WASTE ROCK STORAGE FACILITIES MANAGEMENT

MEADOWBANK MINE

BCMEND ML ARD WORKSHOP

T. LÉPINE

AGNICO EAGLE

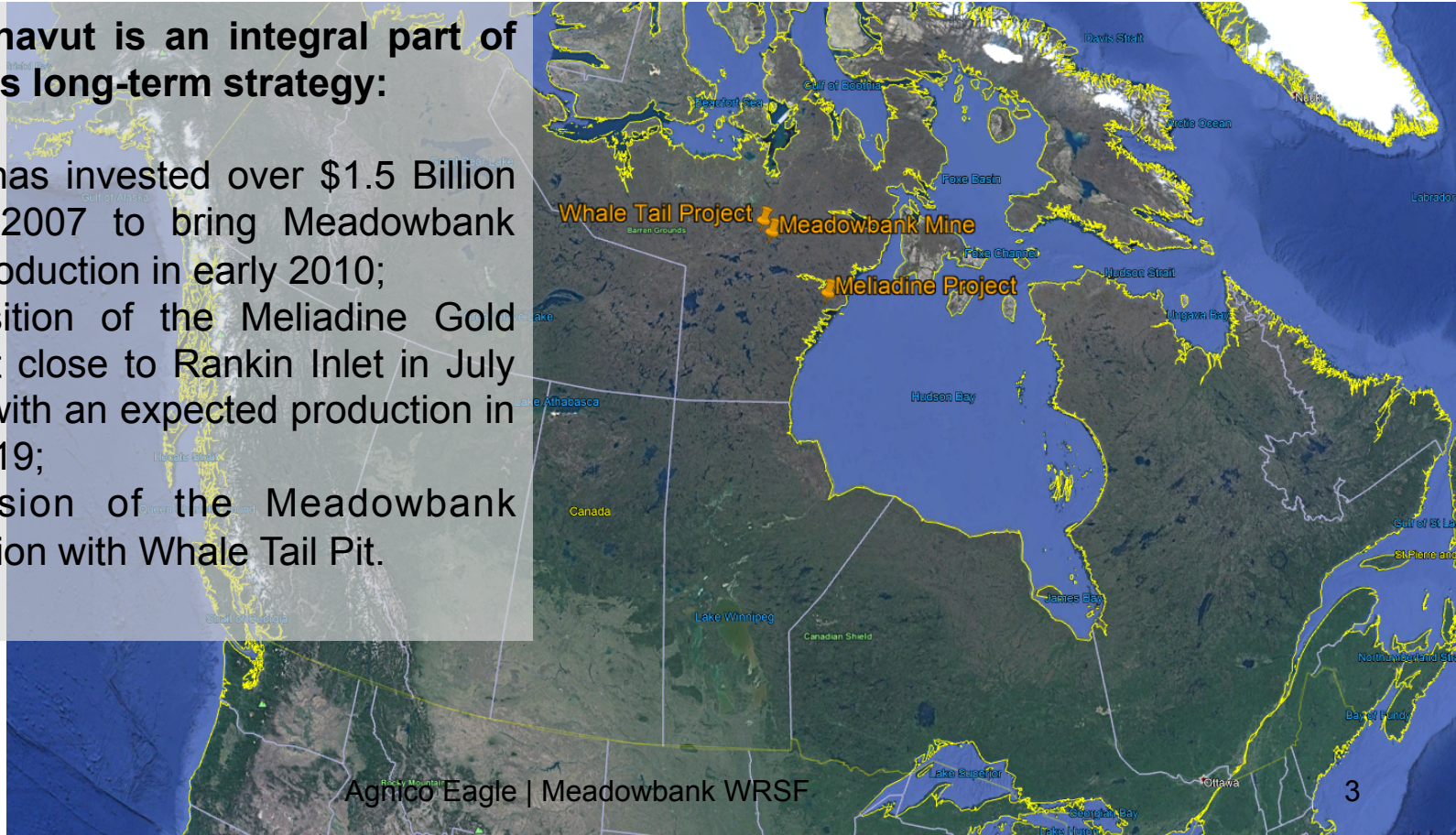
PRESENTATION OUTLINE

- Agnico Eagle Mines (AEM) Nunavut Platform;
- Meadowbank Mine Overview;
- Waste Rock Management;
- Portage Waste Rock Storage Facility (WRSF);
- Conclusion;
- Question?

