



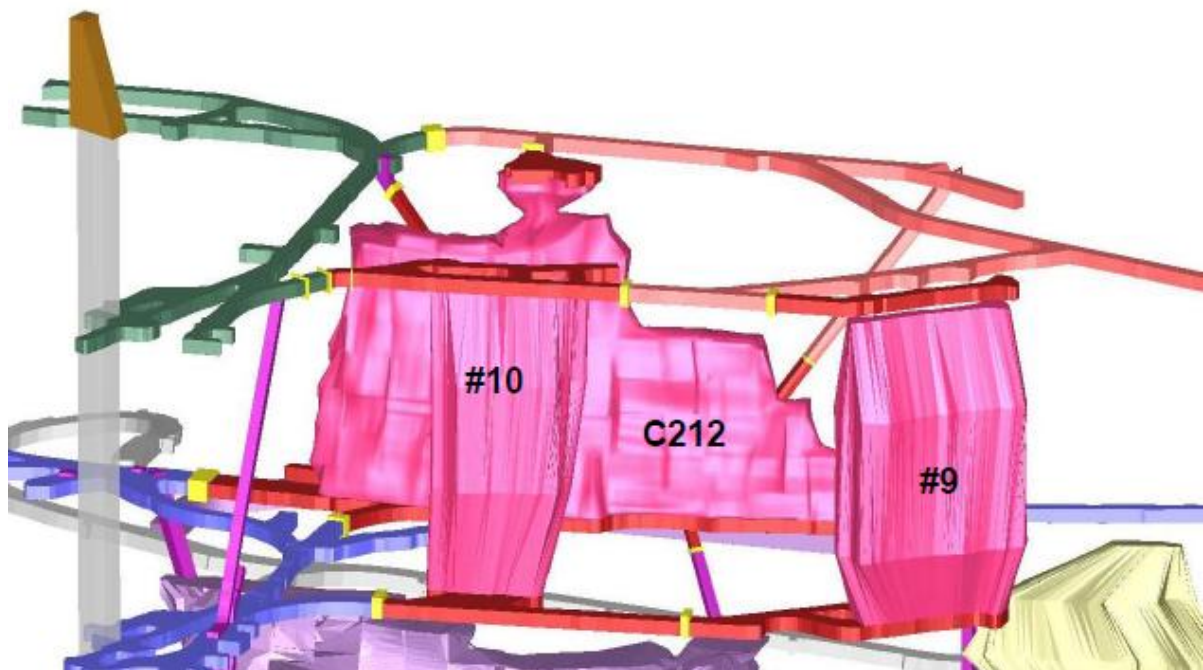
# FOS Update



- FOS Objectives
  - Demonstration
  - Model calibration
  - Testing implementation methods
  - Developing performance monitoring methods
  - Assessing project delivery requirements
  - “Unknown unknowns”



