Agenda for WRM: Jan. 16

Reminders

- Assignment 1: David Schindler
- Independent Research Project
  - Topics
  - Proposal Report Seminar
- Field trip

Lecture 3

Lecture 3: Great Lakes

- Chicago water diversion
- Seaway
- Great Lakes Compact signed in 2008
- Current Great lakes issues

History of the Chicago Diversion

History of Great Lakes Chicago water diversion

- The Chicago diversion is the largest and best known out-of-basin diversion of the Great Lakes
- 1885: 90,000 people died in Chicago from cholera
- 1900: New channel and structures reverse the flow of the Chicago and Calumet Rivers. Sewage from Chicago now flows to the Illinois River to the Mississippi
- 1909 - Boundary Waters Treaty established the International Joint Commission (IJC)
- Flow was as high as 24,000 million litres per day (mld). In 1967, the U.S. Supreme Court limited the diversion to 7,600 mld (2,068 mgd), the level it is supposed to be at today.

Chicago Diversion

Day and night scenes of the modern Chicago River

Great Lakes – St. Lawrence Seaway

St. Lawrence River, St. Lawrence Seaway and the Great Lakes, sometimes termed Hwy H2O, is a 3,700-kilometre (2,300 mile) marine highway that runs between Canada and the United States.

Some history

- **1895**

The first joint Commission is formed to study the feasibility of a Seaway. This is followed by the International Joint Commission in 1909, but no further action on Seaway proposal.

Seaway history (the opening)

- **1954** Completion of the Seaway navigation project links the Great Lakes to global markets.

On April 25, the icebreaker "D'Iberville" begins the first through transit of the St. Lawrence Seaway. Gross shipping weight for this first navigation season amounts to 22 million tonnes.

