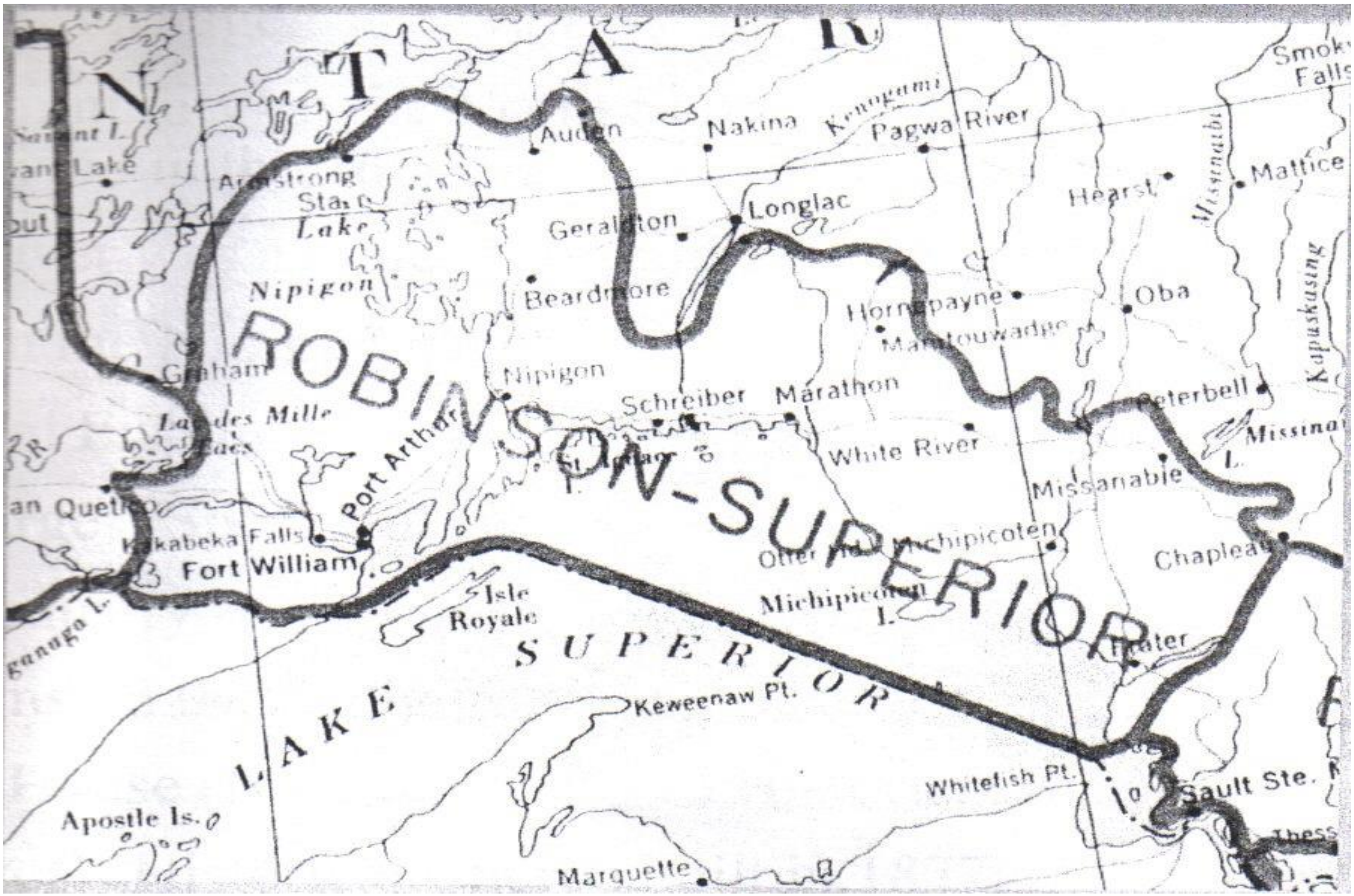
- History
- The aboriginals have been situated in the Nipigon region as early as 8000 BCE.

- They were nomadic hunters and gatherers and they solely relied on fish, wildlife, plants, small and big game in the area.

