Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

CH2MHILL
Polar Services

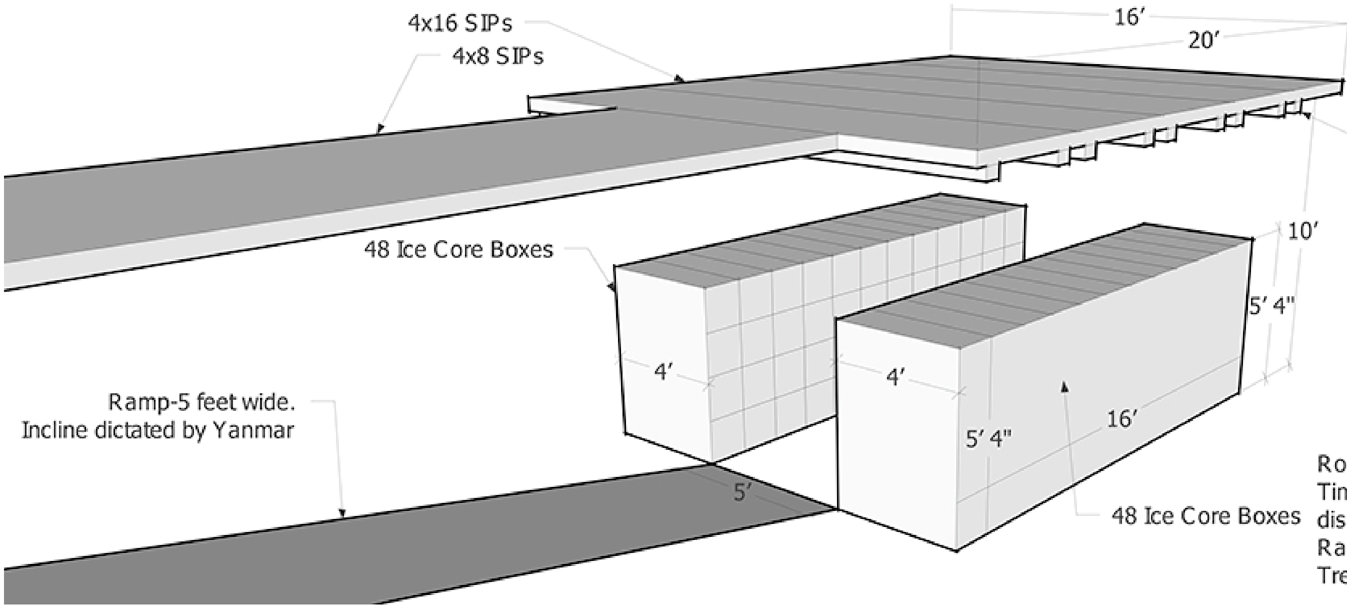
Brandon D. Burmeister, LEED AP^{BD+C}, CPHC, Assoc. AIA
Summit Station Construction Project Manager
Polar Field Services, Inc.

Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

CH2MHILL Polar Services



Common Practice:

1. **Plan, procure, and ship materials** from CONUS to Summit via ANG ($).
2. **Excavate** a trench in the snow via D6 (if local) or Yanmar snow blower.
3. **Cover** with a combination of timbers and SIPs (or steel beams and decking).
4. Observe deflection of roof and **abandon** when deformation is of concern.
5. **Recover materials** (equipment intensive) or leave behind within the snow.

Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

CH2MHILL Polar Services

Compressive slumping dynamic of all four surfaces

Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

CH2MHILL Polar Services

Approach: "*Sullarniq*" - Greenlandic for "***blown-in snow***"