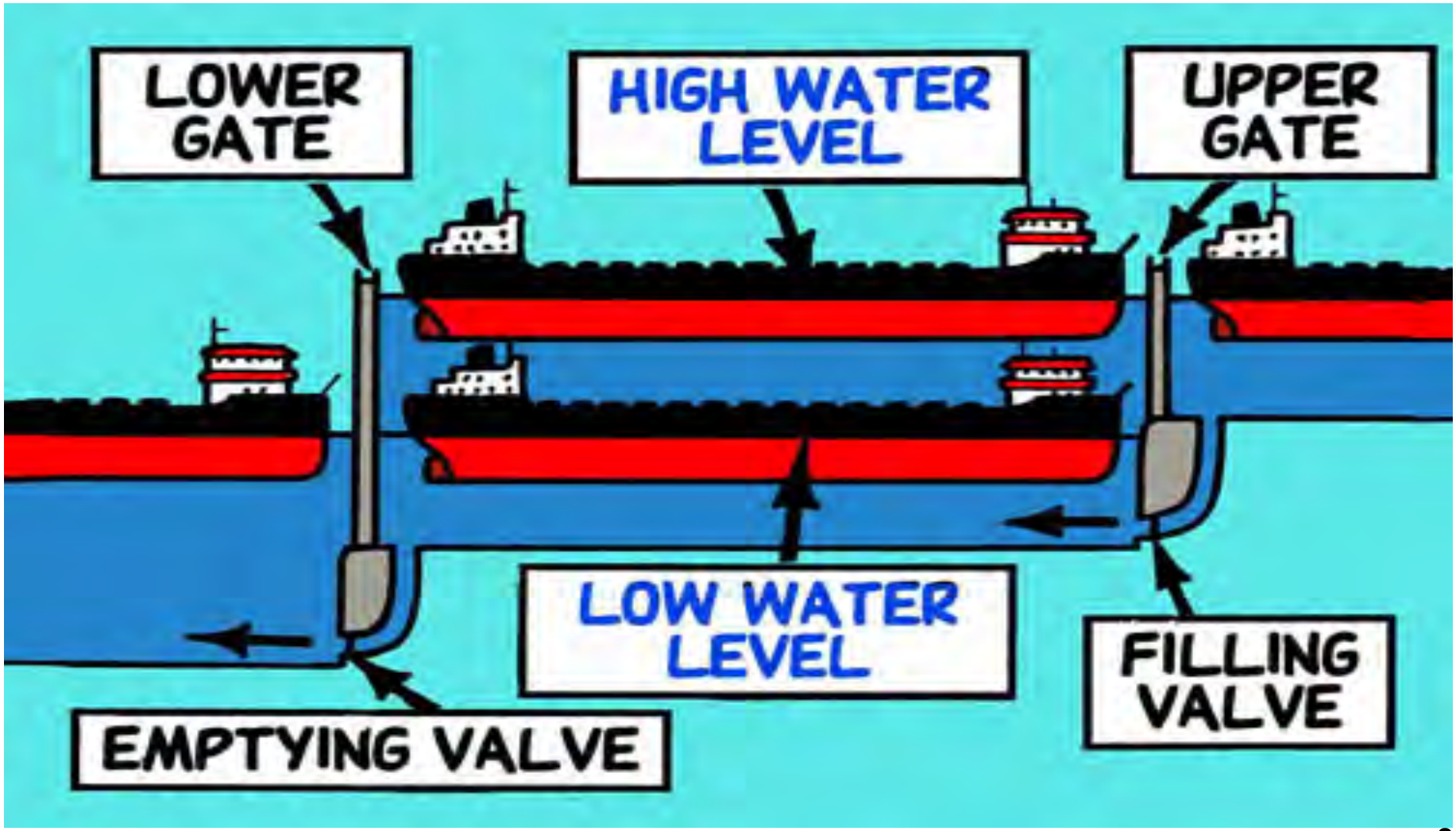
- **1979**

  The gross tonnage of ships passing through the Seaway reaches 80 million tonnes.

- **1996**

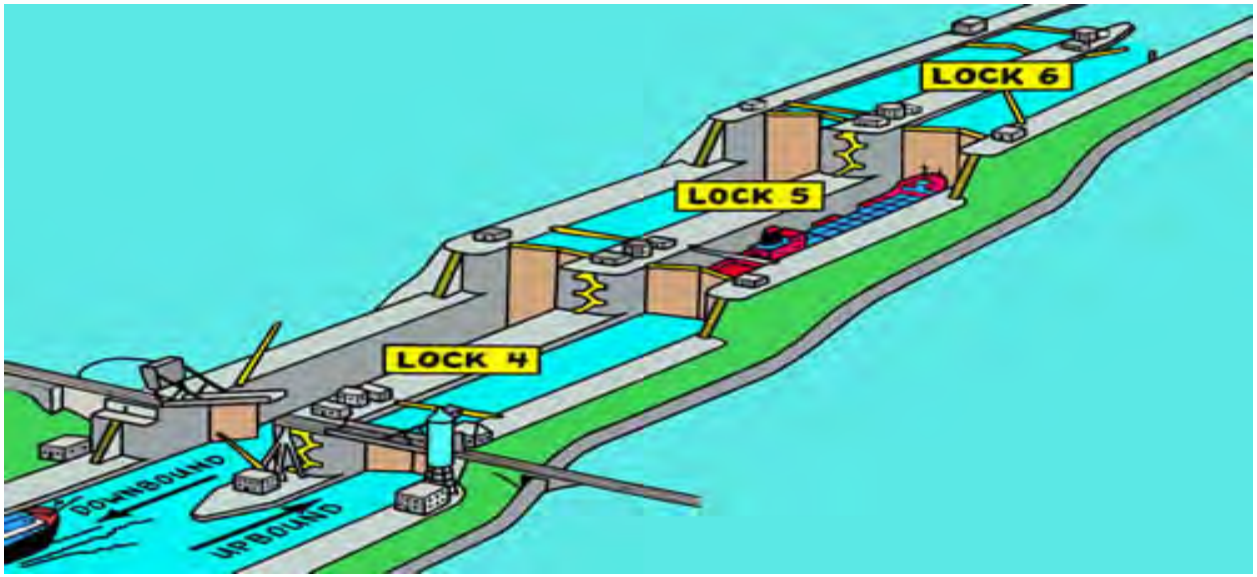
  Total of two billion tonnes of cargo, valued at more than $300 billion.

Example of a lock



Seaway Locks

This lift system and accommodate ships to 225.5 metres in length (740 feet) and 23.8 metres (78 feet) in the beam. Ships can be twice as long and half as wide as a football field and carry cargoes the equivalent of 25,000 metric tonnes. Passage through a lock takes about 45 minutes.