Chamber 10 location



Chamber 10 geometry

## Giant Mine Remediation Project



Canada



Crane installing thermosyphons





Installing freeze pipe and grout pipe



Thermosyphons in place

## Giant Mine Remediation Project



Canada

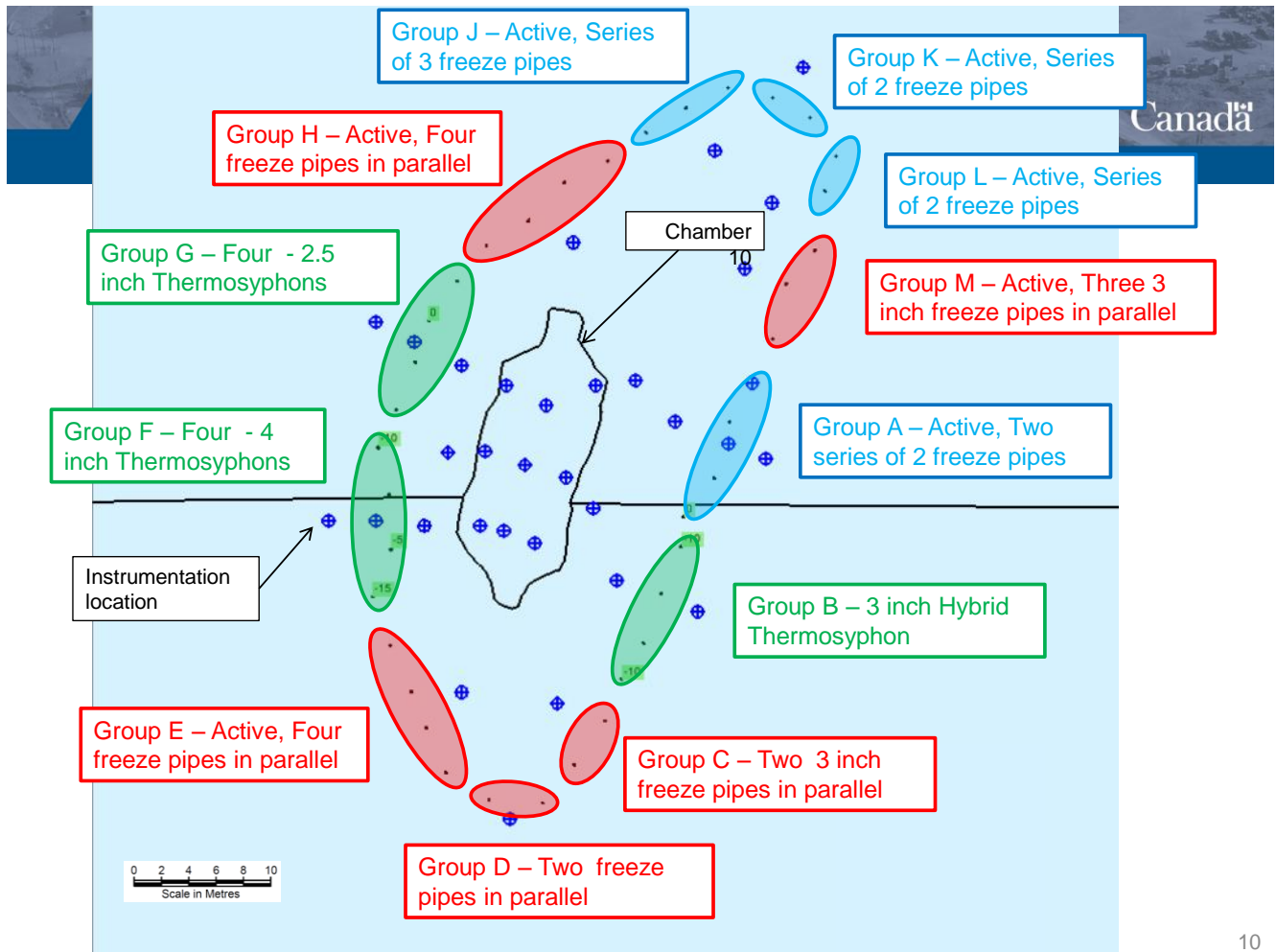


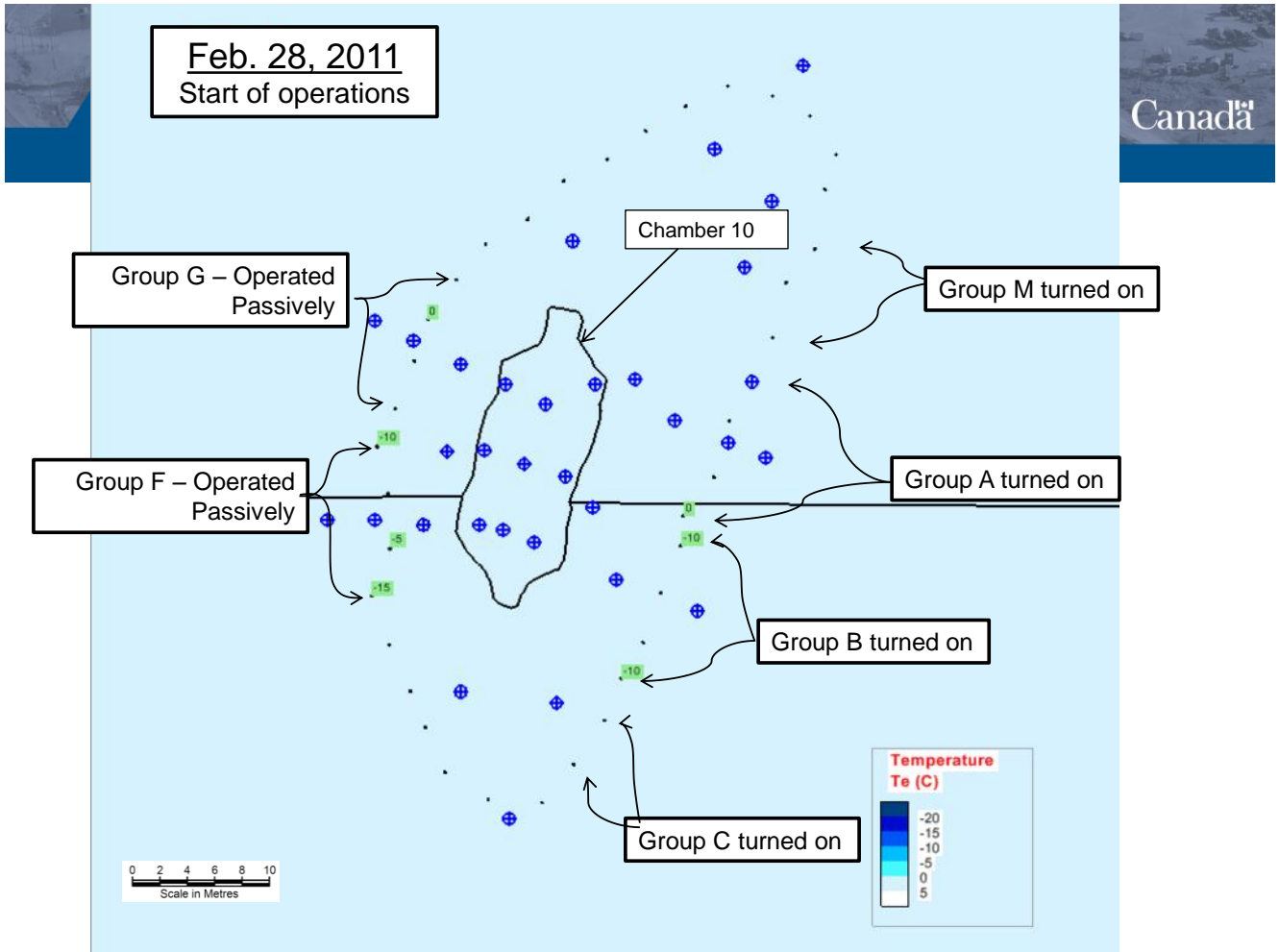
Coolant distribution piping





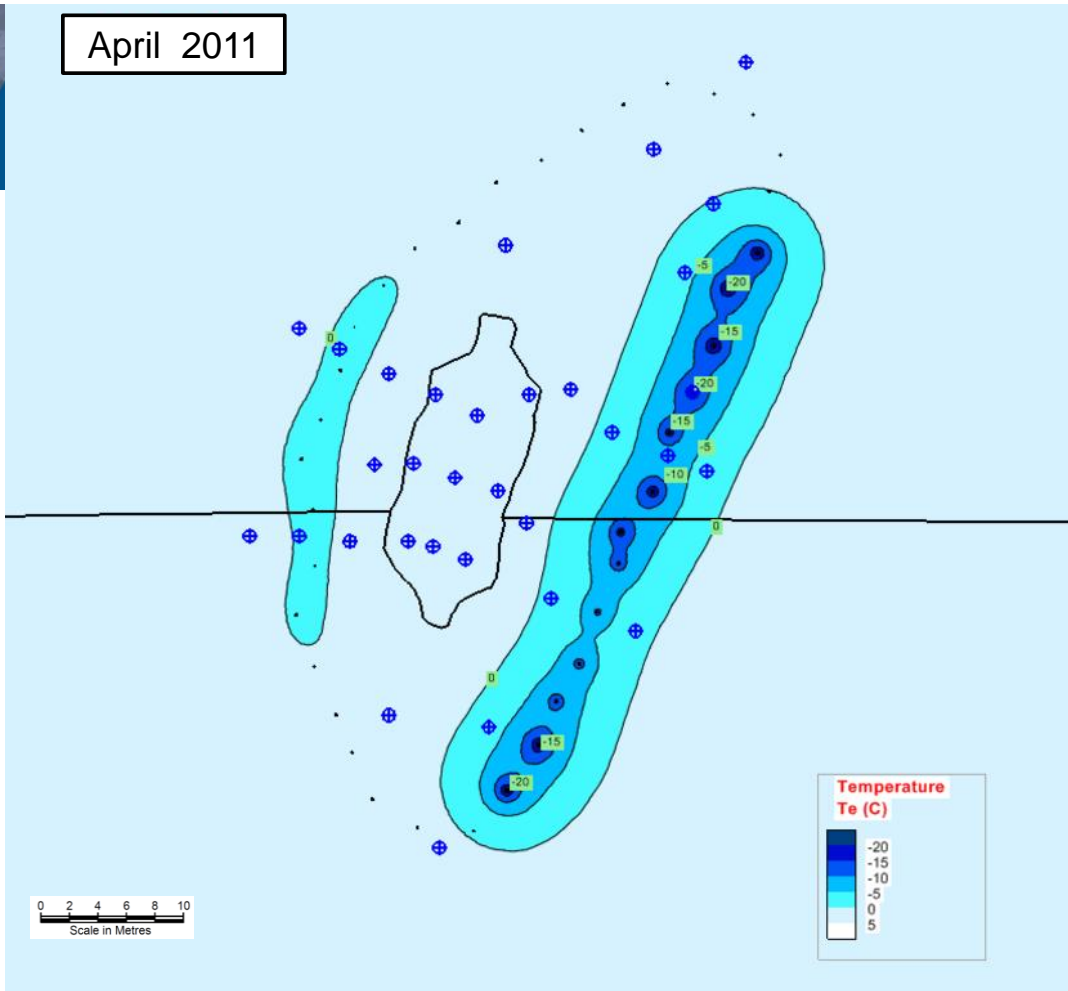
# Findings to Date





April 2011

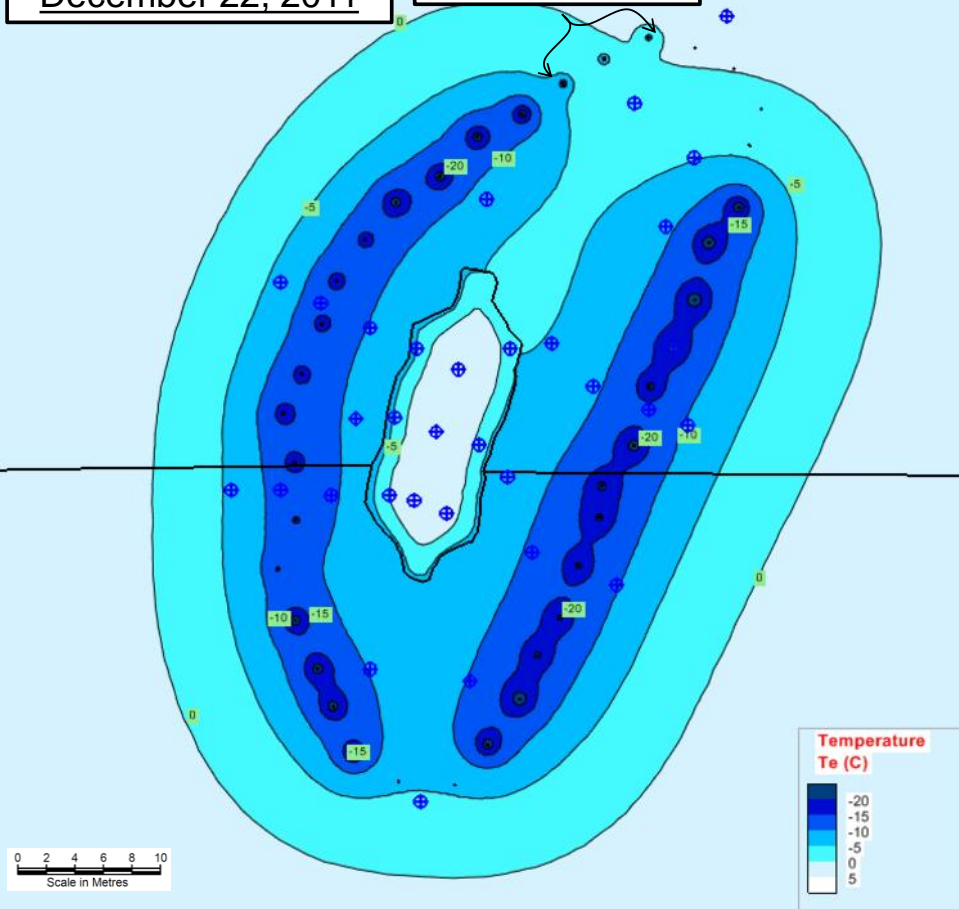
Canada



