



Successful Response and Remediation of a Remote Crude Oil Release in the Canadian North

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About Enbridge

Approximate
Site Location



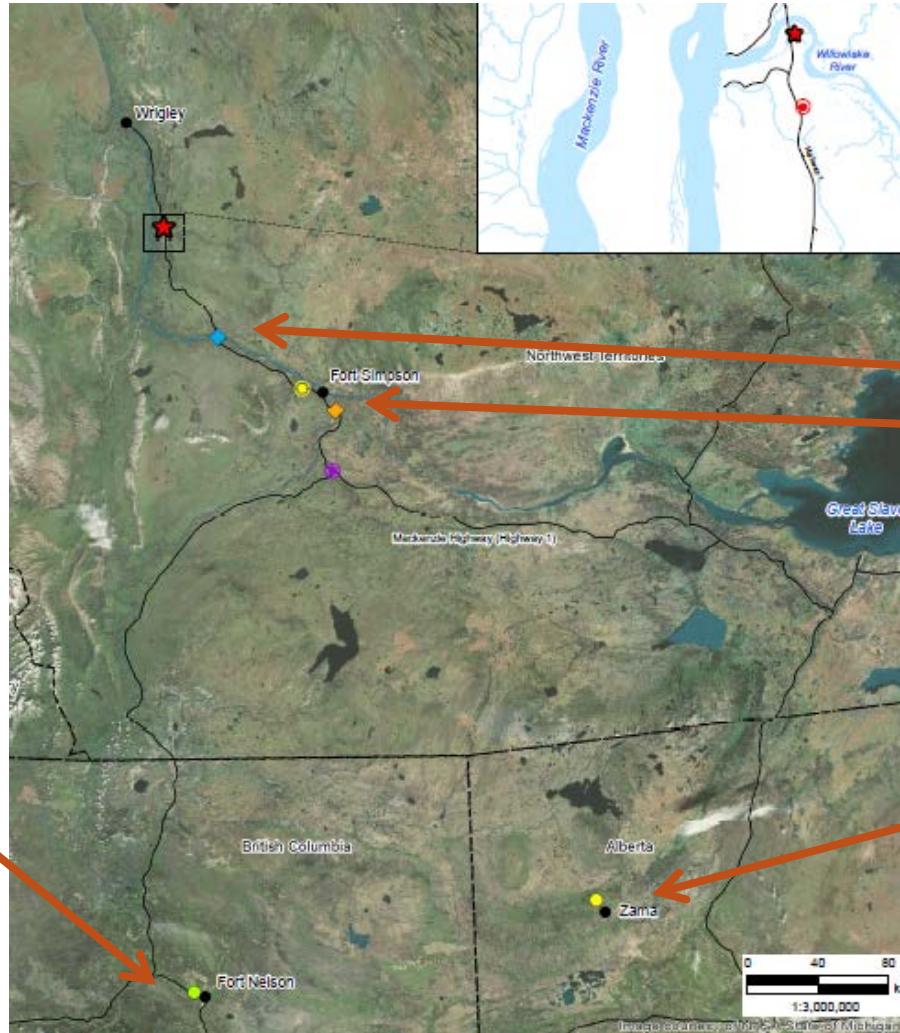
- Operate world's longest liquids pipeline system and Canada's largest natural gas distribution company
- Interest in 80,000 km of pipelines
- Delivers 2 million barrels/day crude and liquid petroleum
- Handles 5 billion cubic ft/day of natural gas
- Employs 10,000+ people
- Wind development capacity of 800 megawatts
- Own and operate the Norman Wells pipeline since 1985
 - 12" crude oil pipeline, 869 km in length
 - Operating capacity of 36,500 bbl/day
 - National Energy Board provides primary regulatory oversight



Incident Overview

- Release discovered on May 9, 2011
- Initial observations suggested a small release (approximately 4 barrels)
- Initial environmental assessment efforts indicated additional oil present in subsurface
- Volume re-assessed to approximately 1600 barrels after delineation
- Contained to land, with no impacts to Willowlake River
- Aggressive remediation goals and schedule

Site Setting



Supporting Facilities:
Camp (5km)
Sand Quarry (155 km)
Staging Area (230 km)

