A Tale of Two Roads:
Consequences of Peat Conditions and Construction Practices on Peatland Effects, Reclaimability, and Best Practice Development

Terry Osko
Circle T Consulting, Inc.

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Outline

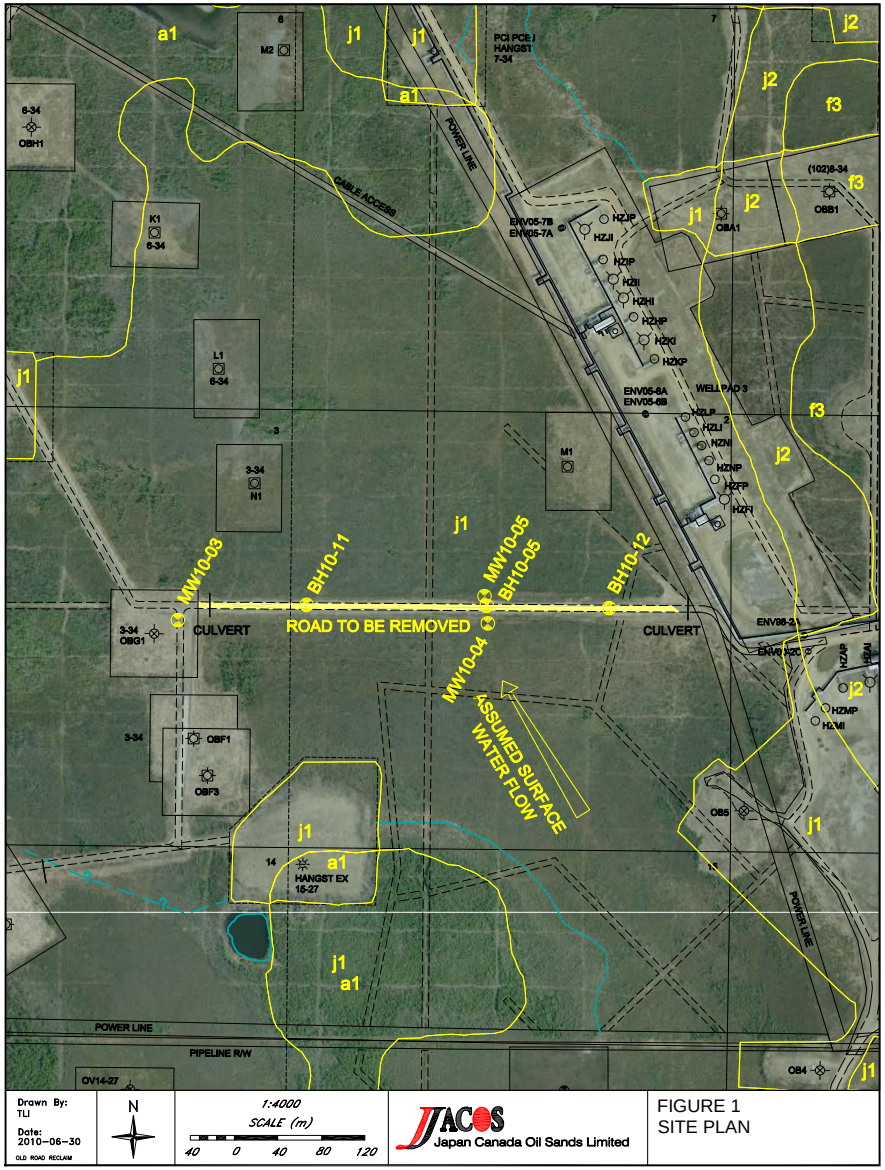
- Describe two experimental road reclamation projects:
  - Site characteristics
  - Study objectives
  - Work completed
  - Observations and insights
- Compare/Contrast Site-specific Consequences
  - Site impacts
  - Reclaimability
  - Post-reclamation recovery
- Implications for Best Practice Selection/Development

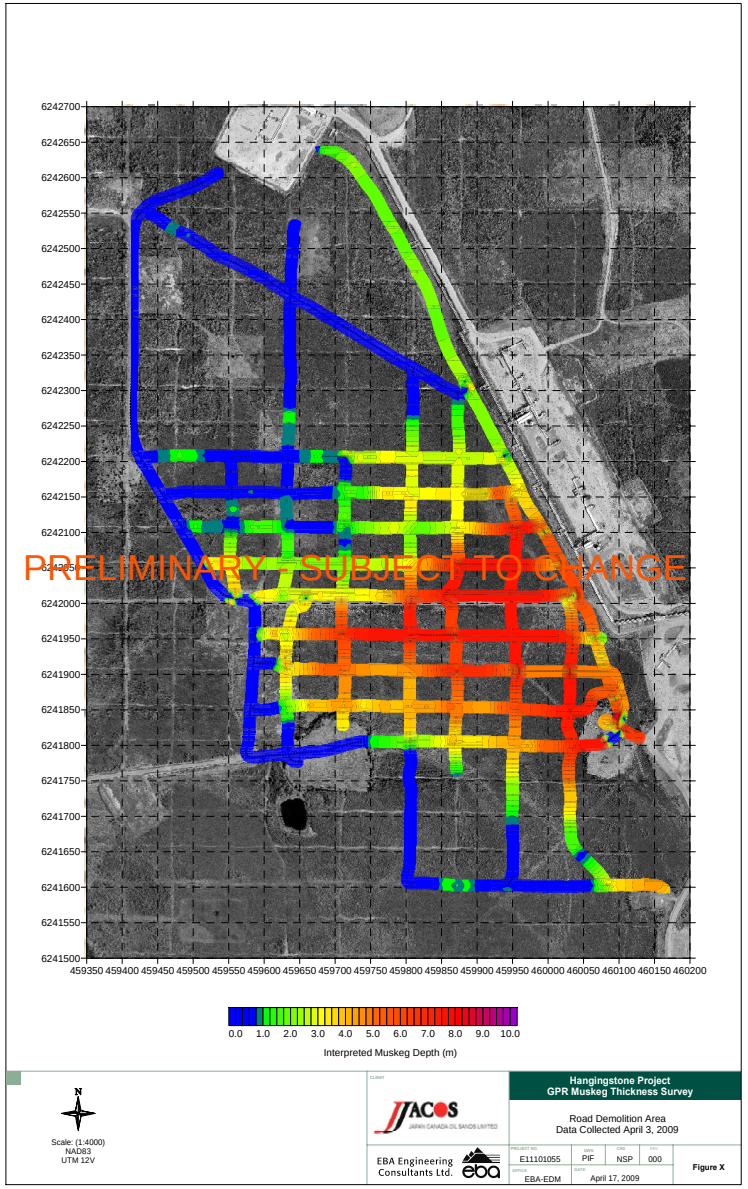
Project 1: JACOS

- Deep peat ☹
- Deep fill ☹
- Clayey Surficial Deposit ☹
- Low volume, slow flow of water ☺