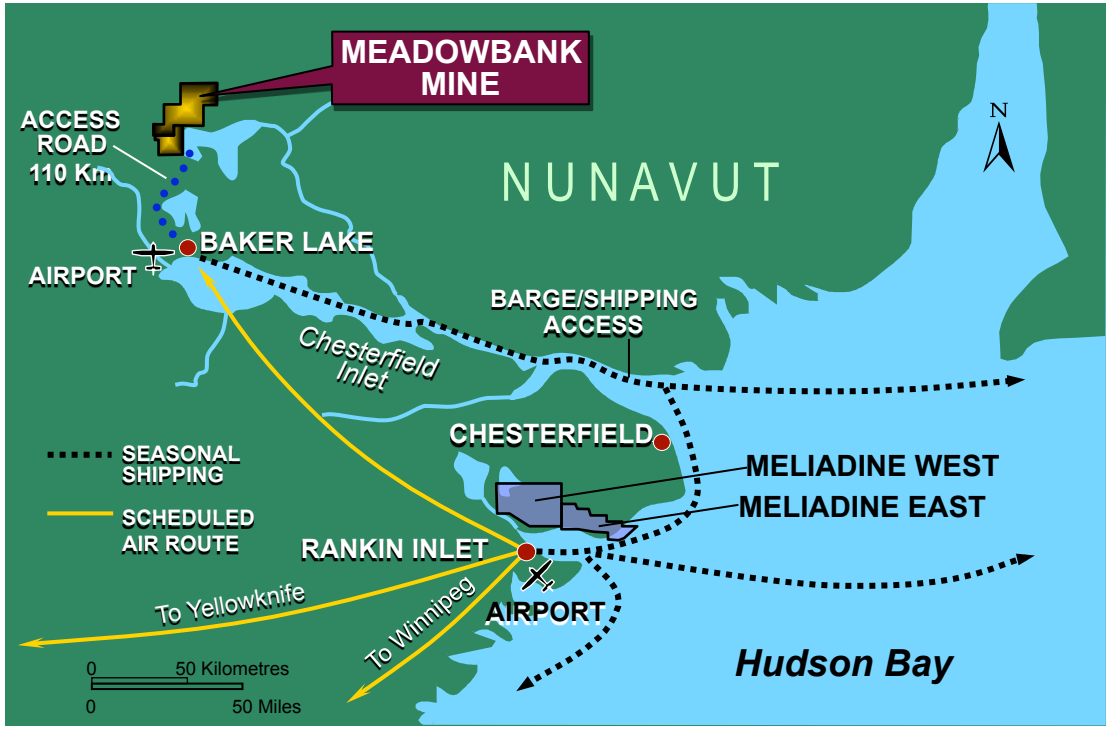
AEM NUNAVUT PLATFORM - OPERATIONS

Mining in Nunavut is an integral part of Agnico Eagle's long-term strategy:

- AEM has invested over $1.5 Billion since 2007 to bring Meadowbank into production in early 2010;
- Acquisition of the Meliadine Gold project close to Rankin Inlet in July 2010 with an expected production in Q1 2019;
- Extension of the Meadowbank operation with Whale Tail Pit.