Mackenzie River
and Liard River –
ferry or ice bridge
only

Fort Nelson Landfill
– 645 km (14 hrs)
south

Zama Landfill – 800
km (10 hrs) south

Site Setting



Initial Response

- Emergency response plans implemented using ICS
- Resources mobilized
- Containment
- Monitoring program
- Wildlife management
- Initial Clean-Up Plan (ICP) developed for NEB

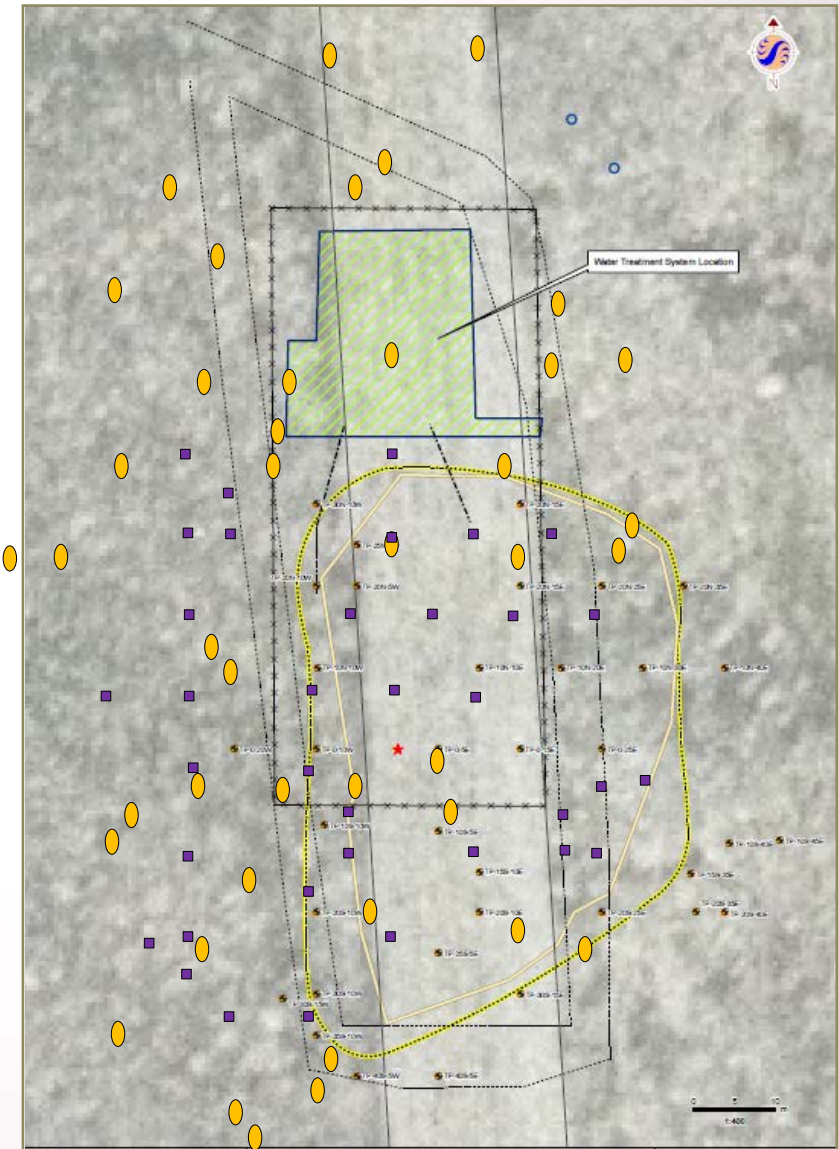


Site Assessment

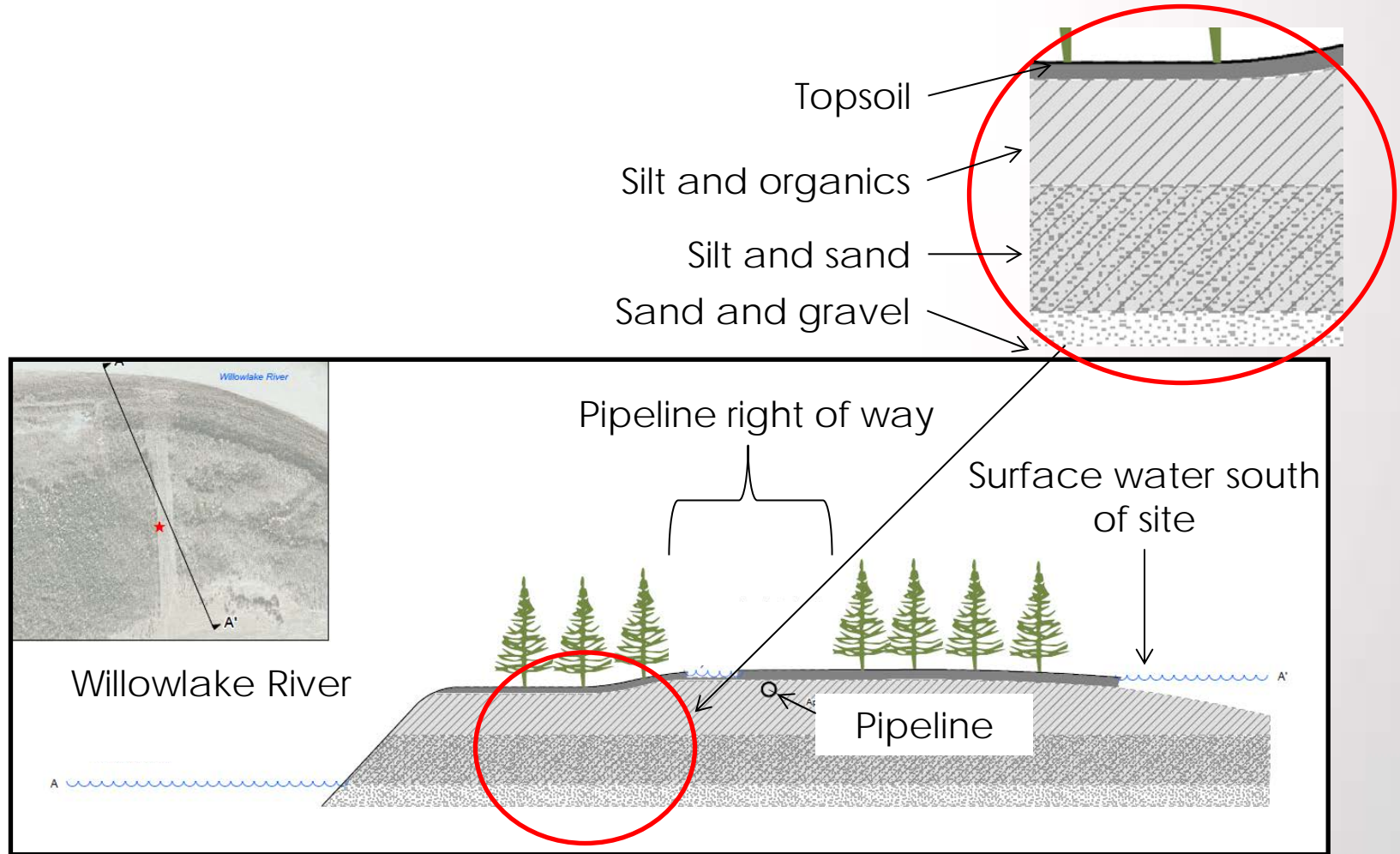


Site Assessment

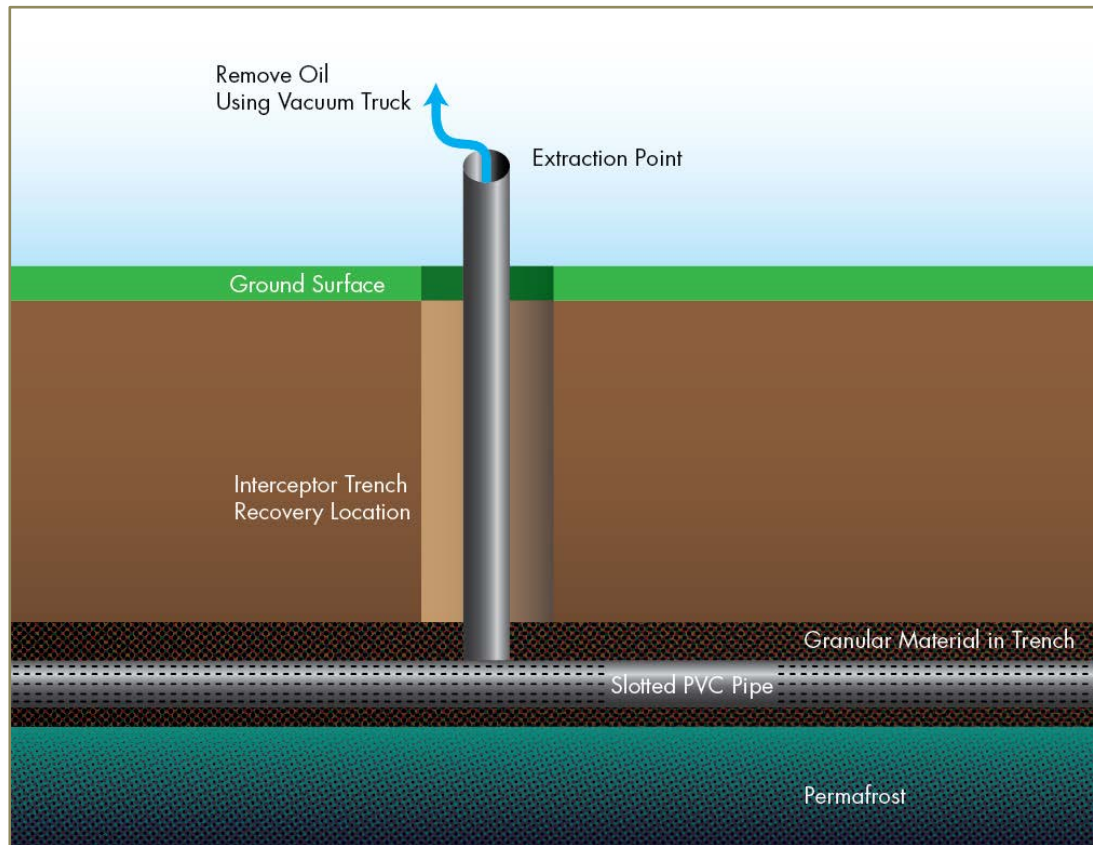
- Investigation included
 - 54 boreholes and 34 monitoring wells
