Nunavut Housing Corporation

November 2013

Pan-Territorial Permafrost Workshop

Climatic Adaptations to Construction in Nunavut

Agenda

- **Basic Facts About Nunavut**
- **Logistical Challenges**
- **Permafrost Foundation Types in Use by NHC**
- **Challenges**
- **NHC Needs**

Nunavut Basic Facts

- 33,980 people in 25 isolated communities
  - Population ranges from 140 to 3,300; 7,000 in Iqaluit – the Capital.
- Total dwellings: 10,000
  - Ranging from 60 to 800 dwellings per community;

    2,560 in Iqaluit
- 1.9 million km^2
  - Representing 20% of Canada's land mass
  - Double the size of Ontario
- **No road or rail access**

---Kugluktuk to Pangnirtung 1800km (East/West)

---Grise Fiord to Sanikiluaq 1850km (North/South)

Shipping Challenges

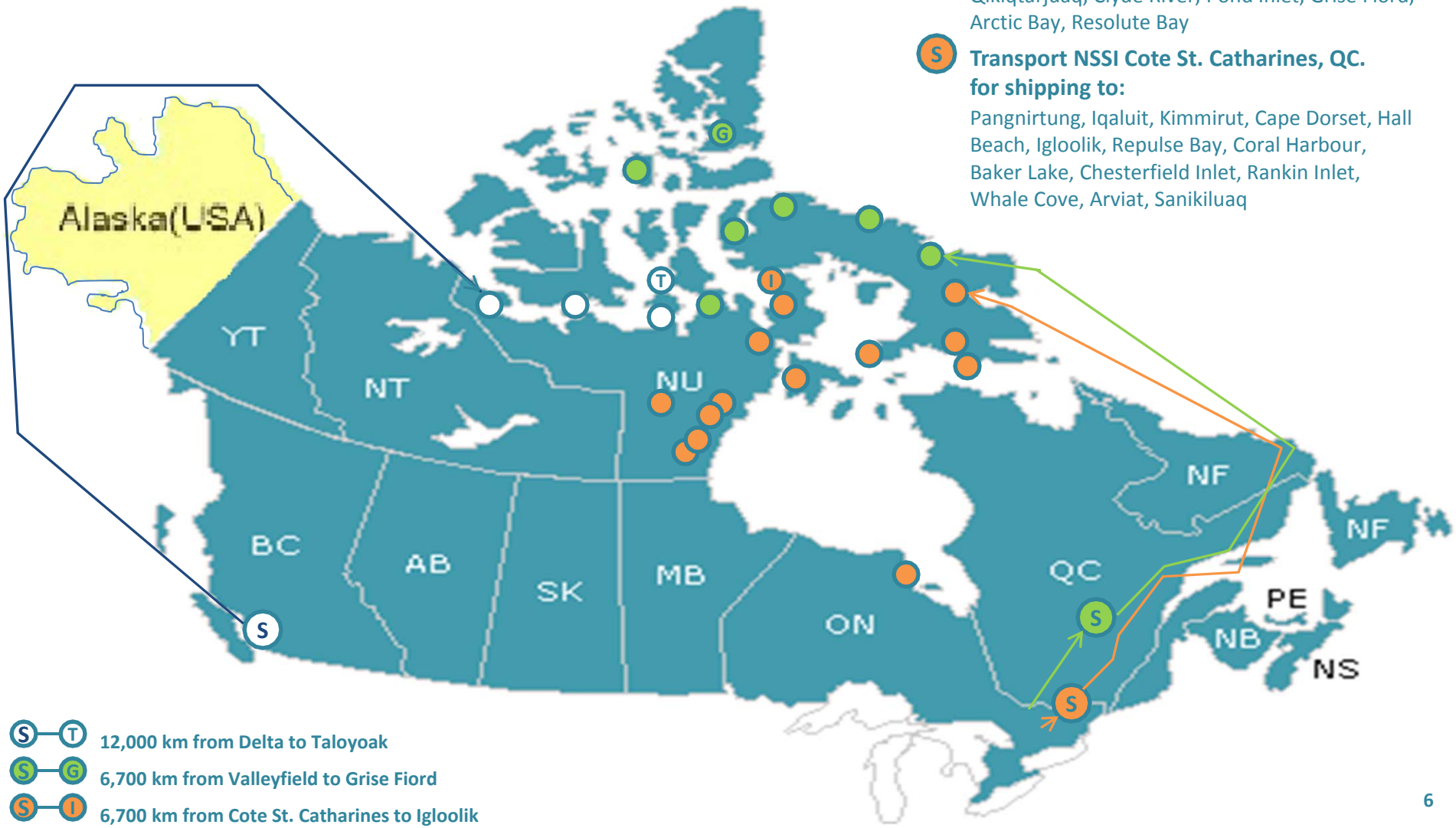
- Heavy reliance on maritime shipping.
- Limited shipping season presents logistical challenges.
- Late summer or early fall shipping limits construction season even further.