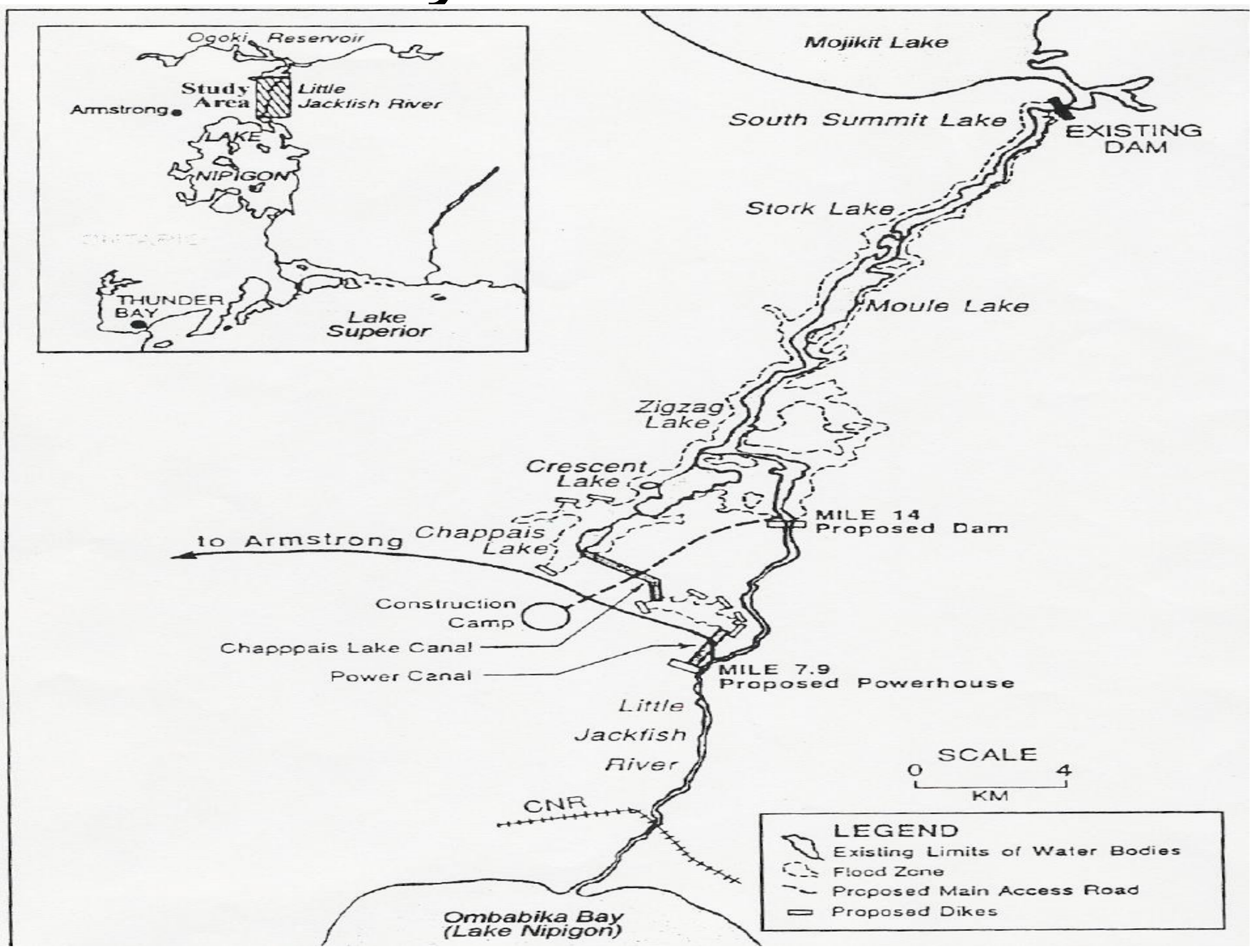
The Aboriginals (cont.)

- Robinson-Superior Treaty
- Treaty signed in the Nipigon region, September 7, 1850
- Prepared by Crown and Ojibway Indians near Superior
- Purpose was for the Crown to remove minerals and other items of value on the land
- In return the Aboriginals are able to live off the land
- Created Indian reserves
- The crown will assist the Aboriginals if there are land claim issues.

The Robinson-Superior Treaty



Proposed Little Jackfish River Hydroelectric



The Aboriginals

Present Conflict

- Conflict between the Whitesand Indian Band and Ontario Hydro concerning the proposed Little Jackfish Hydroelectric Project.
- Whitesand Indian Band is afraid of the same effect the Ogoki Diversion had on their community.
- The proposed Little Jackfish Hydroelectric Project has the potential of damaging the river system by flooding and destroying the land.