Discussion

- **1993**
  The Seaway's draft is increased from 7.87 m to 7.95, enabling ships to carry more cargo per voyage
- **2004**
  - The Seaway's draft is increased 8.03m (26.5 feet) enabling ships to carry up to 300 tonnes of additional cargo per voyage.

In-class discussion/consideration

Water Levels (Lake Superior)

- Lake Superior regulation determined by Plan 1977
  - Plan 1977 designed to balance the levels of Lake Superior and Michigan-Huron *(Hartmann, 1990)*

- Difference: Lake Superior 183.2
  - Lake Huron 176.2

Water Levels

- Shorter duration of ice cover will increase evaporation in winter
- Warmer air temperatures will increase evapotranspiration
- Summers with decreased soil moisture

Lake Superior, the world's largest freshwater lake, has made a major recovery. The period 1998 to 2013 featured well below levels. Its lowest level in 81 years was set in 2007 at 182.98 average and records set in some months.

Decrease of 48 cm from 1998 to 2007

Recovery of about 50 cm

The present level is 183.46 m above MSL

Annual cycle:

Long Term Average: 183.32 m

Minimum: 182.83 (1926)

Maximum: 183.70 (1986)

Oil pressure builds in the Great Lakes

The following slides contain ideas and discussion of Dan Egan, journalist and author of "**The Death and Life of the Great Lakes**"

Construction on the Dakota Access Pipeline was halted late in 2016

- Hundreds of protesters put their bodies on the line to stop the $3.7 US billion project
- Native Americans: Risk the oil line poses to the river - source of drinking water
- Support by environmentalists re climate change, military veterans and the "Hollywood tribe" to draw attention to both global warming and centuries of injustices suffered by Native Americans.

Obama rejected the proposed Keystone XL pipeline that would have carried Alberta tar sands oil to the Gulf of Mexico and other markets in the US in 2015. Part of this decision was to protect theOgallala aquifer, a rapidly depleting underground freshwater reserve.

Egan details history/expansion of pipelines with capacity to carry three times the volume proposed for TransCanada's Keystone XL. This pipe infrastructure already exists - operated by Enbridge in western Canada and the U.S.

Trump reversed Obama's decision early in 2017 and construction has resumed

Murphy Oil (Enbridge): Superior, Wisconsin

Capacity of holding tanks next to lake Superior is 13 million barrels (60% of daily U.S. consumption).

Daily flow in is 2.6 million barrels (bpd)

Planned capacity is 3 million bpd

45,000 bpd refined on site.

Enbridge Pipelines: Superior to Sarnia

From Superior, Wisconsin

Line 5 - 500,000 barrels a day, mainly petroleum from the Bakken shale oil in North Dakota, can flow in a pipeline via Michigan's Upper Peninsula, Straits of Mackinac, southern Michigan – to Sarnia.

Line 6A

Most bitumen oil runs in three pipelines south to Illinois. Much flows to regional refineries (gasoline, diesel and other petroleum products).