Shipping Challenges

S **Transport to NTCL Delta, B.C. for shipping to:**
Kugluktuk, Cambridge Bay, Gjoa Haven, Taloyoak

S **Transport to NEAS Valleyfield, QC. for shipping to:**
Qikiqtarjuaq, Clyde River, Pond Inlet, Grise Fiord, Arctic Bay, Resolute Bay

S **Transport NSSI Cote St. Catharines, QC. for shipping to:**
Pangnirtung, Iqaluit, Kimmirut, Cape Dorset, Hall Beach, Igloolik, Repulse Bay, Coral Harbour, Baker Lake, Chesterfield Inlet, Rankin Inlet, Whale Cove, Arviat, Sanikiluaq



S—T 12,000 km from Delta to Taloyoak

S—G 6,700 km from Valleyfield to Grise Fiord

S—I 6,700 km from Cote St. Catharines to Igloolik

Shipping Challenges

- Sealift often arrives after the first snow.
- Daylight hours are decreasing.
- Often requires a two-year construction cycle.
- **<u>Extra Cost</u>**

Shipping Challenges

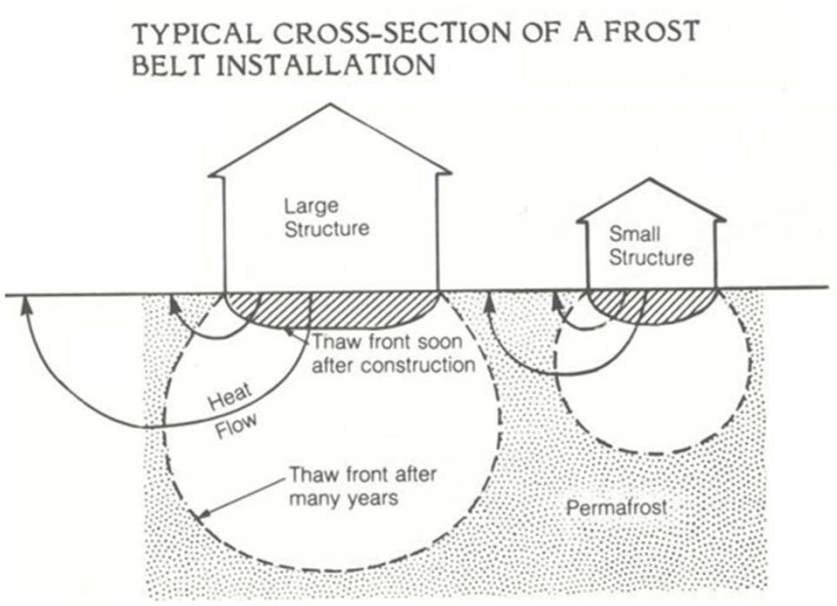
Unpredictable conditions can further cause upset to construction schedules

Shipping Challenges – Air

- After sealift season, all supplies must be delivered through air cargo.
- Air cargo is very expensive with costs into the hundreds of thousands.
- Some items are too large to fly in and aircraft size is limited in communities with short runways.