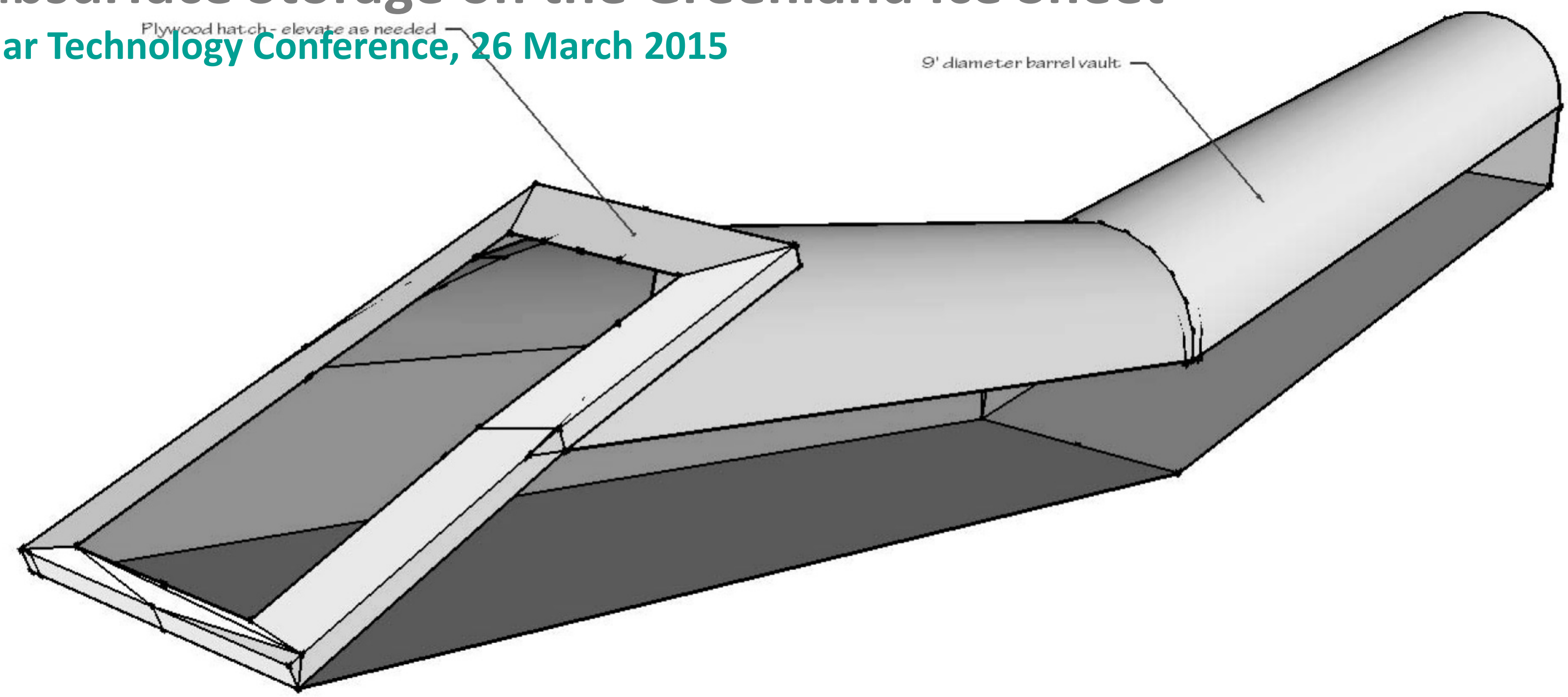
- An inflatable fuel storage balloon later removed to leave a **cavernous subsurface storage** space is a concept initially introduced by Tracy Dahl in 2011 -- citing advantages, challenges, and future potential for NSF applications on the Greenland Ice Sheet.
- Concurrently, the Univ. of Copenhagen making the same plans for the upcoming 2012 NEEM site establishment. *A report on the **test project** has been shared and is referenced throughout this presentation.*
- This 2012 installation **has convinced the Danes to commit** to this approach for all subsurface needs for their 2015 EGRIP camp establishment.

Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

CH2MHILL Polar Services



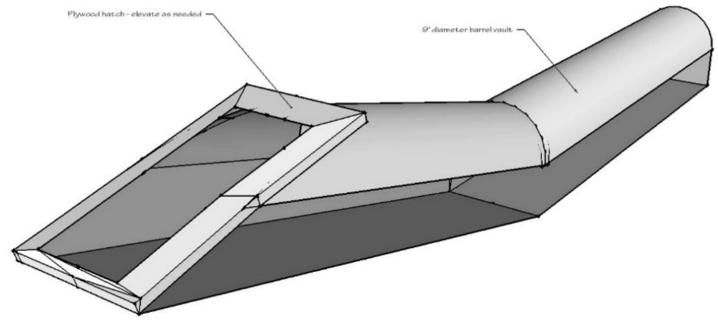
<u>Proposed Sullarniq Approach:</u>

1. Plan, procure, and ship fuel balloon (**initial cost only**).
2. **Excavate** a trench in the snow via D6 (if local) or Yanmar snow blower.
3. **Inflate** balloon and use Yanmar to **cover** in multiple (sintering) layers.
4. **Deflate** balloon and remove debris within resulting cavern.
5. **Carve** away intrusive snow for continued use or abandon w/o materials being left behind.

Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015



Advantages:

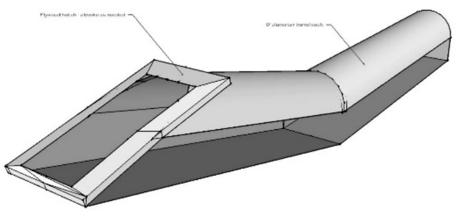
- **Low lifetime cost** (after initial balloon purchase), using snow for material.
- **Reduced strain on logistics chain**, greatly reduced ANG weight/cube.
- **Extended duration** of trench use by being able to reshape interior.
- **Reusable**, repairable balloon(s).
- **Scalable** – translation of balloon allows for limitless length.
- No **embodied energy**/resources left behind.

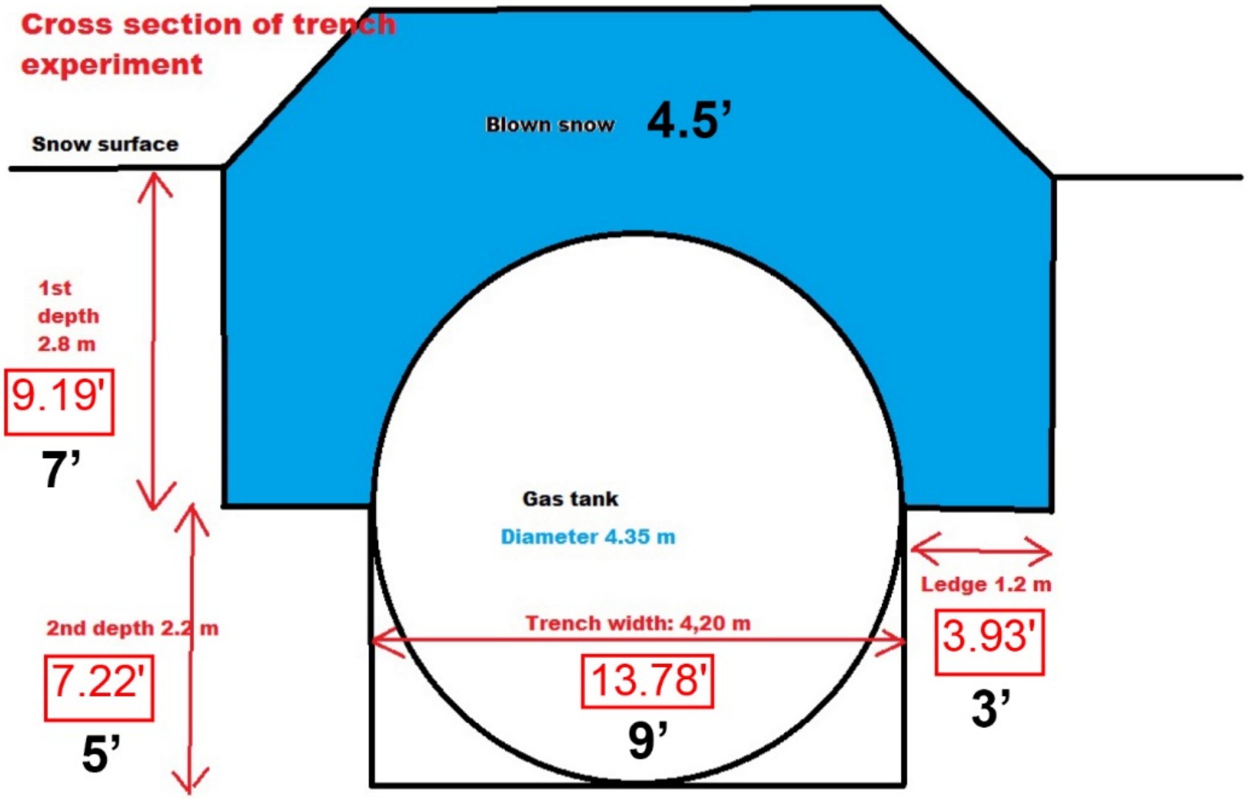
Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