 - 47 test pits
- Supported delineation and volume estimate



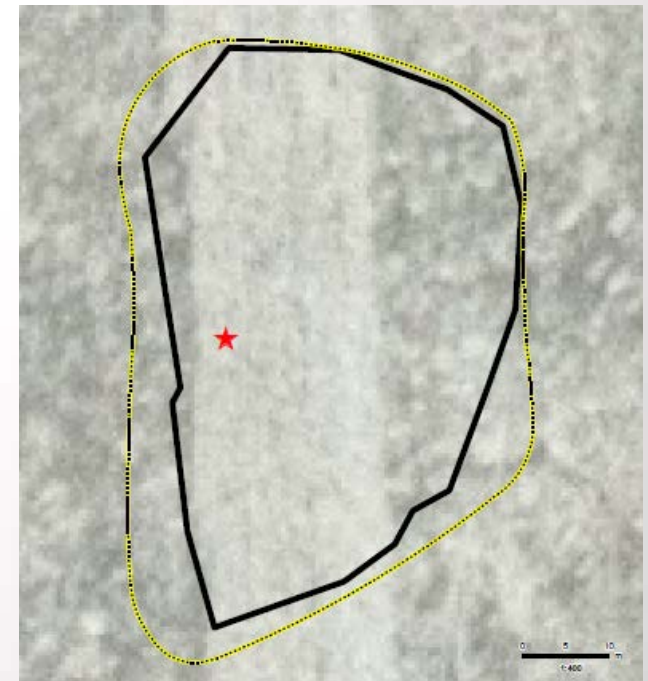
Geologic Conditions



Containment



- Trench keyed into permafrost
- Slotted PVC placed horizontally in trench
- Vertical riser placed for monitoring and recovery