Permafrost Foundations

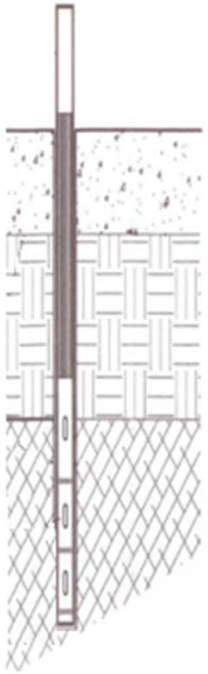
- Foundations are structured to ensure that the heat from buildings does not induce thawing of the permafrost below
- Thaw bulbs occur when houses sit on permafrost OR enclosed skirting on raised houses traps lost heat and warms the area beneath the house.



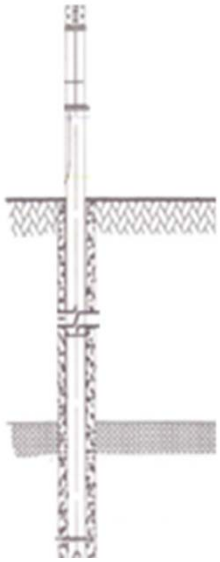
Steel Pile Foundations

- The majority of public housing, homeowner housing built on steel piles.
- Piles are long steel pipes driven into the ground to stabilize the buildings into the permafrost or bedrock.
- Adfreeze piles which rely on permafrost have been either discontinued or are being driven deeper due to increased permafrost active layer depth.

TYPICAL PILE TO BEDROCK DETAIL



TYPICAL AD-FREEZE PILE DETAIL



Steel Pile Foundations

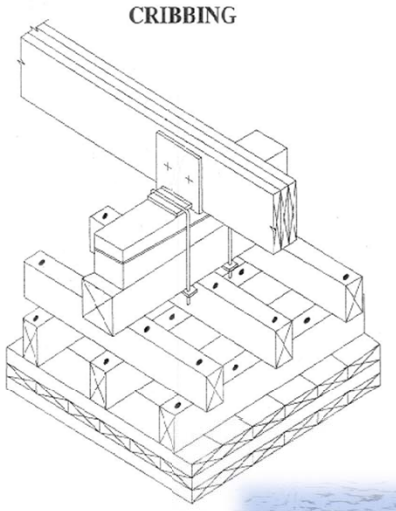
- Low life-cycle cost.
- Minimal site preparation required.
- Building is elevated to allow air flow under building to help protect permafrost.

Pile Jacking

- Failures do occur.
- Failures are more frequent with adfreeze piles which rely on permafrost.
- Solutions often involve abandoning the adfreeze pile foundation

Timber Block Foundations

- Many public housing, homeowner housing built on cribbing.
- Perpendicular stacked wood members with an adjustable wedge to compensate for frost heave.
- Limited to use for small buildings.

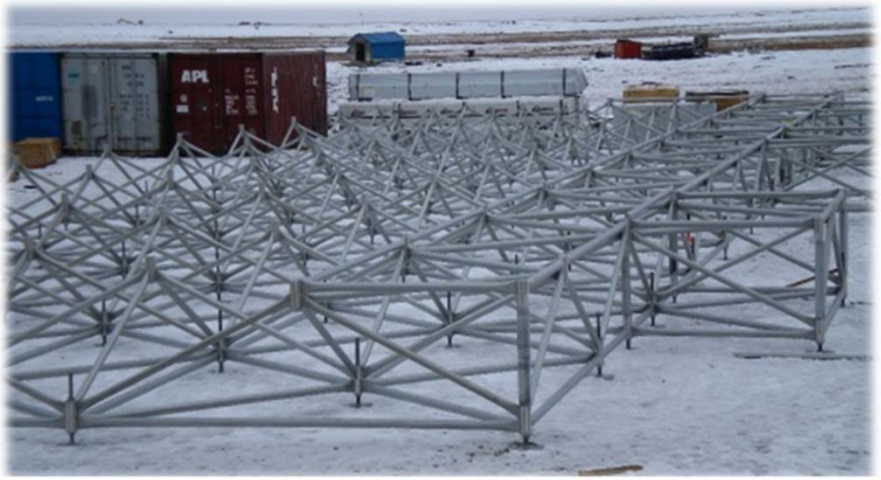


Screw Jack Foundations

- Many public housing, homeowner housing built on screw-jacks.
- Prefabricated jack stands mounted on a grade level spread footing.
- Limited to use for small buildings.