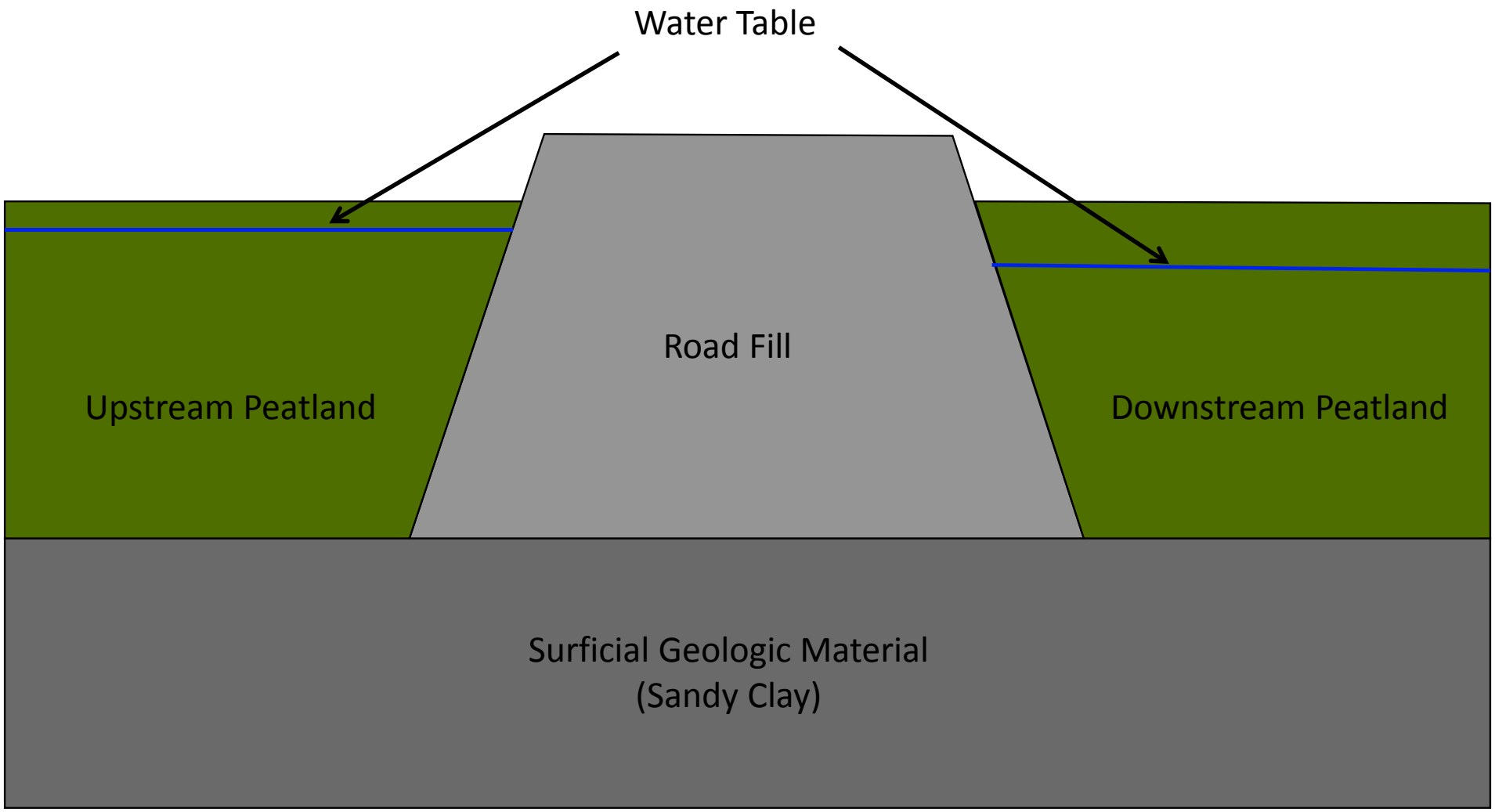
JACOS HANGINGSTONE PROJECT

Site Description



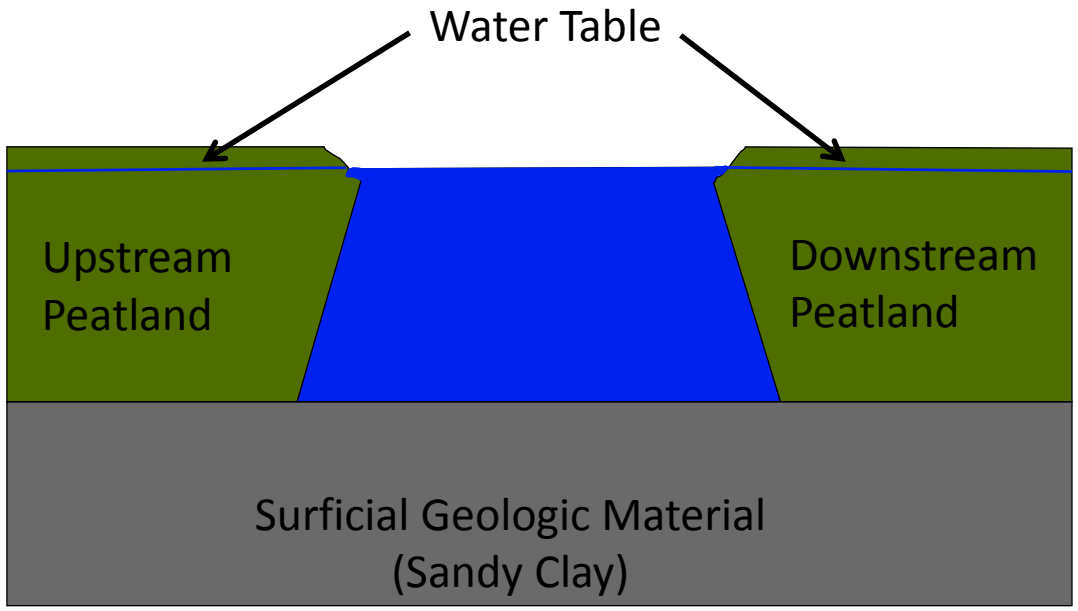


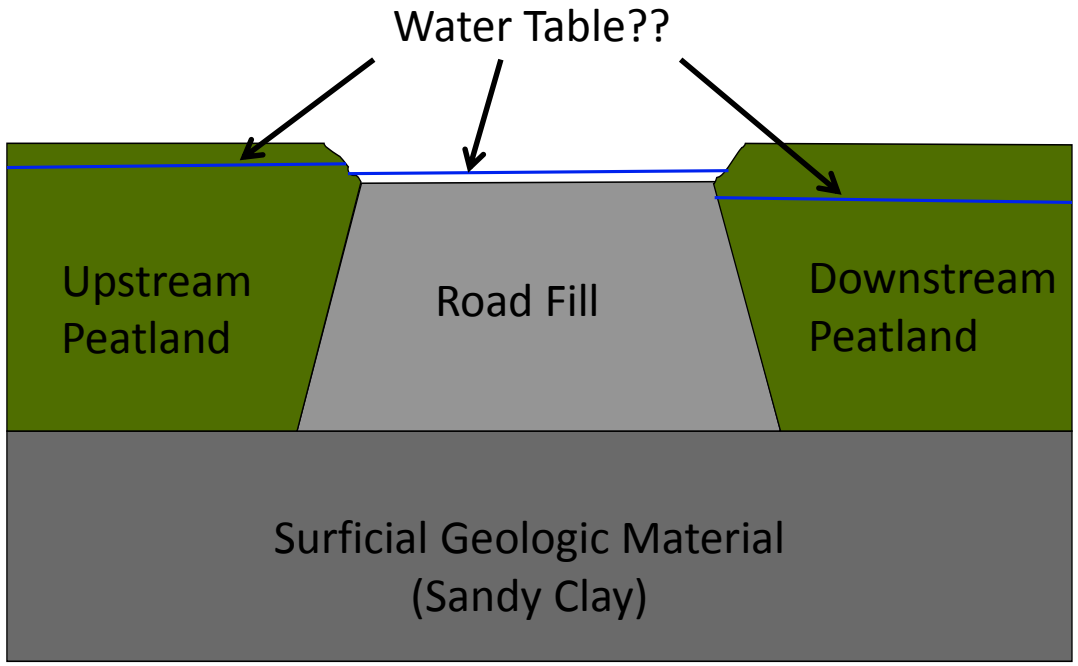
Site Detail: Road Cross-Section



Fill Removal Choices

- Remove all fill from the road
  - Difficult and expensive
  - Leaves open pool of water
  - Should restore hydrologic continuity
- Lower fill to within water table
  - Leaves surface for revegetation