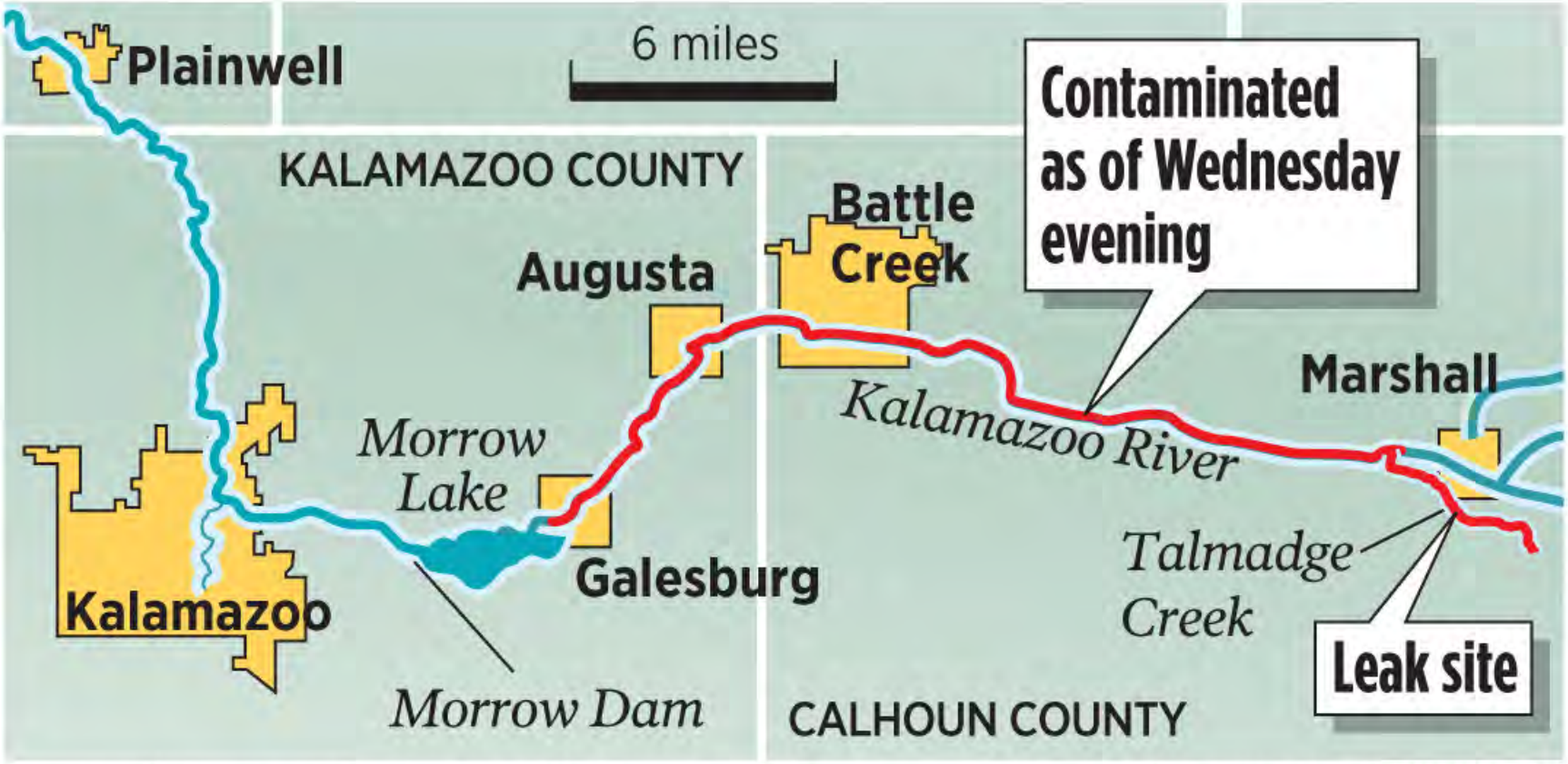
Some of it moves to Indiana, lower Michigan and Sarnia. Some oil now also flows in an Enbridge pipe east from Sarnia to Montreal, onto tankers and shipped around the globe.

Line 6A in Wisconsin, opened in 1968 with a capacity of 300,000 bpd. Now it has a capacity of nearly 700,000 bpd. The line itself never got larger. The increase was achieved largely by increasing pressure on steel tube that is today nearly 50 years old.

Line 6B ran from the Chicago area through southern Michigan and terminated in Sarnia. Enbridge identified six "crack-like" defects in Line 6B in 2005. These ranged from 24 cm to more than a metre and were left unrepaired. On July 25, 2010, alarms went off at Enbridge's headquarters in Edmonton, Alberta, signaling something was amiss near Kalamazoo, Michigan.

Operators in Edmonton tried increased pressure to pump more heavy crude into the line. They tried this twice for a total of about 90 minutes.

July 25, 2010, at about 5:58 p.m. EDT



Source: Kalamazoo Couty Sheriff's Department

GAZETTE GRAPHIC/**KRIS KINKADE**

Line 6B,, burst in Michigan on July 25, 2010

- Spilled nearly 4 million litres of tar sands bitumen
- 60 km of creek and Kalamazoo River directly affected
- Largest on-land oil spill in North American history
- Clean up costs about $1US billion to date
- Enbridge fined $3.7US million dollars because of 22 probable violations
- Environmental Protection Agency (EPA) had not been informed by Enbridge that “Dilbit” initially floats in water but sinks, which compounds problems with clean up.