Oil Recovery



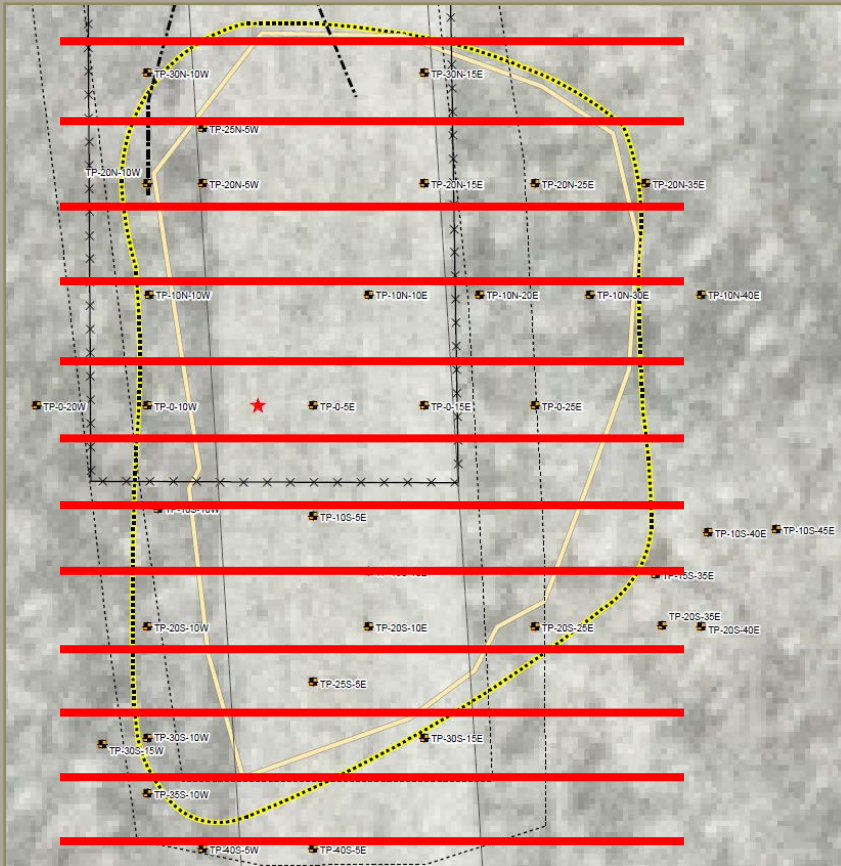
- Where significant quantities of free product observed – recovery well constructed
- Product measured daily
- Vacuum truck recovered measured product

Water Management

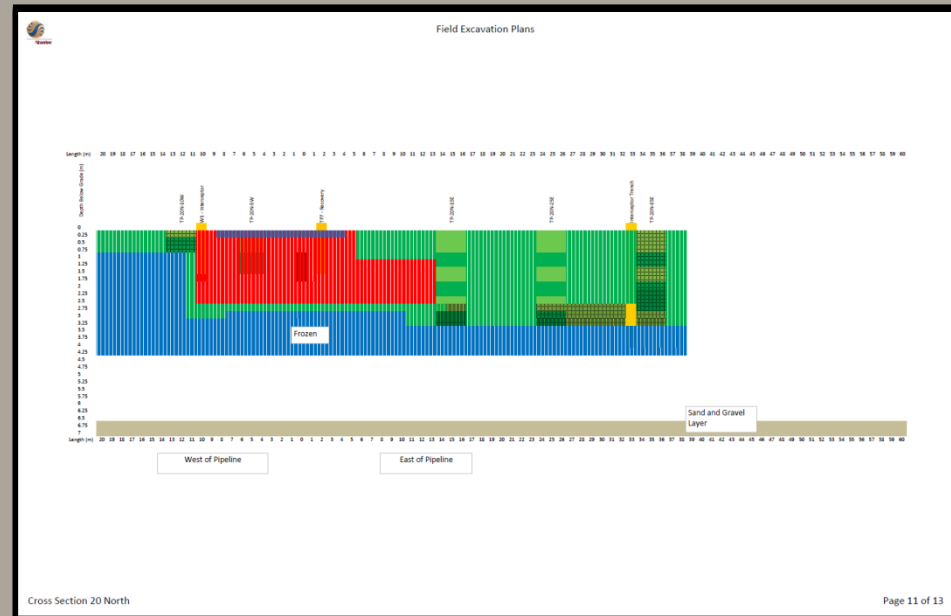
- Water treatment system, assembled on-site
 - settling tanks
 - oil water separator
 - granulated activated carbon vessels
 - sand filters
 - holding tanks
- Discharges approved by NEB and INAC (AANDC)