    - Difficulty?
  - Hydrologic continuity?



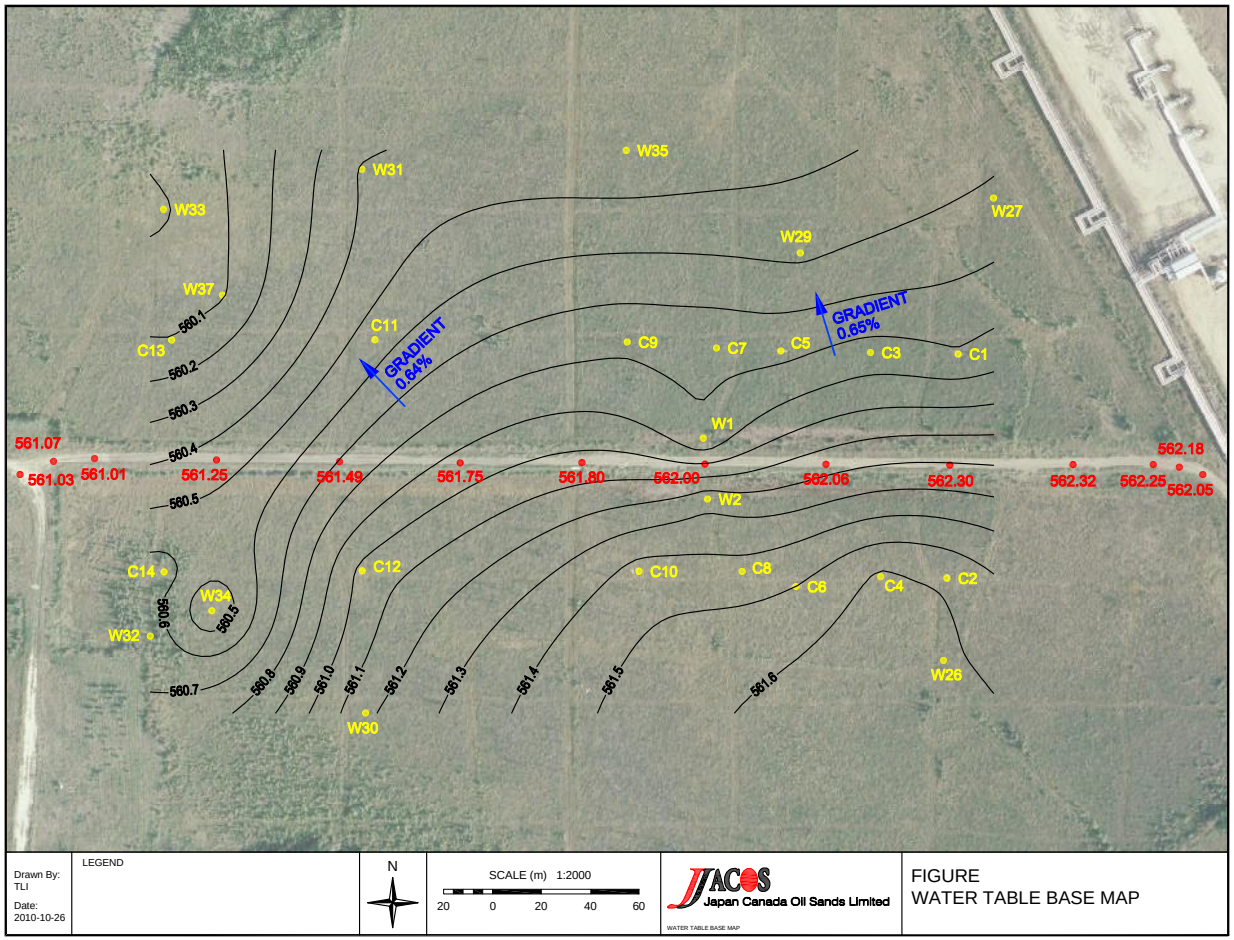


Project Objectives

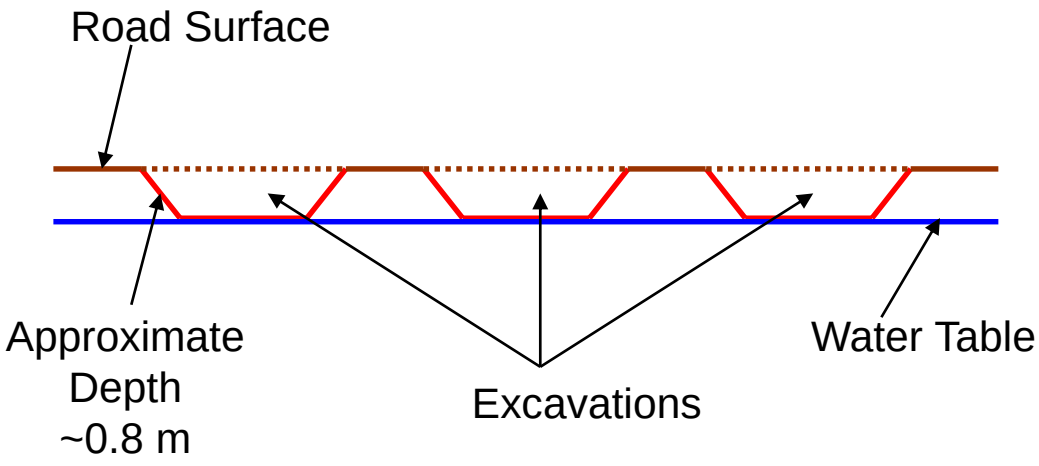
- Characterize ecohydrologic conditions
  - Water table
  - Soil moisture
  - Vegetation
  - Carbon and nutrient dynamics
- Determine whether partial fill removal restores natural drainage and measure impacts on ecohydrology
- Evaluate revegetation methods for road surface