- Enbridge decided that the existing line (began operation in 1968) was too deteriorated to salvage.
- Opened a new version of the line in 2014
- This slightly larger replacement doubled the old line’s operating capacity to 500,000 bpd.

Pipeline Technology

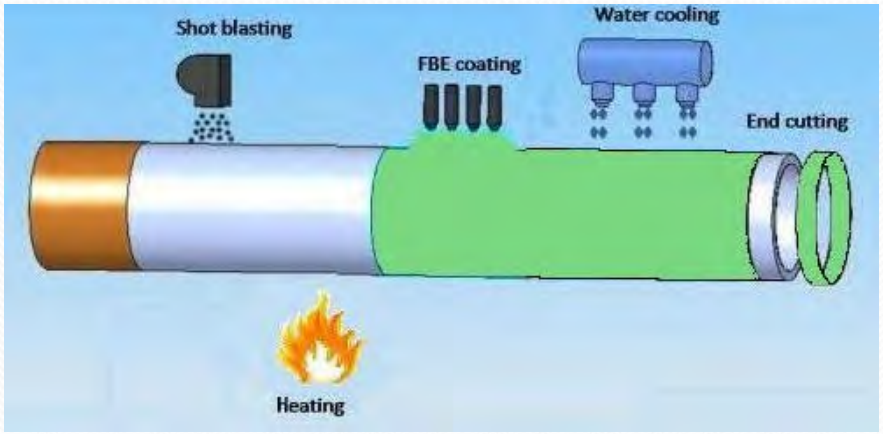
Steel pipe protected by coating

Examples:

Polystyrene tape wrap

Bitumen enamel (better)

Fusion bonded epoxy (FBE) coating (best)



No coating system is perfect

Once coating is broken, it admits corrosive agents from the soil

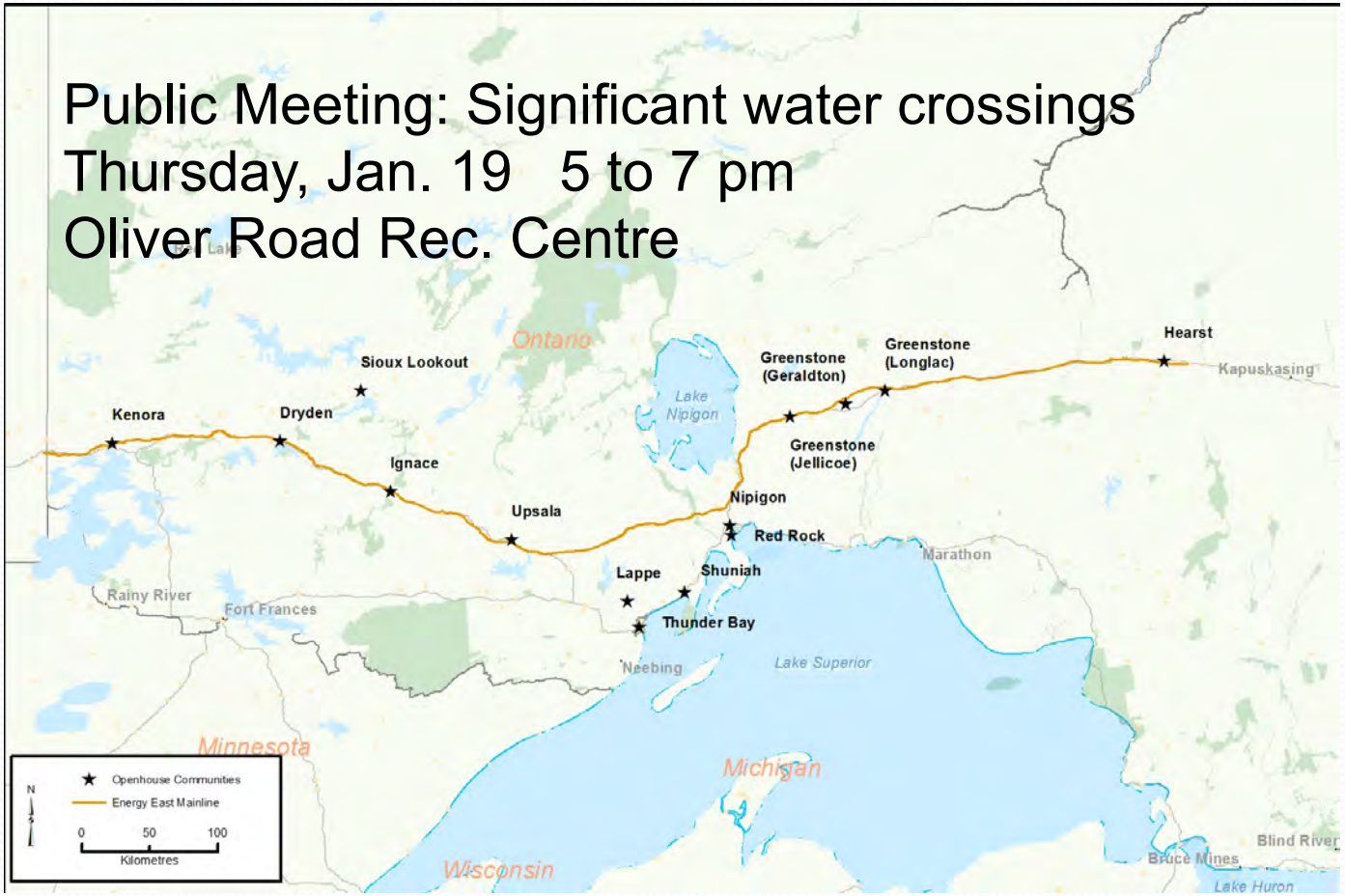
Corrosion is slowed by a cathodic protection system which applies an electrical current.