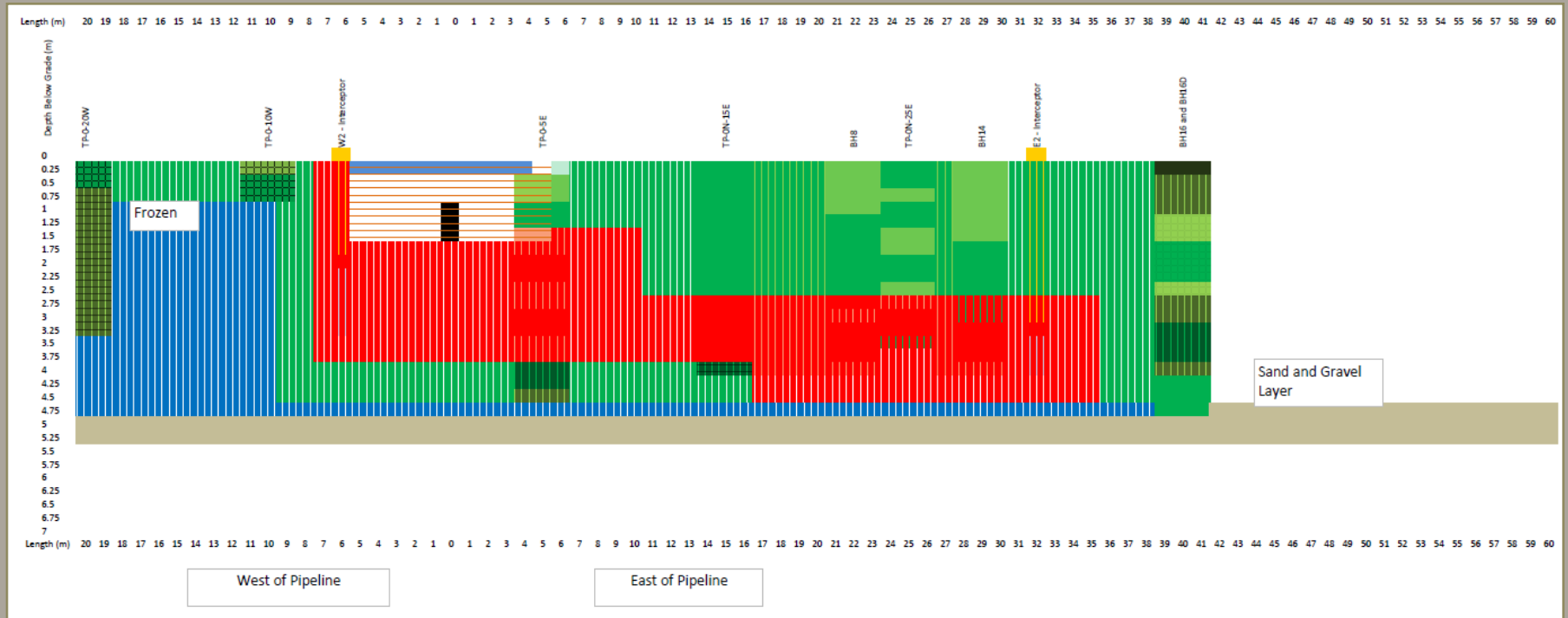
Oil Volume Estimate



Cross-sections used to calculate representative soil volumes



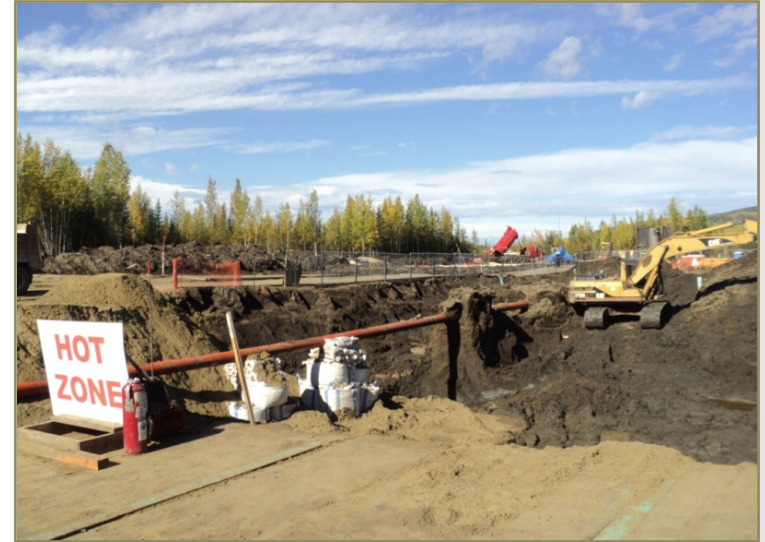
Oil Volume Estimate



$$\text{Volume of oil} = \frac{\text{volume of soil} \times \text{soil density} \times \text{concentration of oil in soil}}{\text{Density of oil} \times \text{conversion factor}}$$