Project Plan

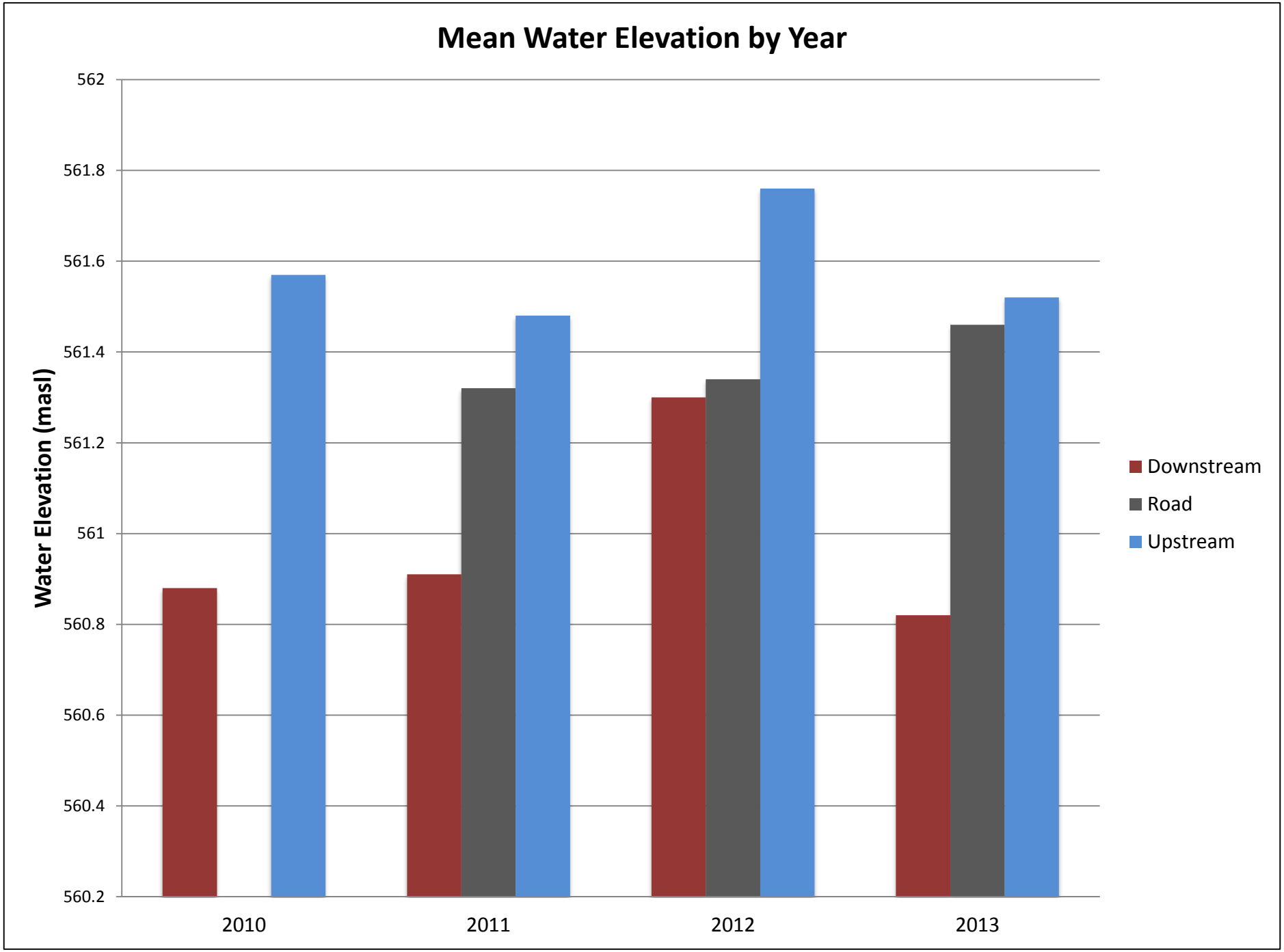
- Document pre-excavation conditions
  - Water wells
  - Carbon exchange
  - Peat properties
  - Nutrient cycling
- Estimate excavation depth based on water table depths
- Excavate
- Apply revegetation treatments
- Measure responses