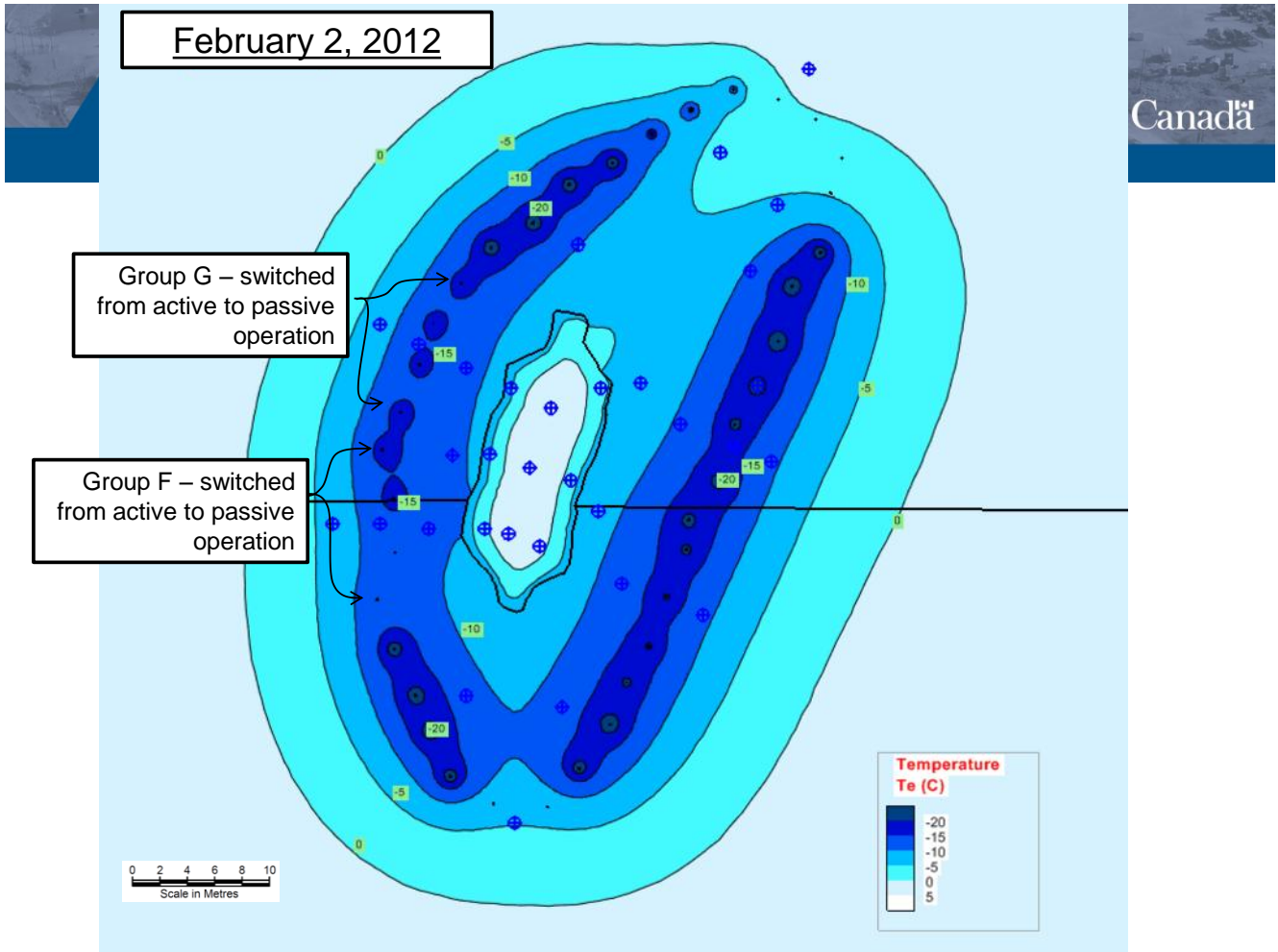
December 22, 2011

Group J – Turned on

Canada







**February 13, 2012**  
Active Freeze Plant turned off

Group J – Turned off

Group H – Turned off

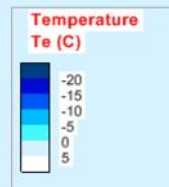
Group M turned off

Group A turned off

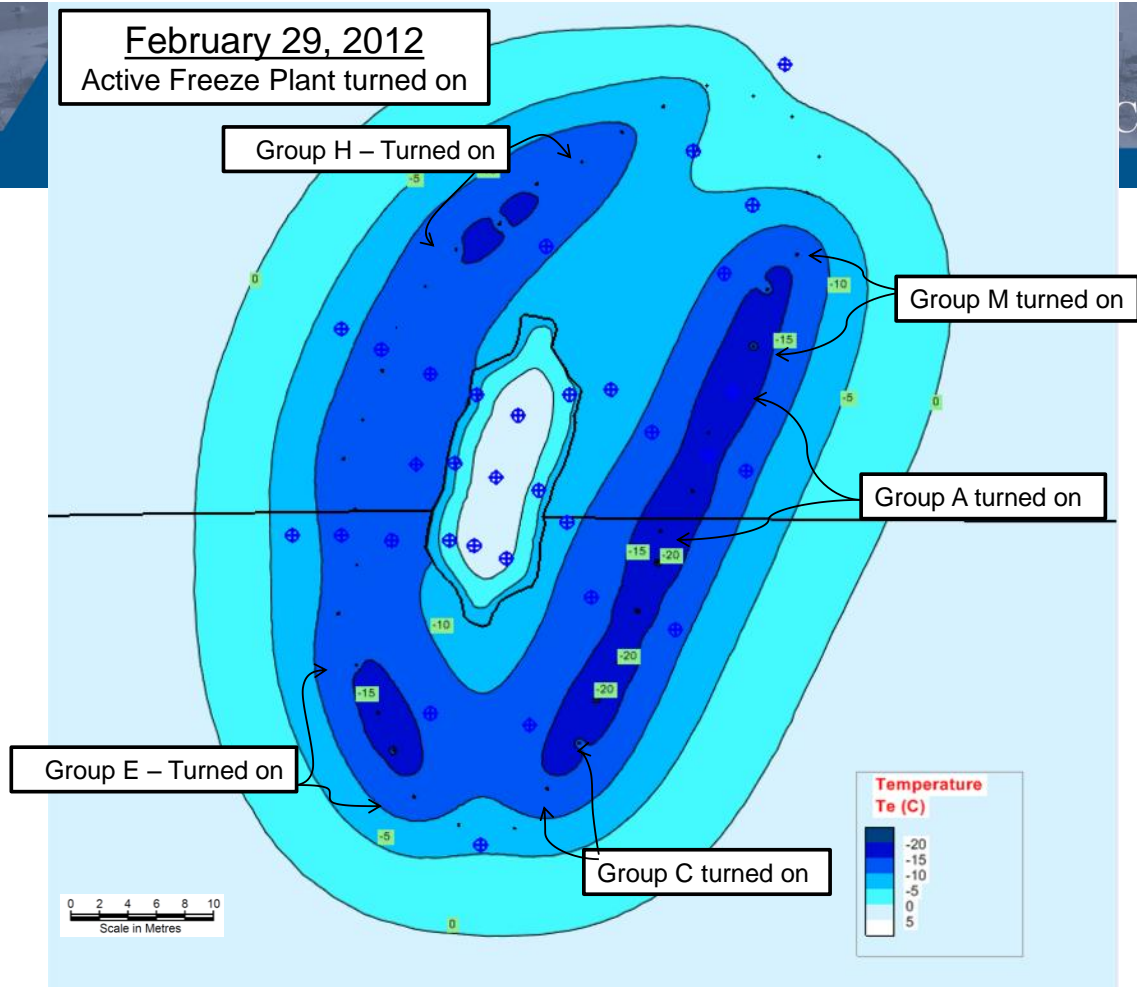
Group E – Turned off

Group C turned off

0 2 4 6 8 10  
Scale in Metres



Canada

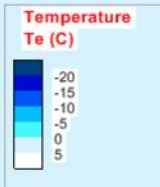


May 2, 2012  
West side turned off

