



Site Restoration Challenges at FOX-C – 2007 Update

April 29, 2008

Acknowledgements

Mark Yetman – INAC

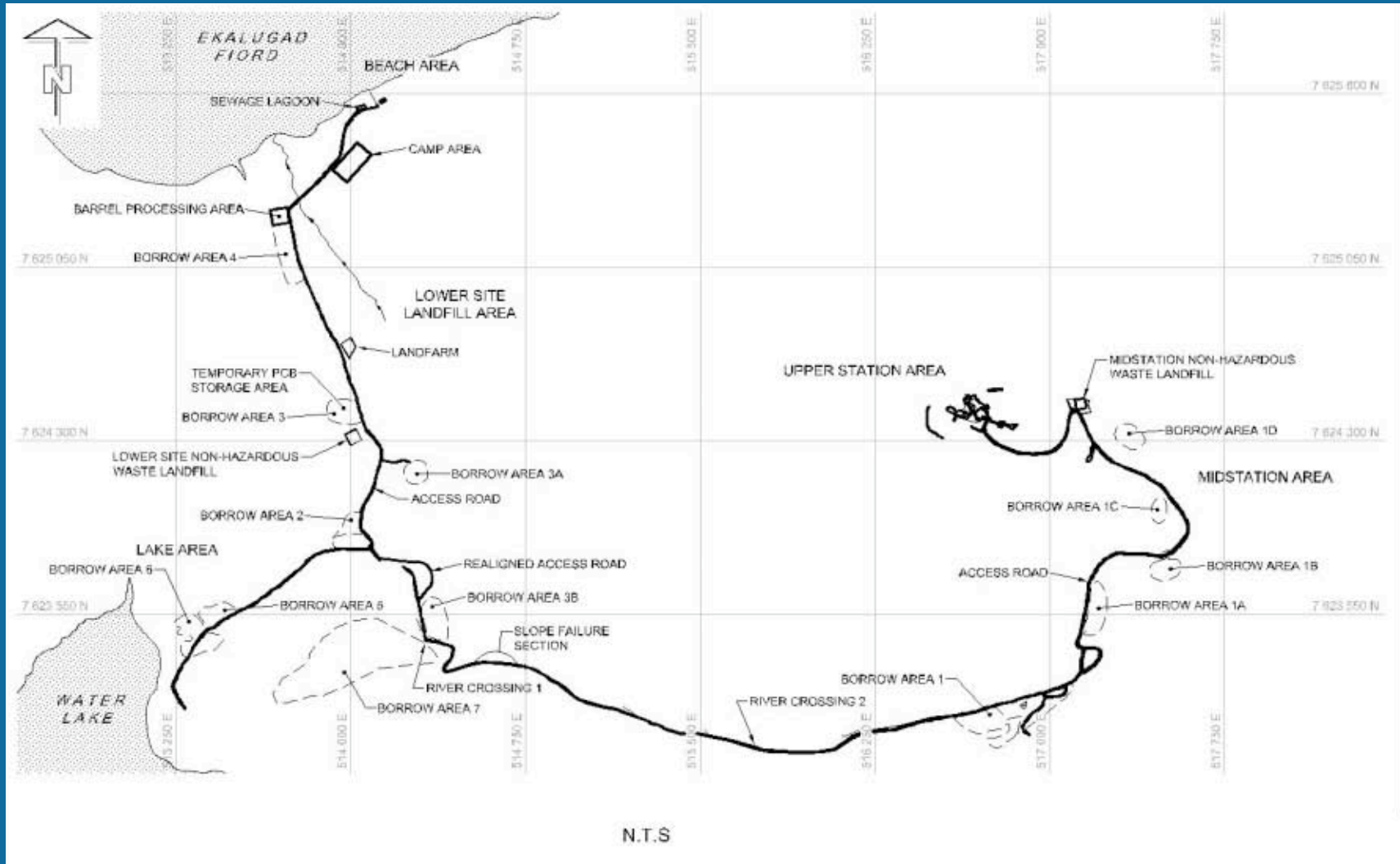
Brad Thompson – PWGSC

Rudy Schmidtke – UMA

Background

- Located approximately 240 km north of Qikiqtarjuaq on Ekalugad Fjord, Nunavut
- Three major site areas:
 - Lower Site
 - Mid Station
 - Upper Site
- Elevations range from sea level to ~800 m





Site Overview

Background

Intermediate DEW Line Site

- Built by US Air Force in late 1950s
- Abandoned by 1963
- Responsibility transferred to INAC



Site Investigations

- Completed between 1994 and 2003
- Gap analysis completed & previous results compared to INAC Contaminated Site Soil Protocol criteria
- Seven borrow sources identified in 2003
- Adopted DND DLCU 6-type classification system