Significant water crossings

Energy East

- TransCanada (TCP) has been lumped together with Enbridge for their poor safety records
- Old converted pipeline and using the same technologies as Enbridge for leak detection
- At a minimum, use 60 km Talmadge Creek/Kalamazoo River spill as a benchmark
- **Small Leaks a Bigger Threat?** TCP detection system can not detect under 1.5%
- TCP's estimate: Over 1000 km of old pipe in northwestern Ontario - expect a failure about every 2.3 years.

Trans-Canada Pipeline: Energy East proposal



Likely locations of pipeline conflicts

Energy East

Mackinac

Line 5 is 90 cm (30 inches) in diameter, except when crossing the Straits of Mackinac
Two 20-inch pipes that lie about 1,000 feet apart.
Construction was completed in 1953, and the twin pipelines under the Straits now carry approximately 540,000 barrels of oil and natural gas liquids per day.

Waukesha, Wisconsin

Photo Credit: University of Michigan

First test case of the Great Lakes Compact signed in 2008

- Access to Lake Michigan water - water diversion out of the Great Lakes basin
- Population 70,000
- Ground water contaminated with radium
- 34 km from Lake Michigan
- Outside the boundaries of the Great Lakes watershed
- Draw 31 million litres of water daily, return same amount of treated water

Waukesha, Wisconsin

CBC's The Current provides views of this controversy.

Shawn Reilly, mayor of Waukesha, Wisconsin

Keith Hobbs, mayor of Thunder Bay, Ontario

Robert Sandford, chair of the Water and Climate Security at the United Nations University Institute for Water, Environment and Health

http://www.cbc.ca/radio/thecurrent/the-current-for-june-23-2016-1.3648733/canadian-mayors-worry-that-water-to-waukesha-sets-a-dangerous-precedent-1.3648749

Root River, near Waukesha, Wisconsin

- *“Waukesha has a reasonable alternative in terms of the quality of water and the treatment available to remove both the radium concerns, as many other cities do, and dealing with other contaminations such as dissolved solids.” (Mayor and Council)*
- *Areas that are not part of Waukesha are included in the service area.*
- *The return flow via the Root River (some contamination already), with relatively small water flow particularly in the summertime. Micro-beads, pharmaceuticals and other contaminants, viruses and those types of things that are not regulated and could cause significant water quality problems in the river, beach area and Lake Michigan. (Mayor of Racine)*