Group H – Turned off

Group E – Turned off

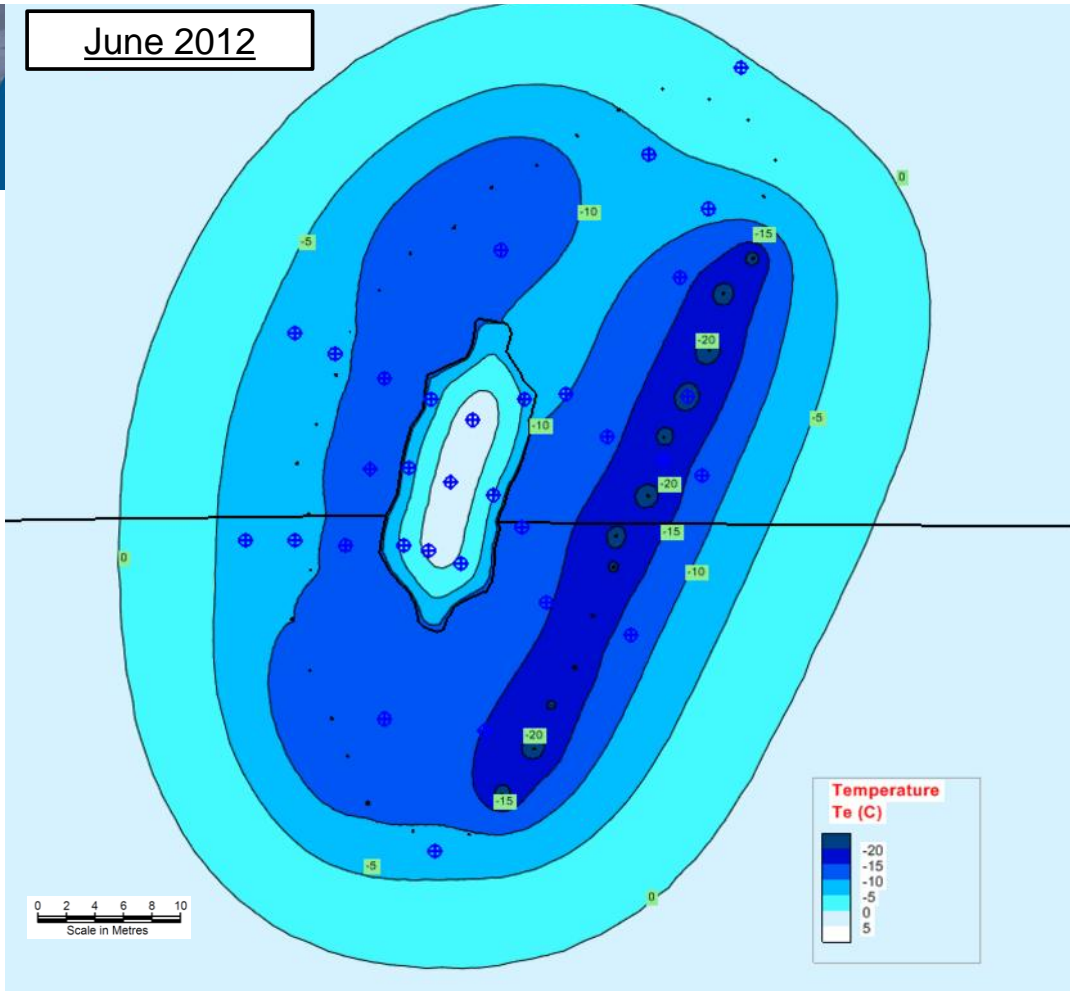
0 2 4 6 8 10  
Scale in Metres



Canada

June 2012

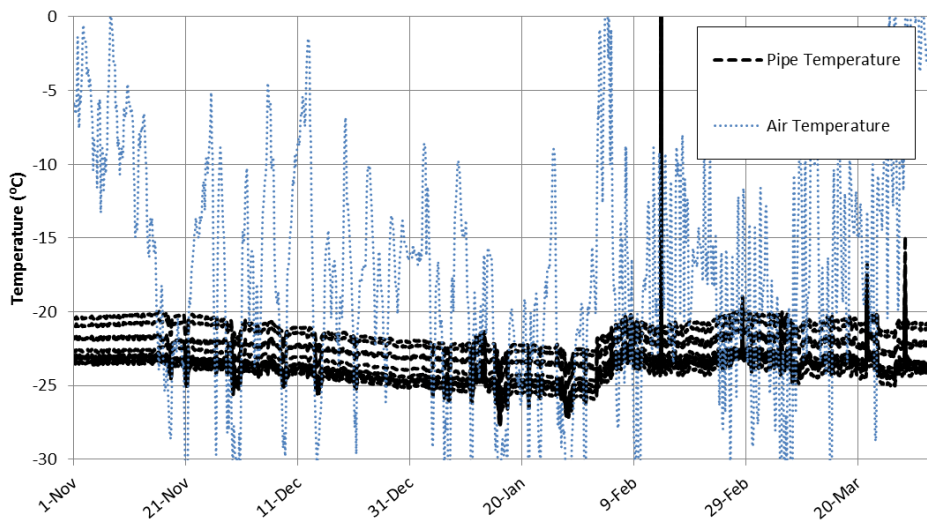
Canada







## Winter Hybrid Thermosyphon



- Graph of Group B hybrid thermosyphons operated actively over the winter.
- Hybrid performance improved during period of cold weather.
- Evidence of passive heat flux can be seen during times when air temperatures are below pipe temperatures.