Site Investigations – Lessons Learned

- Additional delineation during construction is feasible
- Identification of easily accessible, good borrow for construction start-up is key
- Provision for borrow searches included in contract - permits



Design

- Typical northern clean up facilities

Lessons Learned

- Regulatory submittals should consider field changes
- Flexible specifications – measurement for payment clause



Construction Summary

- Equipment mobilization September 2005; construction commenced June 2006 and continued in 2007
- Construction of most temporary and permanent facilities started in 2006
- Borrow sources developed
- Processing of barrels and landfilling of non-hazardous and hazardous waste



Borrow Sources

- Borrow material at FOX-C obtained from natural deposits
- Considerable effort to find additional borrow areas
- Borrow areas developed in 2006 and prepared for 2007 were not necessarily usable
- Introduction of Type 1 (cobbles and boulders) fill to mitigate high moisture of some borrow areas
- Contributed to revision of Upper Site facilities



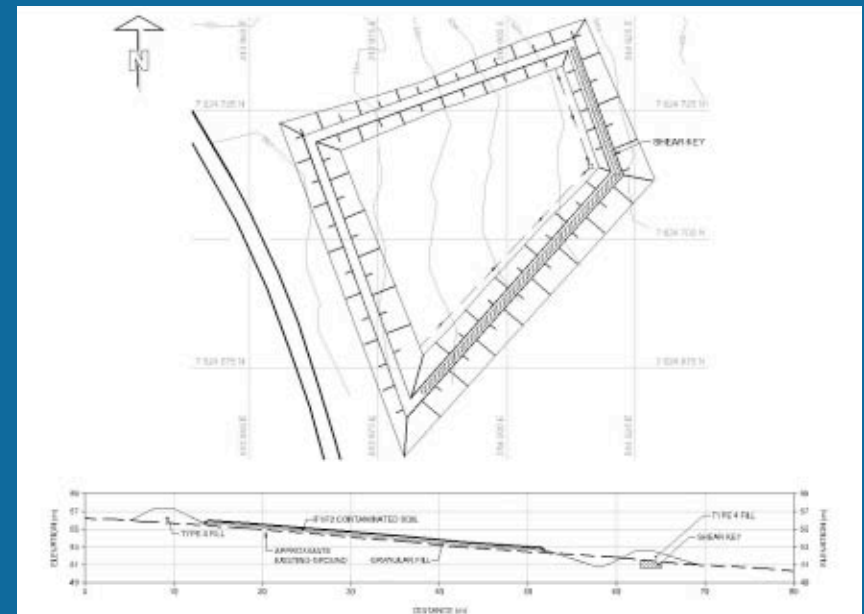
Active Layer Instabilities

- Active layer 0.6 m to 1.5 m
- Native soils at the lower site are sand, silts and gravels; slopes dominated by colluvium
- Removal of thermal cover problematic
- Previously disturbed soils



Landfarm

- Situated at lower station on a long, gentle slope
- Movement occurred after completion of the east berm
- Ruptures at toe and tension cracks noted – shallow slab failure
- Shear Keys incorporated in berm repairs
- No additional movement noted in 2007



Slope Failures

- Slope failure occurred along road to upper station in 2006
- Occurred after ditching exposed permafrost and removed toe support
- Same failure mode noted throughout the site
- Generally cooler temperatures in 2007 plus equilibrium of slope may have contributed to stability in 2007



Active Layer Instabilities – Lessons Learned

- Fine-grained saturated soils at FOX-C are especially prone to movement
- Low-strength slip planes at the base of the active layer provide a preferential location for slope failures
- Shear keys are effective measures for stabilizing embankments
- Removal of toe support can create slope failures that are difficult to control



Road Construction/River Crossings

- The original road had deteriorated such that it was impassible by ATV – considerable effort went into upgrading in 2006; only maintenance required in 2007
- Ditches provided short-term stability by draining active layer; generally contributed to long-term road stability
- Wet subgrades caused fine-grained soils to migrate into the granular road fill



Road Construction/River Crossings

- River Crossing 1 designed as a porous embankment
- High sediment load caused pore spaces to fill with sand
- Breached during heavy rains in August 2006
- River Crossings 1 & 2 redesigned with culverts



Road Construction/River Crossings – Lessons Learned

- Design of porous embankments should consider high glacial sediment load; 2007 culvert embankments performed adequately
- Ditching provides short-term stability for roads, but exposes more permafrost, which could introduce seasonal stability issues
- Ditching likely alters permafrost level, and road instabilities may be seasonal



Conclusions

- Construction challenges in the Arctic are diverse - toolkit
- Even careful planning cannot account for all situations – flexibility
- Design and tender should consider alternatives



Questions?