The Aboriginals

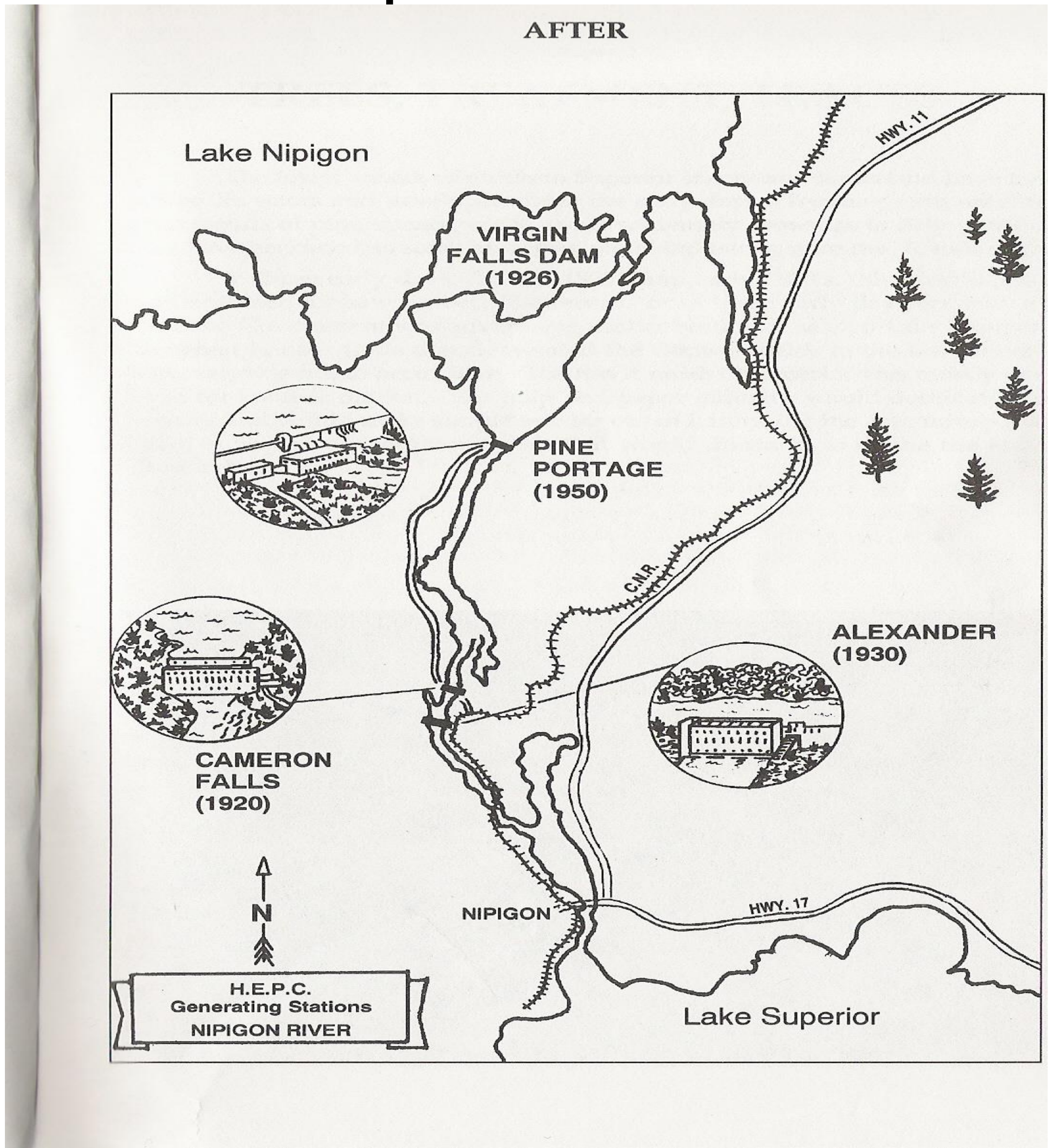
- Actions Taken
- June 4, 1990, Ontario Hydro and the Chief and Council of the Whitesand Indian band announced a comprehensive land use and harvesting study.
- Highlights from the study included the economic, social, cultural, and spiritual importance of living off the land.
- Conflicts between Whitesand Indian Band and Ontario Hydro dealt with in a fair and effective manner.
- The Little Jackfish River Hydroelectric Project has not started construction.

Hydro-Electric Dams and Their Effect on Fish Populations

Problems Associated with the Damming of the Nipigon River

- Brief history of the hydro-electric dams
- Problems with water level fluctuations
- Effects on fish populations

Map of Dams


AFTER
Lake Nipigon
HWY. 11
VIRGIN FALLS DAM (1926)
PINE PORTAGE (1950)
C.N.R.
ALEXANDER (1930)
CAMERON FALLS (1920)
N
NIPIGON
HWY. 17
H.E.P.C. Generating Stations NIPIGON RIVER
Lake Superior

Brief History of Dams in the Nipigon Region

- Cameron Falls Dam – 1920
- Alexander Dam – 1930
- Pine Portage Generating Station – 1950

Problems Associated with Water Level Fluctuations

- Water level fluctuations necessary to regulate flow to dams
- Resulted in flooding of surrounding land and lakes
- Erosion of stream banks and sediment load
- Negatively affected fish populations: migrating and spawning patterns.

Effects of the Dams on Fish

- Construction of dams has reduced migration and affected spawning
- Greatest impact on Brook Trout
- Fluctuating river levels in combination with competition from other introduced fish species, and extensive fishing caused populations to drop significantly
- 1989 rehabilitation program put into effect
- Populations are improving since implementation of program.