Hybrid thermosyphons

## Giant Mine Remediation Project



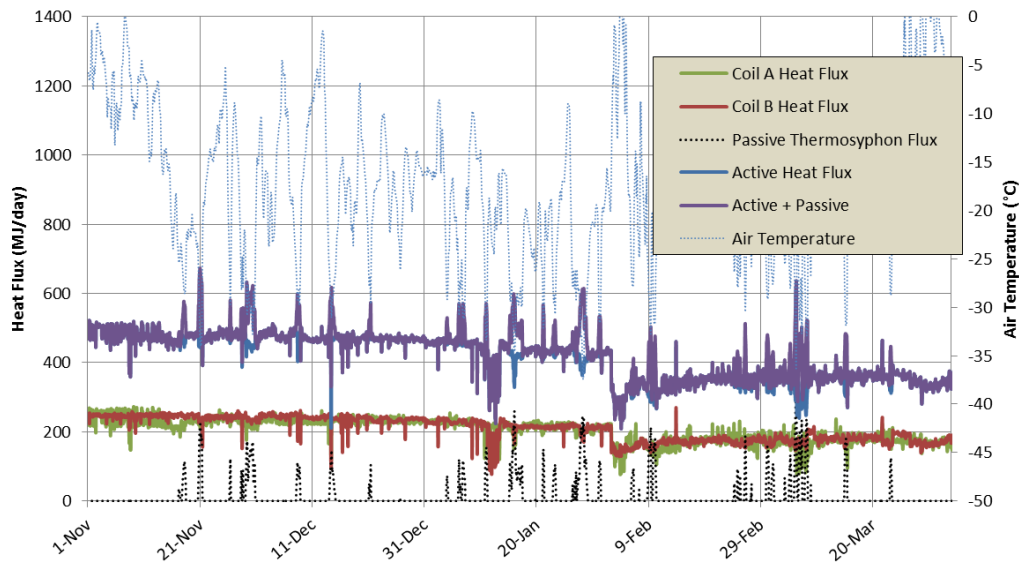
Canada



Thermosyphon cooling system



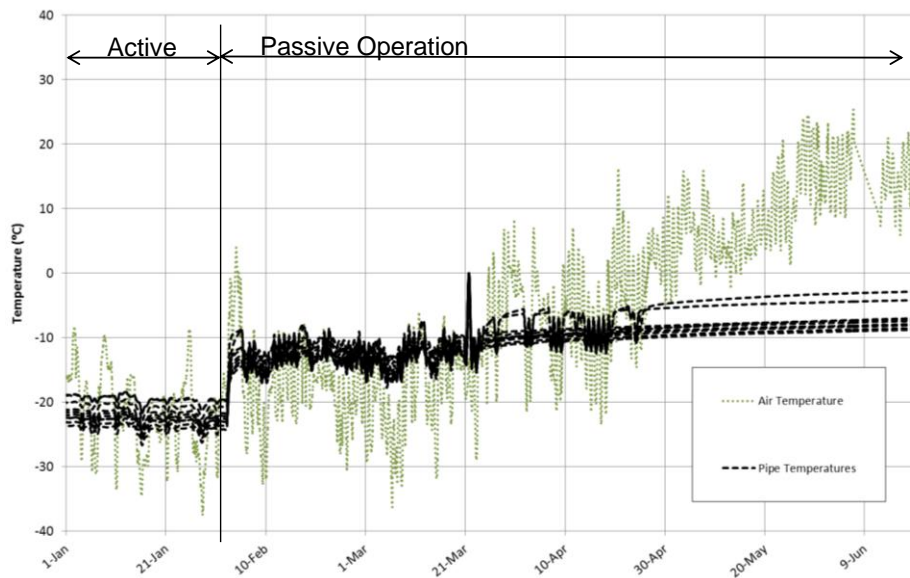
## Winter Hybrid Thermosyphon



- Heat removal rates for Group B hybrid thermosyphon pipe P04 operated actively over the winter.
- Passive heat removal is a small percentage of the overall ground heat extraction rate.



## Hybrid Thermosyphon – Passive Performance



- Hybrid thermosyphon groups F and G have been operated passively since February 2012.
- Ground temperature data collected during summer 2012 will be used to calibrate thermal models to confirm long-term passive performance predictions.





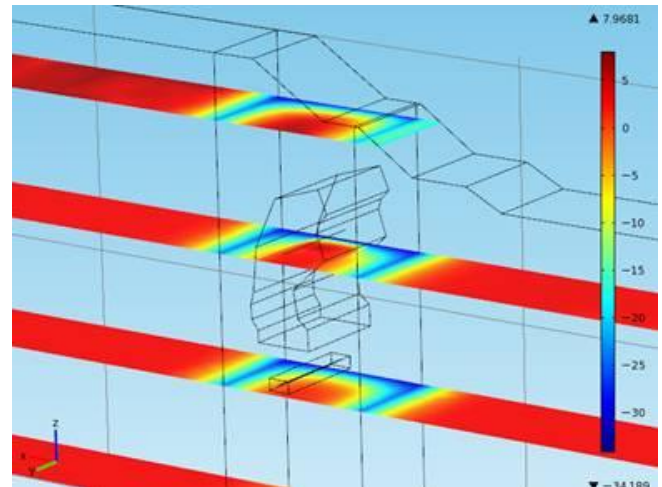
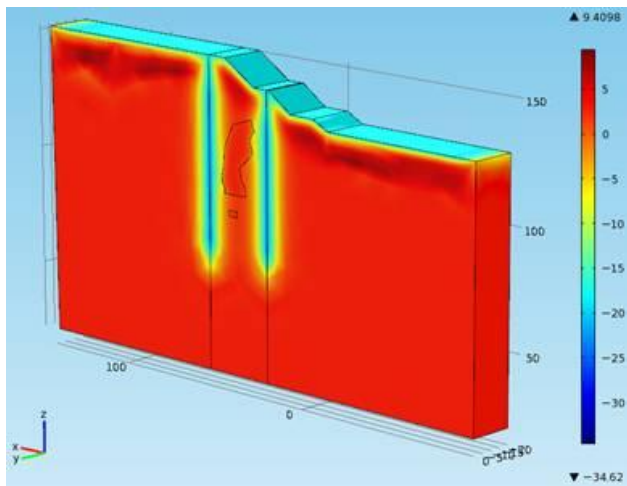
# Freeze Modeling



- Modeling to help identify primary design criteria
  - Using up to date material properties
  - Assess impacts on initial freeze
  - Assess long-term passive performance with climate change
  - Assess opportunities for cost saving