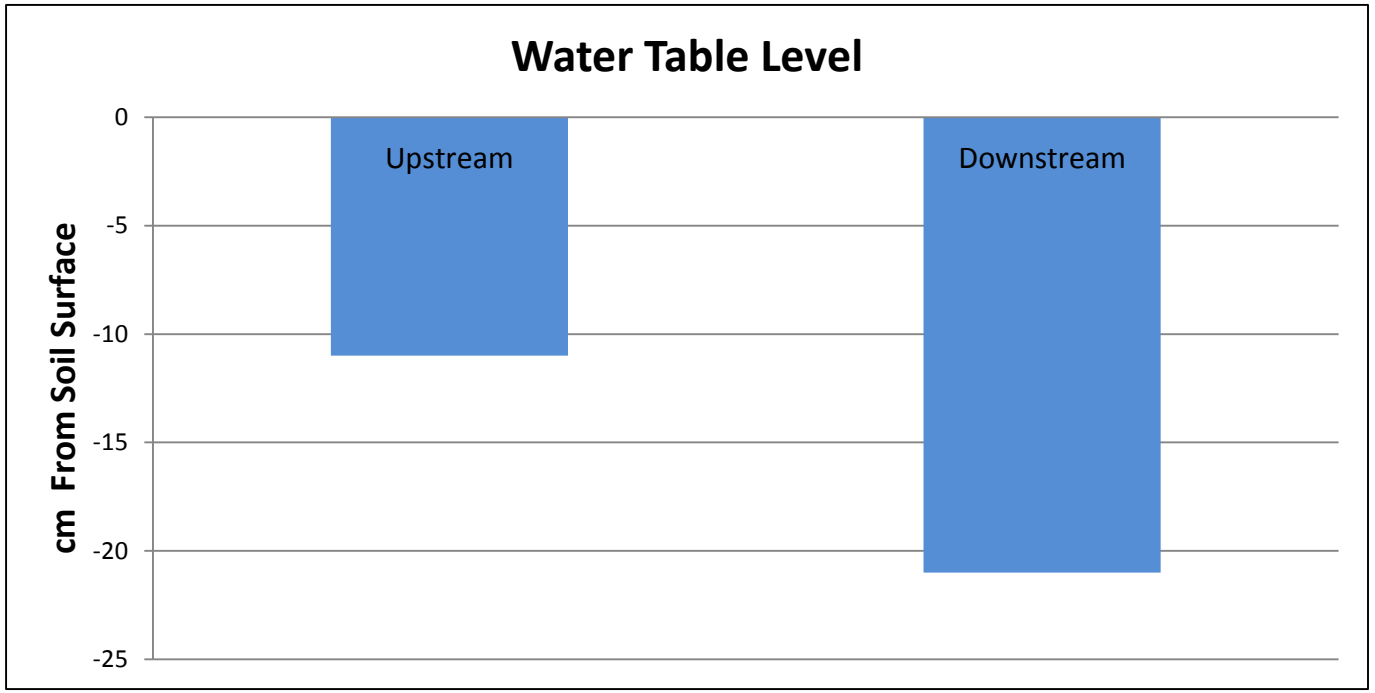


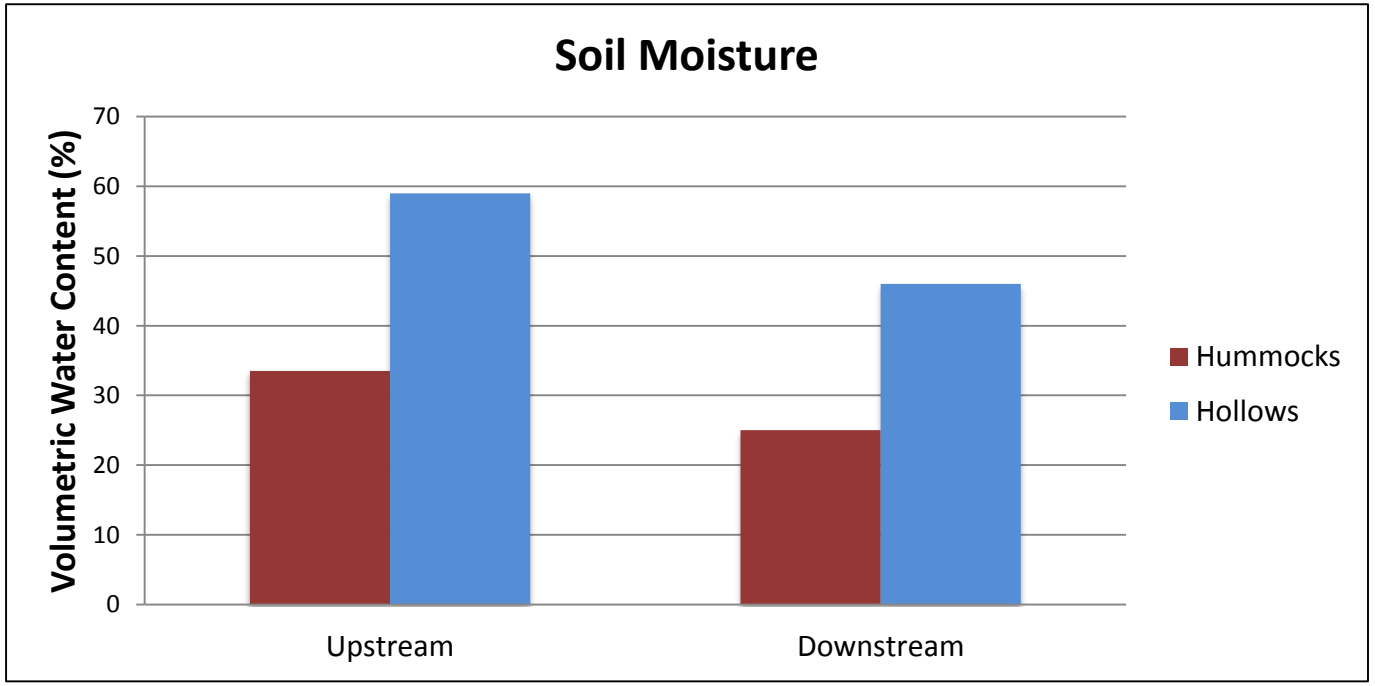
Road Excavation



- 2 prior seasons of water table observations
- 3 excavations as replicate “blocks”
- January excavation
  - Reduced impact from equipment
  - Logistically easier
  - Still some water flow


Mean Water Elevation by Year
Water Elevation (masl)
562
561.8
561.6
561.4
561.2
561
560.8
560.6
560.4
560.2
2010
2011
2012
2013
Downstream
Road
Upstream


Water Table Level
0
-5
-10
-15
-20
-25
cm From Soil Surface
Upstream
Downstream

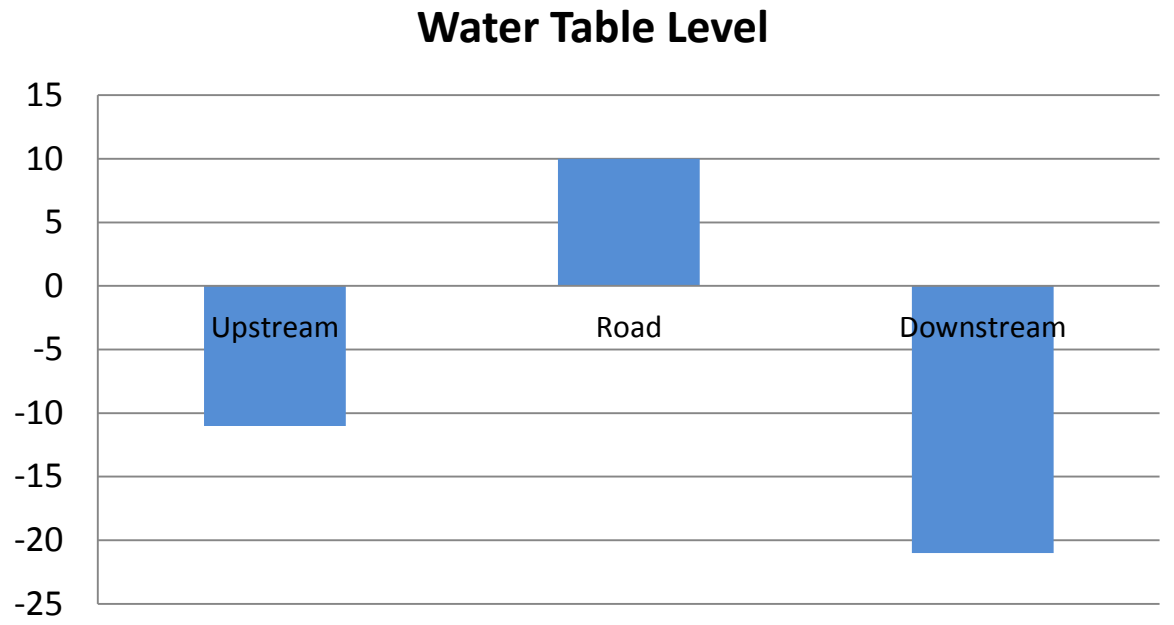

Soil Moisture
70
60
50
40
30
20
10
0
Volumetric Water Content (%)
Upstream
Downstream
Hummocks
Hollows