Spaceframe Foundations

- Larger multi-plex housing built on Spaceframes.
- Pre-manufactured frame members installed on site.



Foundations on Grade

- Use becoming prohibitive due to the need for relatively level sites.
- Requires a greater level of site development to provide a level and well drained structural pad.
- Require frequent adjustment in areas of unstable soil.

Thermosyphons

- Flat-loop thermosyphon systems.
- Use typically reserved for larger buildings.
- No current installations within NHC's owned infrastructure.
- Generally cost prohibitive in terms of housing projects.

Site Selection

- In addition to how to build, knowing where to build is also important.
- Despite best efforts to select appropriate sites, unexpected hazards do occur.
- Site selection is becoming more difficult as premium land becomes less available leaving us with second or third best options.

NHC Needs

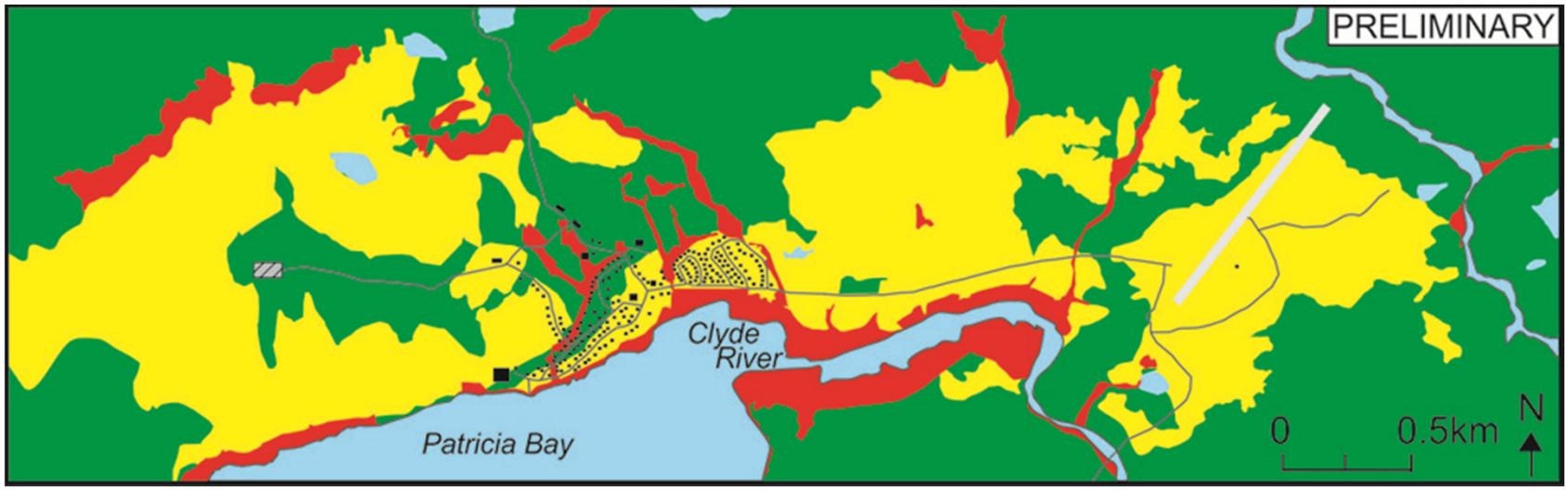
NHC Needs include:

- Improvements on existing technologies and new technologies to support affordable and sustainable development.
- Identification of solutions to adapt existing stock to the changing environment.

NHC Needs

NHC Needs include:

- Identification of hazards that will allow informed decisions in terms of future development.



http://ittaq.ca/post-project/terrain-hazards-and-permafrost

Conclusion

•For over 40 years, there have been varying levels of residential construction by the territorial government throughout Nunavut.

•Diverse geology and geography create a variety of challenges to construction in the north. As technologies advance, new construction methods emerge.

•Building on permafrost is not a new issue for Nunavut but an ongoing challenge, one which is not insurmountable.