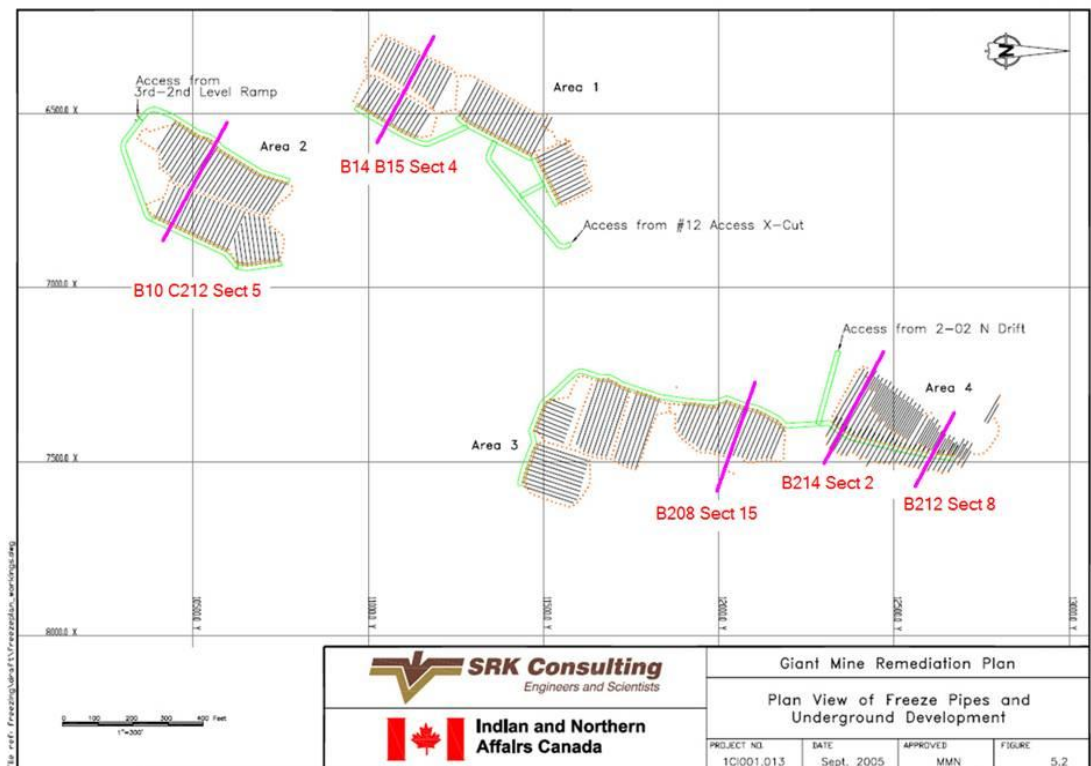


- 3D Modeling





- Look for unique geometry from a surface proximity or depth perspective



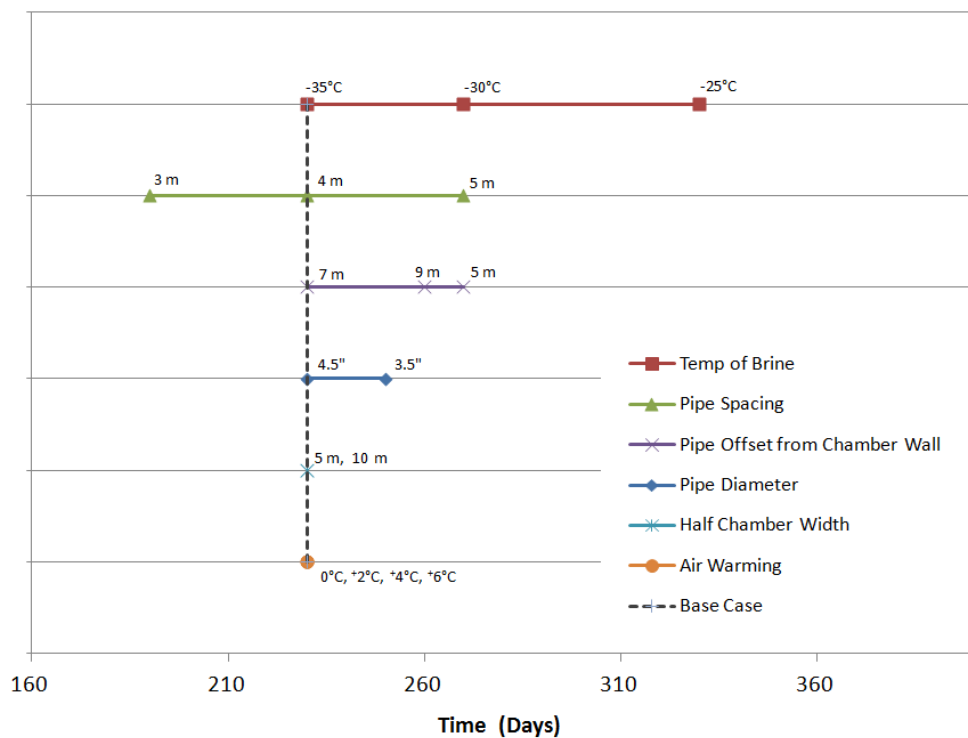
# Giant Mine Remediation Project



Canada

Time to achieve a 10m thick wall using a brine system before dust wetting

- What are key design considerations for the initial freezing?





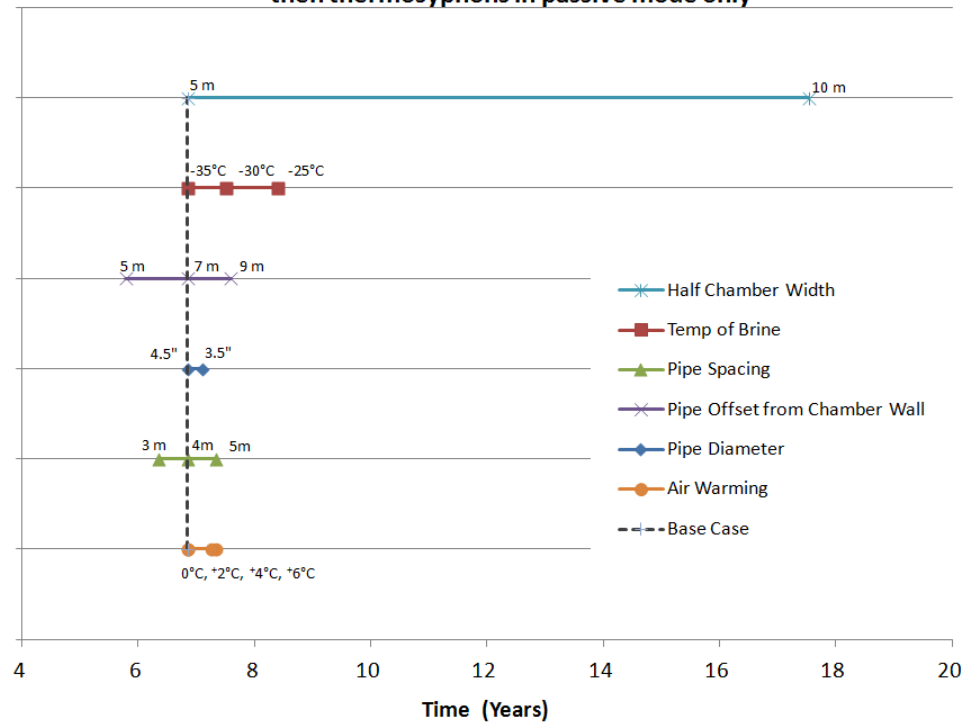
# Giant Mine Remediation Project



Canada

- How long to freeze saturated dust using combination of active and passive

Time to remove the latent heat from saturated dust using brine for 2 years and then thermosyphons in passive mode only