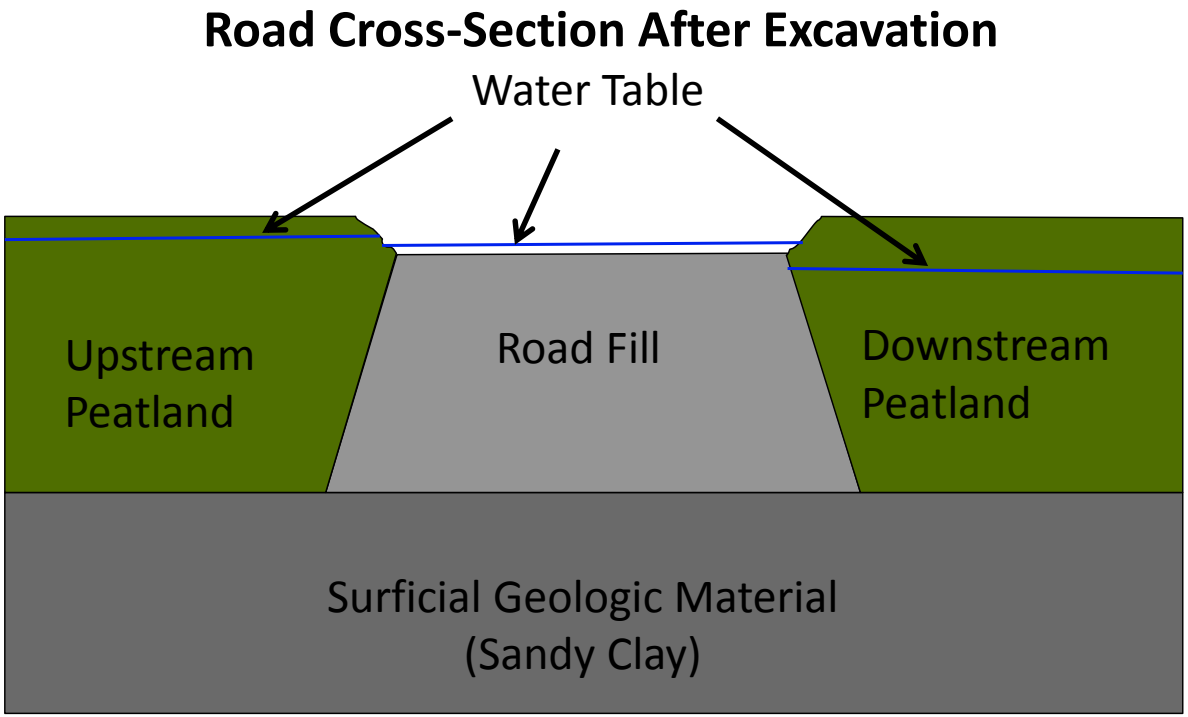
Impact Summary

- Road has impeded water flow
  - Water table and moisture differences between upstream and downstream sides of road
    - Some impact on vegetation
    - Minor impact on peat
    - Little impact on carbon and nutrient dynamics
    - Impacts may have been greater with higher water flow
- Lowering road surface did not sufficiently improve water flow
- Water table differential on opposite sides of road make managing water table on road difficult

Relative Water Table Position

- Water table is below soil surface both upstream and downstream
- Water table is above soil surface on road for at least part of the year
  - Excavation surface is lower than adjacent peat surface
- Fill surface is poor substrate and difficult to revegetate

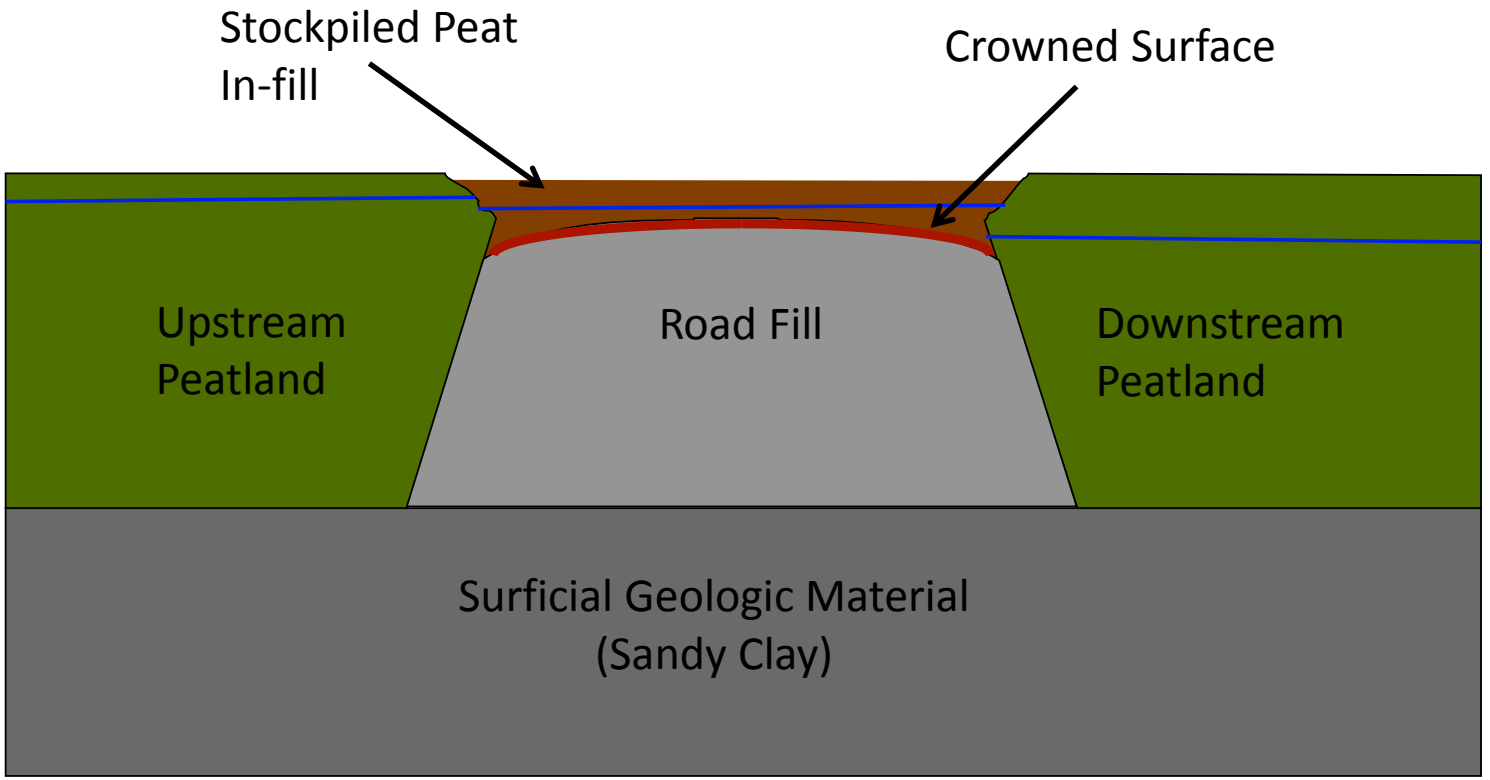





Long periods of flooding hinder revegetation efforts

Recommendations

- Crown road to improve surface drainage
  - Cut drainage channels also?
- Fill excavation with stockpiled peat
- Improve porosity of road (culverts, deep channels, remove sections of road)



Project 2: Suncor

- Shallower peat ☺
- Shallower fill ☺
- Sandy Surficial Deposit ☺
- Low volume, slow flow of water ☺

Site Description

- Gravel-capped clay fill road on fabric liner over fen peatland.
  - 250 m long
  - 6 years old
- Clay thickness: 1.4 – 1.7 m
- Compressed peat thickness: 0.7 – 1.4 m
- Underlain by sand
- Evidence of vegetation mortality due to flooding on the upstream side