CH2MHILL Polar Services





2012 NEEM Profile Measurements- JP Steffensen
(2015 Sullarniq Eurocore dimensions in black)

Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

CH2MHILL Polar Services

Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

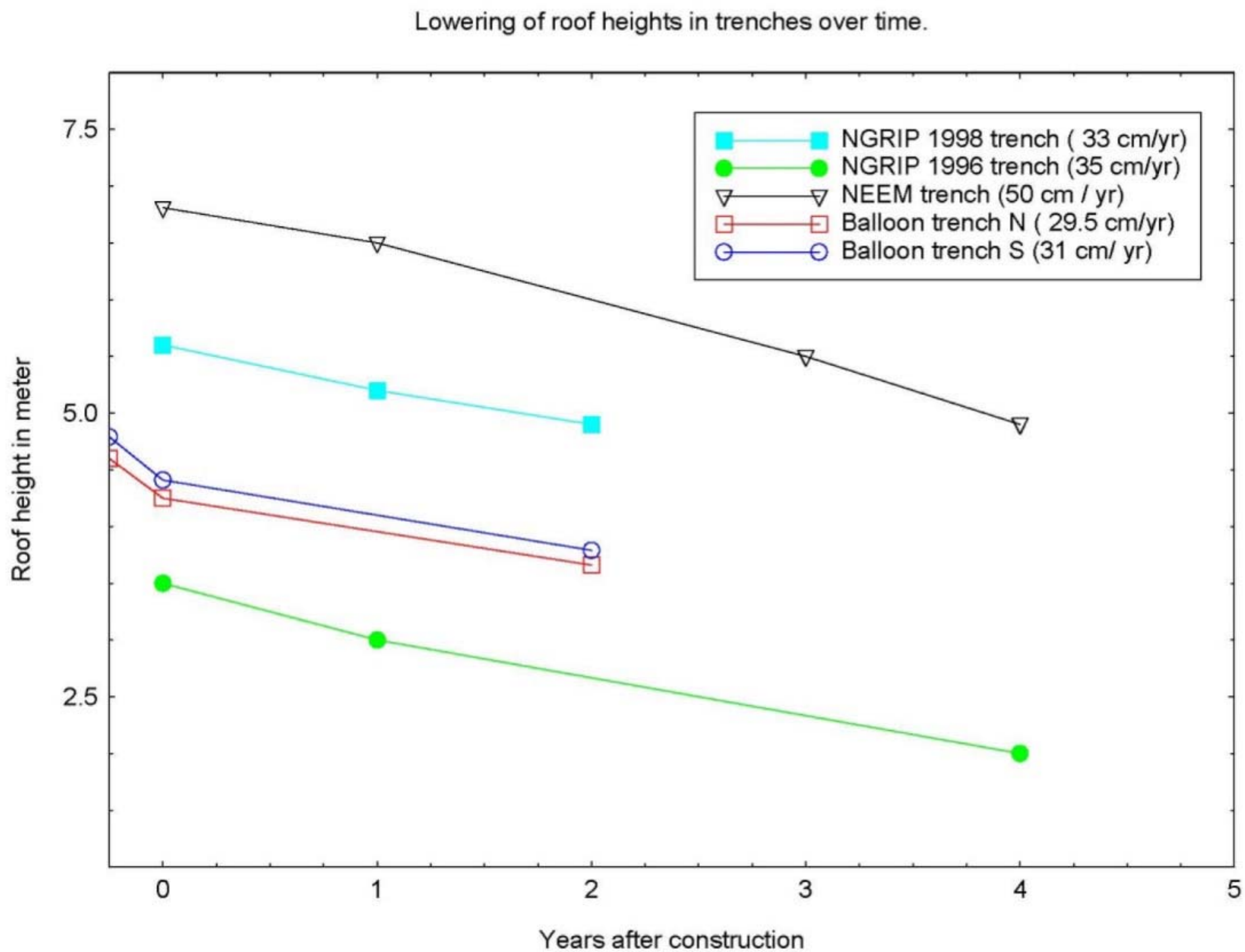
- 2 days to excavate
- 2 days to back blow
- 3 days for sintering
- Arch density of 0.55 g/cm^3

Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015

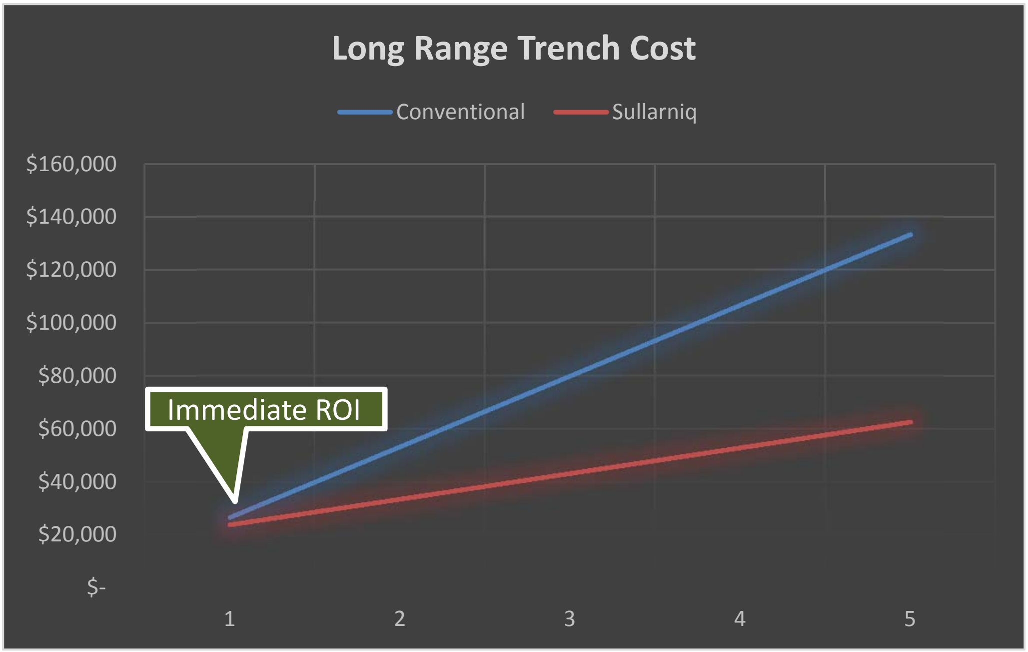
CH2MHILL Polar Services



Sullarniq ARC (Appropriate Resource Construction)

Subsurface Storage on the Greenland Ice Sheet

Polar Technology Conference, 26 March 2015



Outstanding Questions:

- **Number of -30F inflations** before balloon degradation?
- **Maximum width/size** of snow bridge?
- Will there be conducive Wx?

Potential Long Range Uses:

- **Subsurface winter berm** for both small and large objects such as tractors (reduced equipment ops & Station Open labor)
- Next generation **utilidor** (full access & extended life by reducing stress)
- **Occupied facilities**– places of work and research (Flux, Noone facility)
- **Pedestrian corridor** from skiway, to AWO & telescope (allowing for safe passage even during inclimate Wx)
- Anything over 2,000cf