Site Remediation

- Site-specific criteria established to identify the most applicable guidelines to use as remediation targets.
- Combination of federal (CCME) and provincial (Alberta and Ontario) guidelines.

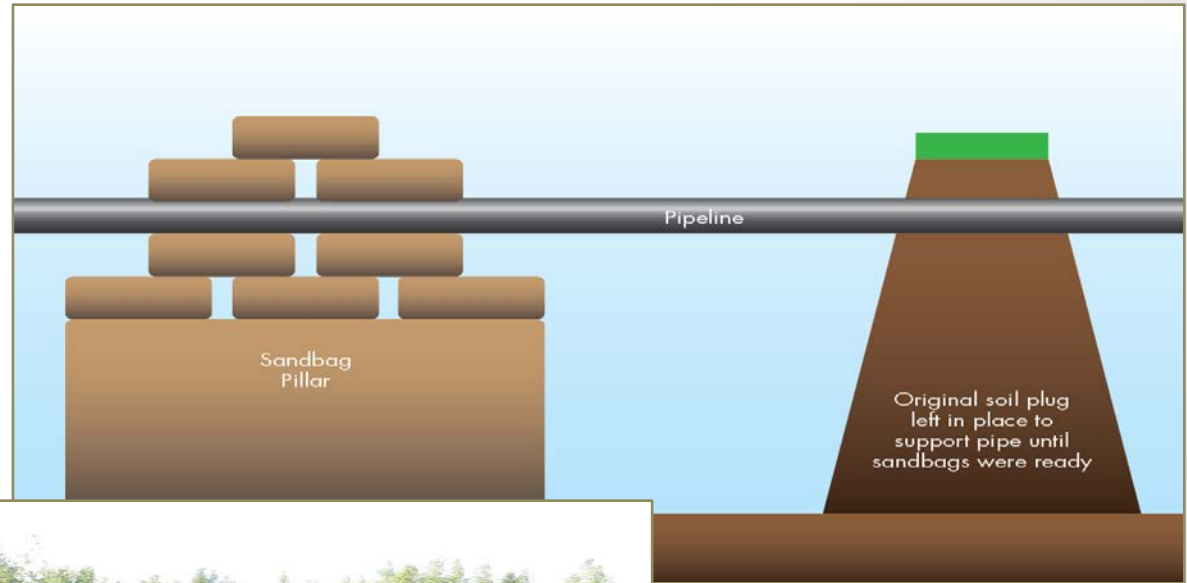


Site Remediation

- Remedial Action Plan approved by NEB.
- Logistical considerations:
 - On-site mobile lab
 - Soil staging areas
 - Establish camp
 - Waste disposal
 - Source backfill
 - Protect wildlife
 - Support active pipeline



Site Remediation: Excavation



Remedial Summary

- Remedial criteria met
- 260 m³ (1600 barrels) of oil recovered
 - 75 m³ as free product
- 500 m³ of water treated
- 12,800 m³ of soil hauled off-site



Reclamation

- Aggregate area used as borrow source
- Salvaged topsoil, trees, and shrubs replaced



Site Status: 2013

- Post-remediation monitoring program underway
- Hydrocarbons have not been detected in groundwater
- Post-reclamation monitoring program underway
- Additional work to address settlement scheduled for fall 2013



An aerial photograph of a forest clearing. The central area is a large, irregularly shaped plot of land where the forest has been removed, leaving a ground covered in brown soil and scattered tree stumps and branches. A small, dark, circular pond is located in the upper left corner of the cleared area. The cleared plot is surrounded by a dense forest of tall, thin evergreen trees. Several yellow survey markers are visible on the ground within the cleared area. The word "Questions?" is overlaid in large orange text in the upper center of the image.

Questions?