Objectives

- Remove fill entirely
- Re-use the fill
- Achieve natural revegetation of re-exposed peat to an acceptable peatland community
- New peatland community naturally sustainable by restoration of suitable hydrologic regime

Questions/Unknowns

- Will the road fill be reusable? If so, how much of it?
- Will the buried, compressed peat decompress naturally?
- Will the peat regain its pre-disturbance hydrologic properties?
- Will favourable hydrologic conditions establish on their own?
- Plus other questions – e.g. revegetation

Road Removal Process

- Progressively removed fill and carefully removed liner from one end to the other
- Pumped water off at excavation front to keep working area “dry”
- Organics and very wet soil along apron, as well as liner and geo-grid separated and land-filled
- Drier material hauled nearby onsite for parking lot construction
- Start to finish approximately two weeks, 10 full days of work

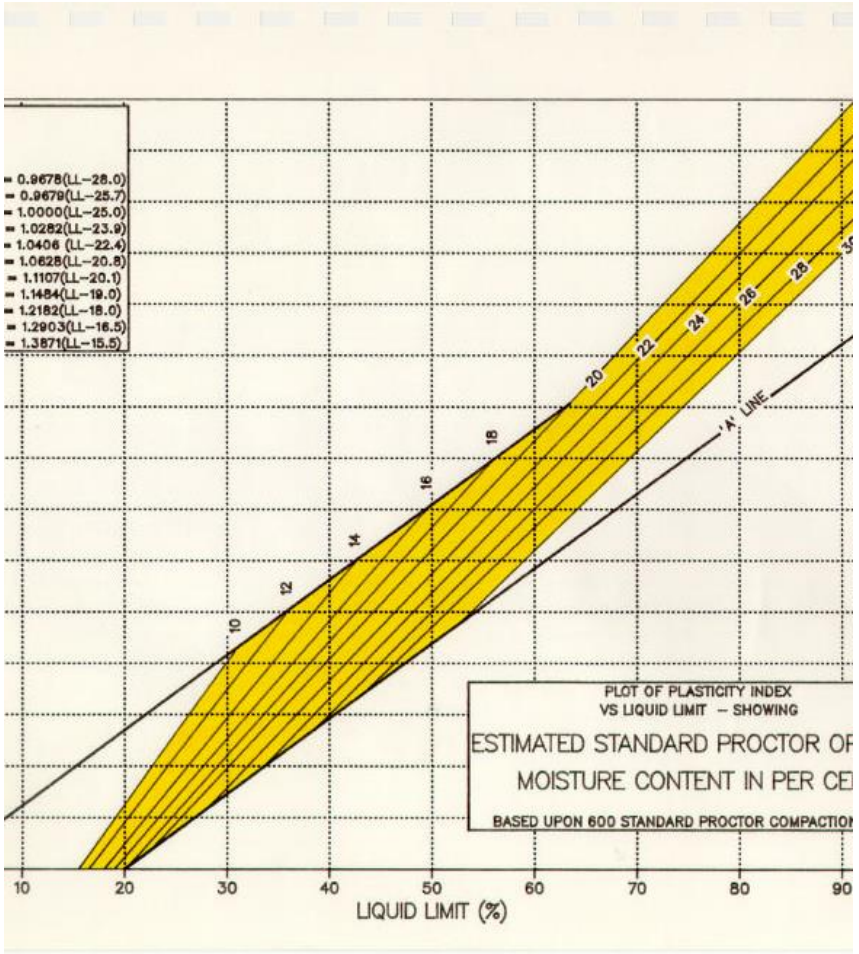

DEERE

Soil Moisture and Density Analysis

- Estimated maximum density:
- 1844 (kg/m^3)

- Estimated optimum moisture to achieve max density: 13.8%

- Moisture of samples:
- Mean = 11.5%
- Range = 8.1% - 14.2%
- (2 of 72 samples >13.8%)



(From: AB Transportation Method TLT-413 (02))

Moisture Trends in Road Profile (% moisture)

	Upstream Shoulder	Middle	Downstream Shoulder	Depth Average
0-25 cm	9.4^{a1}	9.0^{a1}	10.3^{a1}	**9.5^{a}**
25-50 cm	10.9^{b1}	10.5^{b1}	12.7^{bc2}	**11.4^{b}**
50-75 cm	10.0^{a1}	11.8^{c2}	11.7^{b2}	**11.2^{b}**
75-100 cm	11.9^{bc1}	11.8^{bc1}	12.9^{bc1}	**12.2^{c}**
100-125 cm	12.4^{c1}	11.5^{bc1}	12.7^{bc1}	**12.2^{c}**
125-150 cm	12.3^{c1}	12.2^{c1}	13.4^{c1}	**12.6^{c}**
Position Average	**11.1^{1}**	**11.1^{1}**	**12.2^{2}**	

Fill Volumes

- Total volume of fill removed (m^3):
  - Gravel: 181
  - Mud, organics, liner material: 987
  - Useable clay: 4866
- Useable clay as a proportion of clay fill = 83.1%

Road Fill Summary

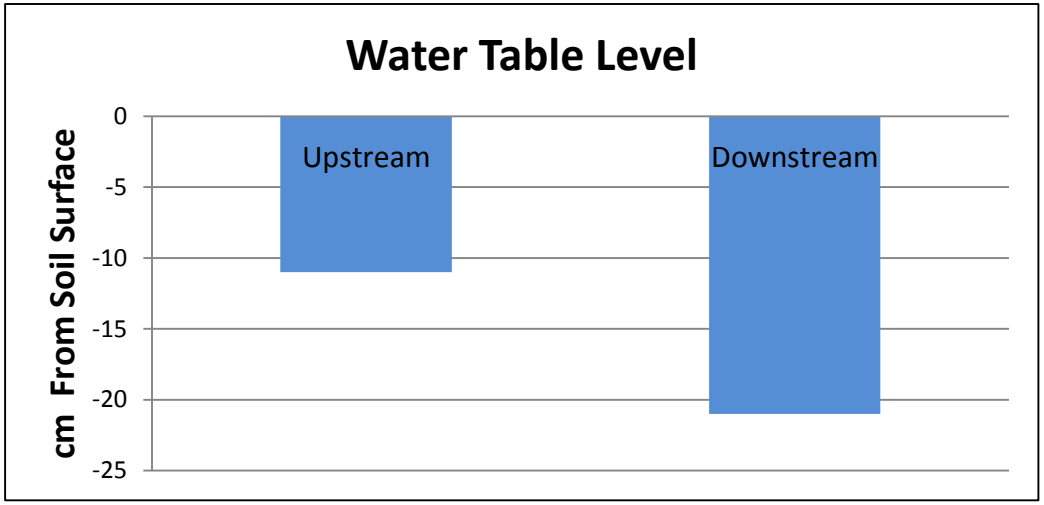
- Bulk of fill (83%) immediately reusable
- Soil quality excellent
- Much cheaper than a new borrow if the fill can be used nearby
- Less footprint than new borrow also, thereby reducing reclamation liability
- Excavation was not complicated, probably depends on depth of fill, depth and nature of underlying peat, initial construction