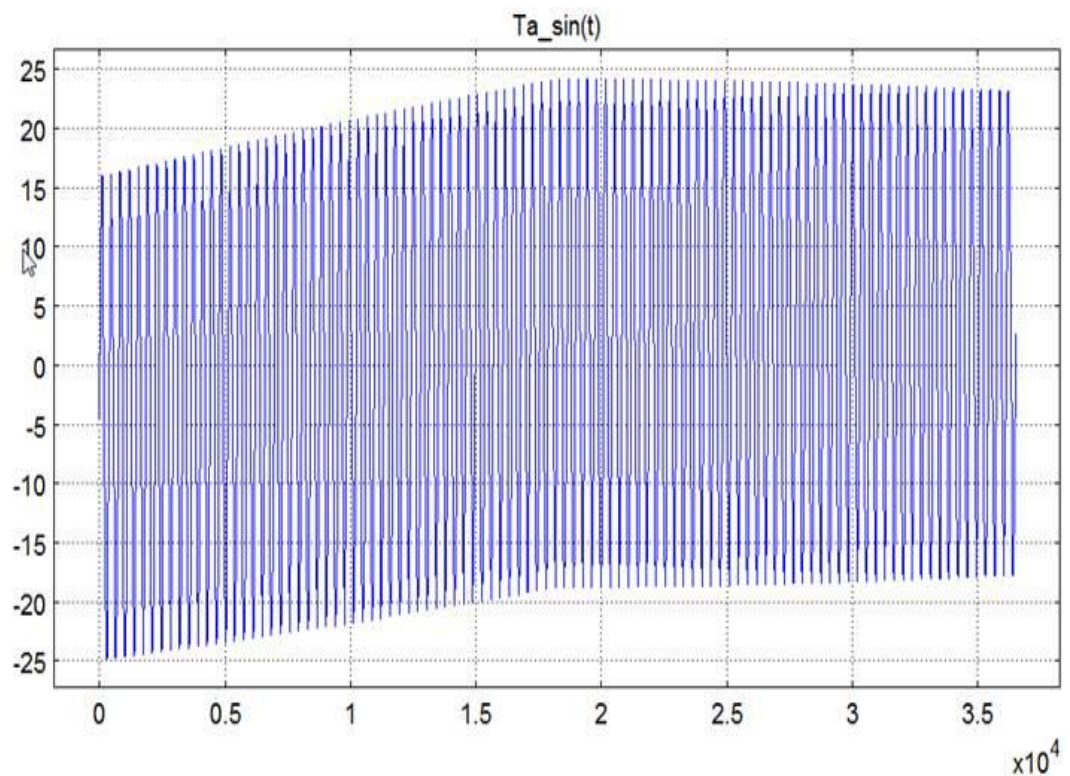


# Giant Mine Remediation Project



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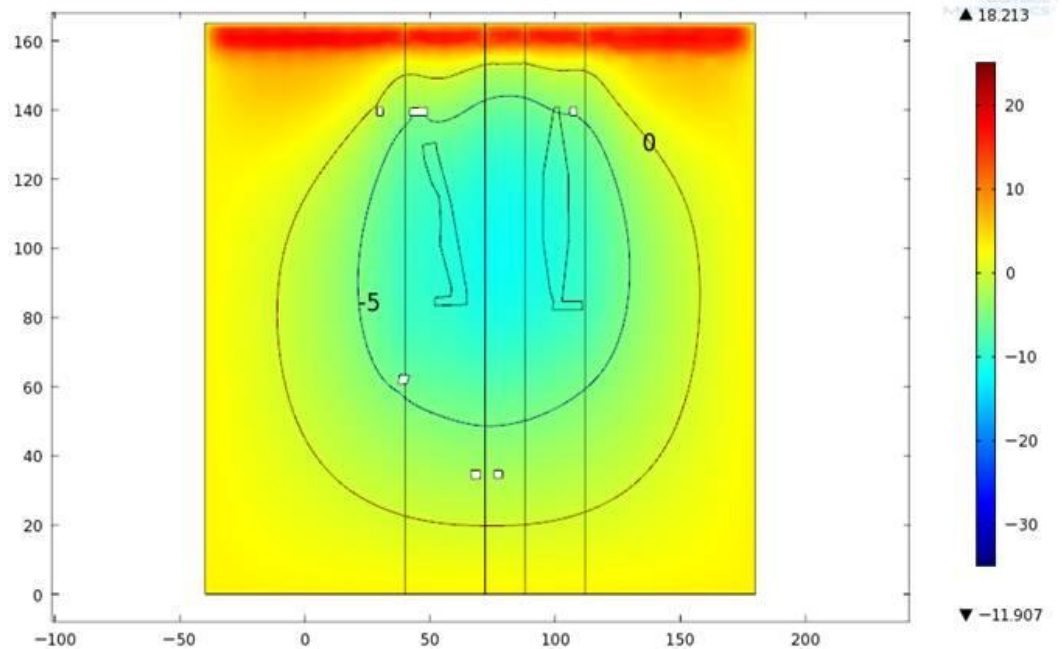
- Warm 7.2°C over 50 years (this is accelerated) followed by 50 years to reach a steady state trend if one exists in that time





- Check that there is no rock – dust contact that thaws under long term passive cooling - with climate warming considered

