Arctic Ice-Road and Snow Transportation Networks

Michael R. Lilly
Geo-Watersheds Scientific

Horacio A. Toniolo
University of Alaska Fairbanks

Ron Paetzold
Geo-Watersheds Scientific

Pete Cott
Fisheries and Oceans Canada

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Climate Change Issues?

- **Lack of Past Data**
  - Mainly undeveloped areas
  - Little to no past data

- **Lack of Current Data**
  - Current operations have worked in water rich areas
  - Conservative permit limits, not requiring information

- **Lack of Future Data??**
  - Terrestrial, ocean networks
  - Regional meteorological, hydrologic agencies, partners
Climate Change Issues?

- **Shorter Seasons**
- **More Variable Seasons**
  - Too warm
  - Longer to freeze
  - Too cold
  - Safety
  - Equipment breakdowns
- **Mid-Season Closures**
- **Changing Water Source Thresholds**
- **Increased Uncertainty**
  - Real/ Perception
Climate Change Issues?

- **Needs!**
  - RWIS concepts
  - Testing permit assumptions
  - Forecasting tools
  - Network management and design tools
  - Better design and permitting data
  - Frozen-soil geotechnical data
  - Watershed mapping
  - Partnerships
    - Industry, Agencies, professionals, non-profits
Why Winter Transportation Networks?

- **Resource Development, Support**
  - Remote Communities
  - Remote Mining
  - Oil and Gas Development

- **Seasonal Constraints**
  - Other Access = High Cost for Heavy Loads
  - Environmental Protection
  - Short-term use
    - 1-20 years
  - Long-term use
    - Decades
    - Life of community
Oil and Gas Development

- **Road, Pad Infrastructure**
  - Exploration, Largest User
    - Road construction speed is highest priority
  - Operations and Maintenance of Pipelines
  - Short/Medium-Term Use

- **Facilities**
  - Mud and Drilling Support Operations
  - Enhanced Recovery
  - Processing Facilities
  - Main Camp Operations
    - Potable water
    - Medium-Term Use
Remote Mining Operations

• Lack of Port Access
  – People, Perishables by Air
  – Diamond Mines
    • Low resource weight

• Regional Networks
  – Routes to Mines, Villages
  – Cost Sharing
Ice and Snow Roads

- **Snow Roads, Trails**
  - Faster Build Time
  - Lower Vehicle Weights
  - Slower Transport Times

- **Ice Roads**
  - Small Roads
    - Pipeline O/M
    - Environmental Restoration
  - Large Roads

- **Ice Pads**
  - Seasonal Camps
  - Drilling Platforms
  - Multi-Season Applications
    - Rare, limited years
How – Materials?

- **Snow**
  - Prepacking
  - Drift Harvesting
  - Lake Harvesting
  - Needed for Construction Equipment Loads

- **Ice Harvesting - Lakes**
  - Ice Chips
    - Build road-bed faster
    - Less maintenance
  - Not Rivers

- **Water**
  - Mainly Lakes
  - Canada – Large Rivers
How – Process, New Routes?

- Design
- Permitting
- Tundra-Travel Opening
- Construction
- O/M
- Decommissioning
- Tundra-Travel Closing
- Permit Compliance
How – Process, Repeat Routes?

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How – Process, Repeat Routes?

- Tundra-Travel Opening
- Construction
- O/M
  - Mobilization
  - Work Period
  - Demobilization
- Decommissioning
- Tundra-Travel Closing
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How – Process, Repeat Routes?

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How – Process, Repeat Routes?

**Repeat Every Year!**

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- Construction
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  - Mobilization
- **Work Period**
  - Demobilization
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How – Areas to Improve?

Repeat Every Year!

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Improve

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How – Design?

- Flat Terrain
- Distance to Water Sources
- Stream/River Crossing
- ~1M Gallons Per Mile
  - Smooth terrain
  - Rigs, heavy loads
- ~2M Gallons Per Mile
  - Rough terrain
- ~ 20 mile Practical Limit
- Permitting
  - Land, water use
How – Construction?

- **Snow Packing**
  - Early protection
  - Low impact equipment

- **Water Flooding**
  - Heavy loads
  - Build up over many layers

- **Ice Chips/Water Flooding**
  - Build up fast layers
  - Water flooding
  - Less maintenance

- **Grading, Grooving**
  - Safety friction
How – O/M?

- **Traveler Safety**
- **Road Integrity**
- **More Water!**
  - Water Spraying
- **Surface-Roughness**
  - Grooving
  - Traveler Safety
- **Sublimation**
  - Less clean ice
  - More dark (silty) ice
- **Spring Melt/ Refreezing**
  - Solar degradation
How – End of Season?

- **Let It Melt!**
  - Before major snow drifts

- **Streams, Rivers**
  - Notching
  - Reduce damming
  - Fish passage

- **Summer Permit Compliance**
  - Stream crossings
  - Lake recharge
  - Tundra Surface damage
Winter Gravel Roads?

- Winter Icing
- Reduce Loss of Roadbed Material
- Reduce Environmental Impact
- Ice Grooving
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Thank You
Questions?

http://www.uaf.edu/water/projects/nsl/nslakes.html