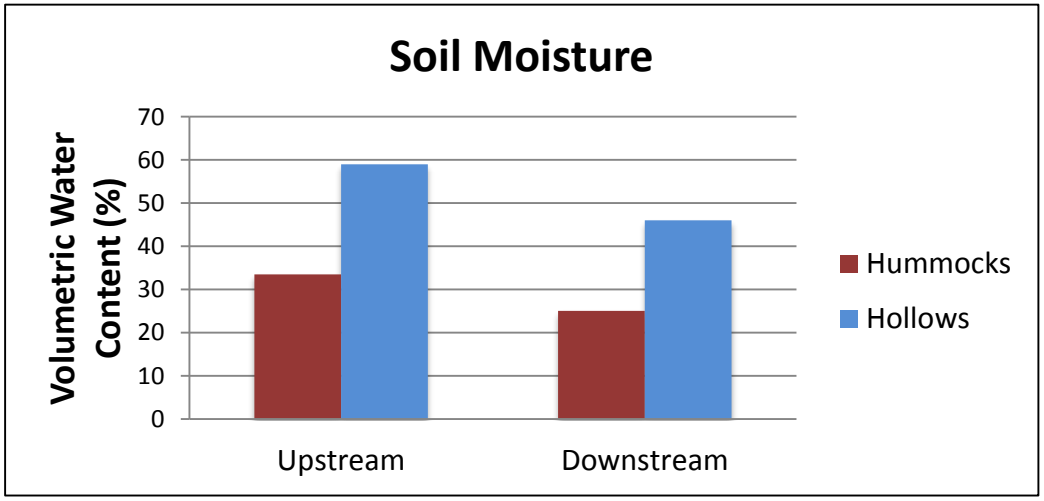
Peat Response Summary

- While compressed, formerly buried peat surface showed seasonal oscillations with moisture conditions, therefore decompressing naturally.
- Physical and hydrologic properties of previously buried peat within natural ranges
  - Additional evidence that properties able to restore naturally.
  - Increasingly likely if appropriate vegetation establishes
- Additional interventions likely not required.

Review of Impacts

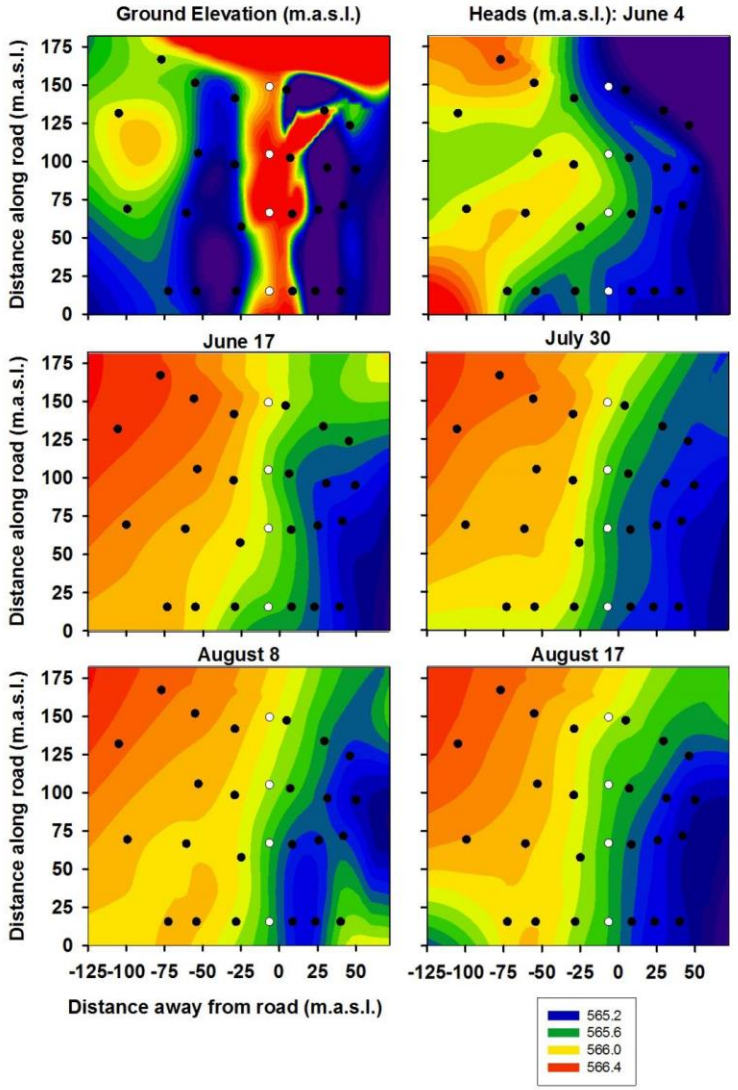
- JACOS
  - Road disrupted hydrology, with impacts on vegetation
  - Logistically difficult to remove road impacts
  - Impacts not addressed by just lowering road surface
  - Vegetation effects permanent





Review of Impacts

- Suncor
  - Road had minimal impact on hydrology
  - Removal of road was easy
  - Hydrology and peat properties will likely recover naturally
  - Likely to achieve acceptable revegetation naturally



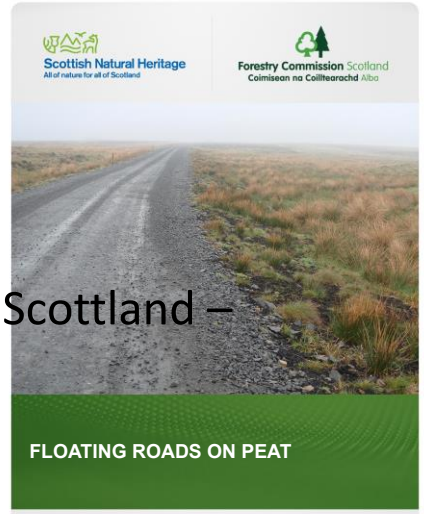
Implications for Best Practices

- Reclamation of Existing Roads
  - No reason not to try to fully remove relatively shallow fill from relatively shallow peat
  - While difficult to remove fill from below water line, fill quality is likely acceptable (i.e. road failure if fill was saturated)

- Managing Future Footprint (Wetland Policy)
  - Avoidance
  - Minimization
  - Compensation (reclamation)

Better Planning = Better Practices

- Avoidance, Minimization, Compensation (Reclamation)
  - Avoid undesirable impacts, not necessarily peatlands
  - Evaluate peatland conditions
    - Select route options
    - Adopt condition-specific practices
      - Adopt practices already proven elsewhere (e.g. Scottland – proper pre-loading of peat)
  - Plan to make reclamation easy
    - Following the strategies of avoiding negative impacts and adopting condition-specific practices will reduce reclamation difficulty and improve reclamation success



Thanks!

- CAPP - PTAC
- Alberta-Pacific Forest Industries
- Canadian Natural
- Cenovus
- ConocoPhillips Canada
- Devon Canada
- Husky Energy
- Imperial Oil
- Japan Canada Oil Sands
- MEG Energy
- Nexen Energy ULC
- Statoil Canada
- Suncor Energy
- University of Alberta
- University of Waterloo