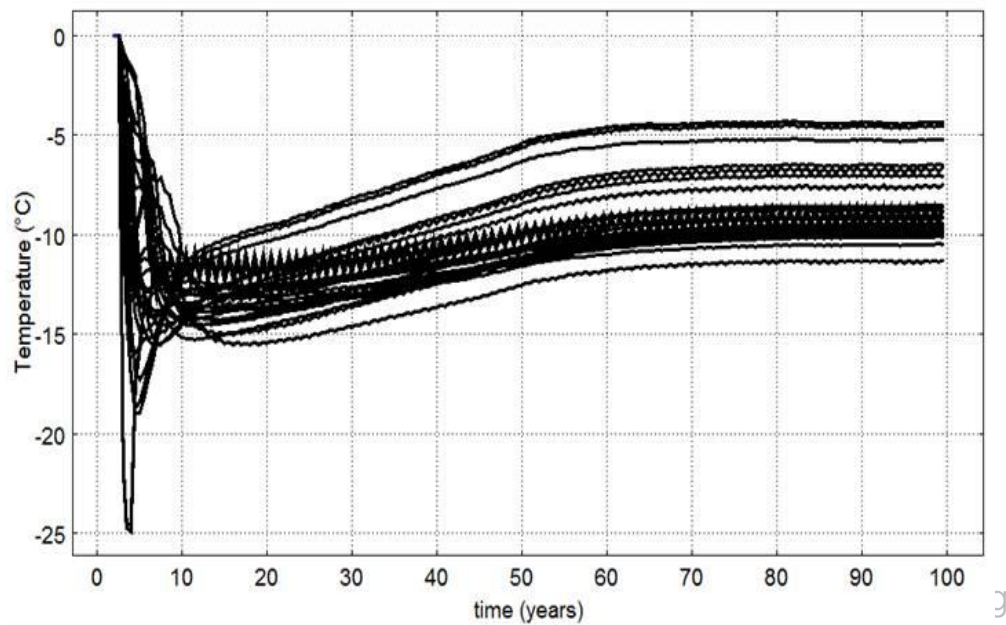
# C10, C212





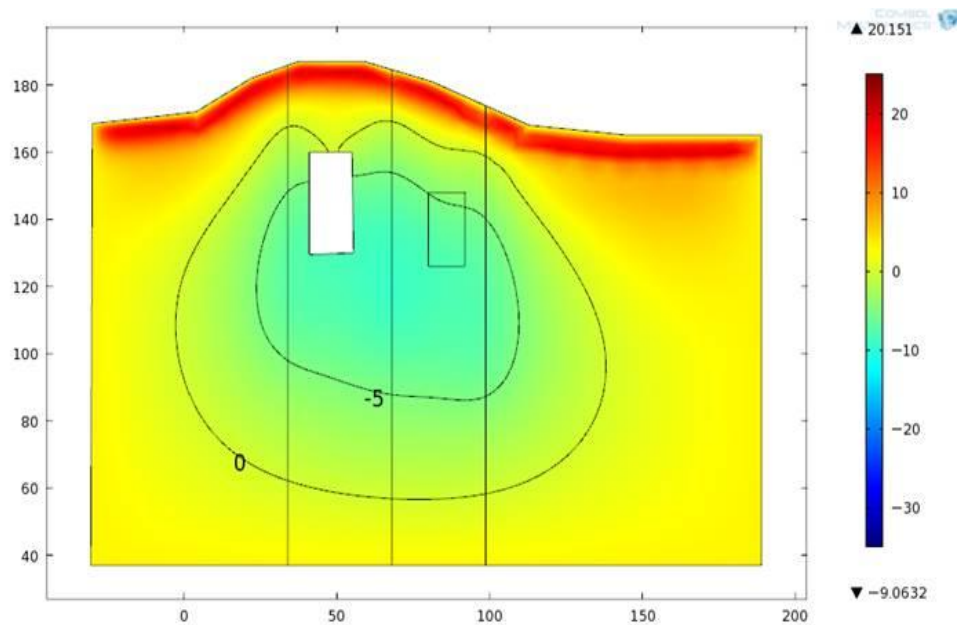
## C10, C212

- Temperatures at all points on stope or chamber surface





## B14, B15

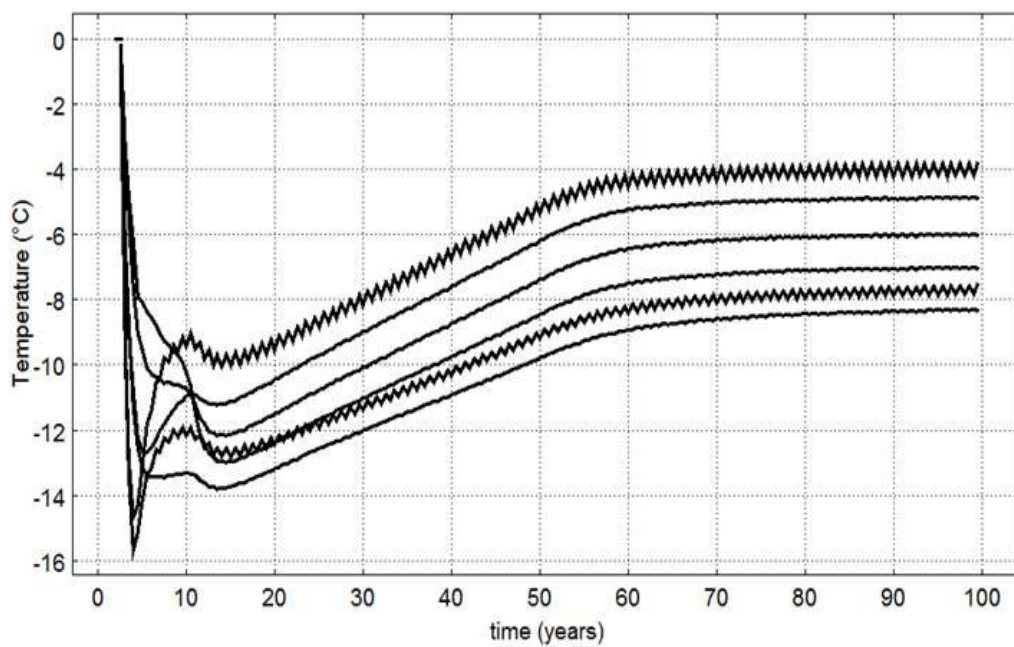


# Giant Mine Remediation Project



Canada

## B14, B15

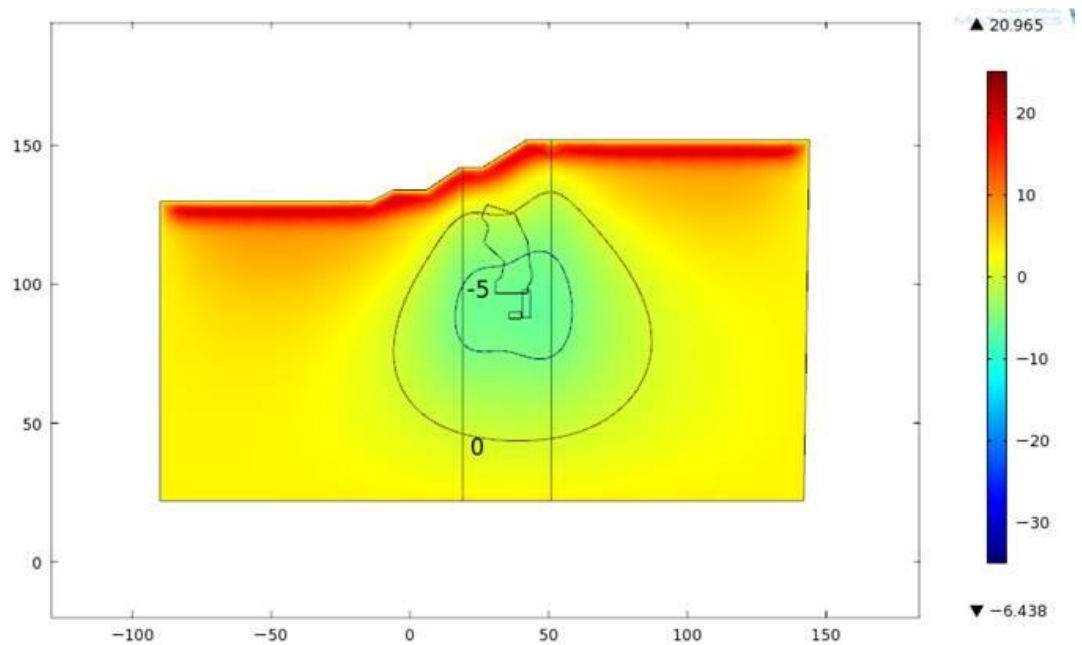






Current plan is to backfill B1 pit. Is that really necessary?

## B208 without Pit Backfill

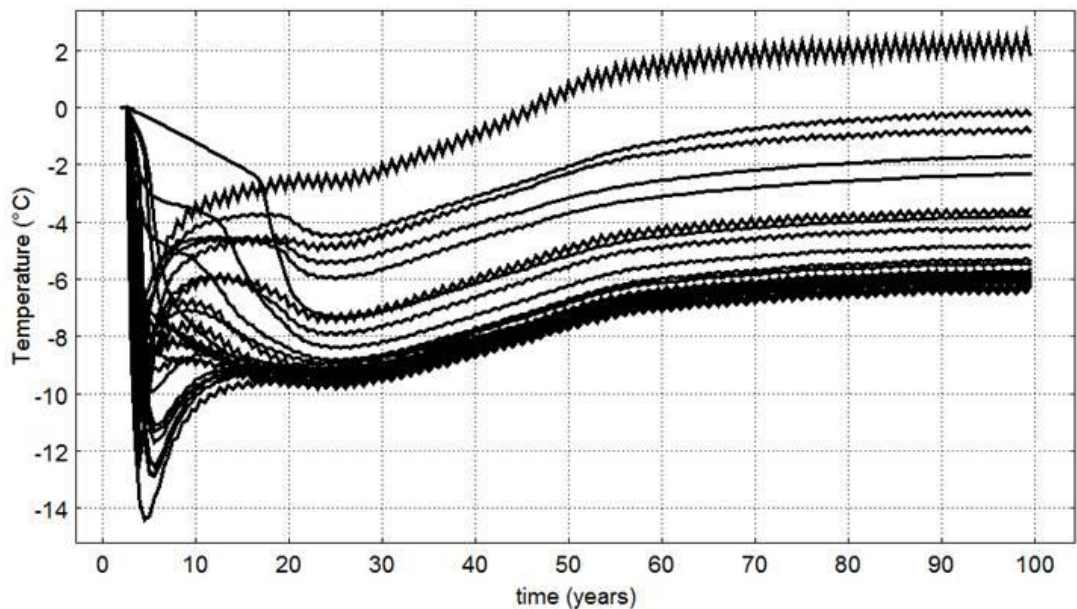


3  
5



- Backfill is a good idea. It protects the upper corners of B208 from thawing.

## B208 without Pit Backfill





# Lessons Learned to Date



- Lessons learned - Progress of freezing
  - More rapid than predicted in DAR
  - Opens up possibilities for optimization
- Lessons learned – Active vs hybrid
  - Active & hybrid systems both viable options
  - Freezing is fast enough that even fully passive might be reasonable



- Lessons learned - Cost comparisons
  - Not attempting to come up with an overall cost estimate now
  - Instead focusing on “trade-off studies”
  - Comparison of two or more variants, e.g.
    - Active vs. hybrid freezing
    - Underground freeze pipes vs. longer vertical pipes
    - Wet frozen blocks vs. dry frozen blocks
    - Steel vs. HDPE surface piping
    - Methods of active to passive conversion



- Expecting to pull together trade-off study results in July
  - May not be able to release them
- Important caveat
  - Process of considering variants will continue throughout detailed design
  - We are only considering variants that would have the same or less environmental impacts and equivalent or better long term performance





- Other
  - Instrumentation still performing well
  - Data management system under continuous improvement



# Wetting Study Update



- Wetting study update
  - Listed all phenomena that have a potential to complicate the wetting process
    - Currently evaluating each one using available data & calculations/modeling
    - No impact on ultimate effectiveness of frozen blocks
    - Could be cost impact - no significant problems identified but not yet finished those assessments
    - Draft findings of this initial step expected in July
  - Identified candidate lab to test phenomena that prove to be doubtful (if any)



## Continuing Work with FOS



- Longer term opportunities under consideration for FOS
  - Winter operation to cool dust to  $-5^{\circ}\text{C}$
  - Test methods of active-passive conversion
  - Test remote installation of bulkhead/plug
  - Continue testing instrument reliability
  - Continue testing monitoring data capture and management system
  - Continue demonstration and test improved accessibility to local stakeholders