AEM NUNAVUT PLATFORM - LOGISTIC



AEM NUNAVUT PLATFORM - PEOPLE

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MEADOWBANK OVERVIEW

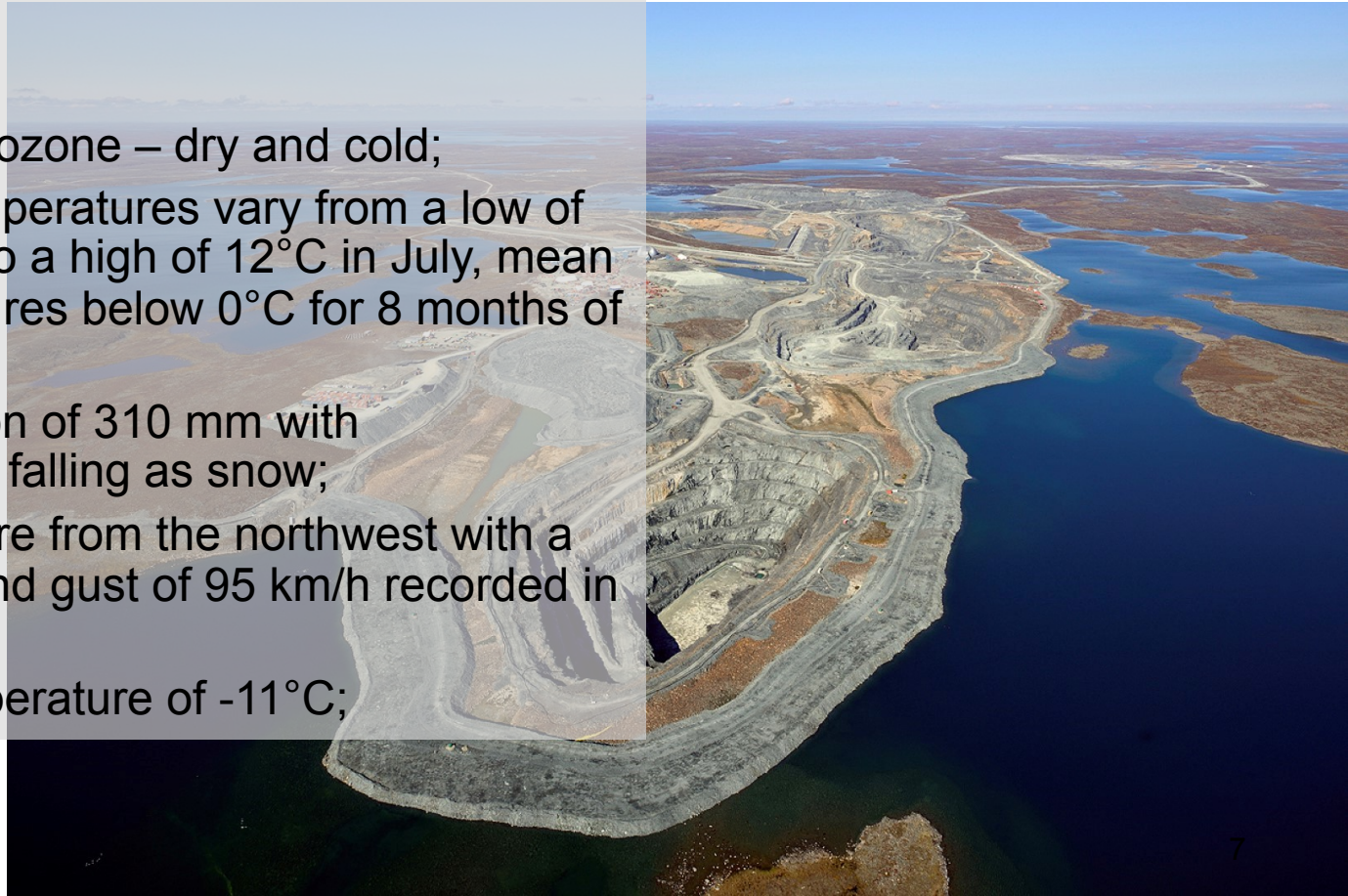
History Facts

- **1987:** Discovery of Portage Gold Deposit
- **2000:** Discovery of Vault Gold Deposit
- **2003:** Application to Nunavut Water Board (NWB) and Nunavut Impact Review Board (NIRB)
- **December 2006:** Project Certificate Issued by NIRB
- **July 2008:** All Permits Received
  - License A
  - DFO Authorization
  - MMER Schedule 2
- **August 2008:** Construction of Dikes and Pit Stripping start up
- **February 2010:** Start of Commercial Production
- **Q3 of 2019:** Whale Tail Commercial Production (extension until 2023 approved and permitting project extending until the end of 2025)

MEADOWBANK OVERVIEW

Climate

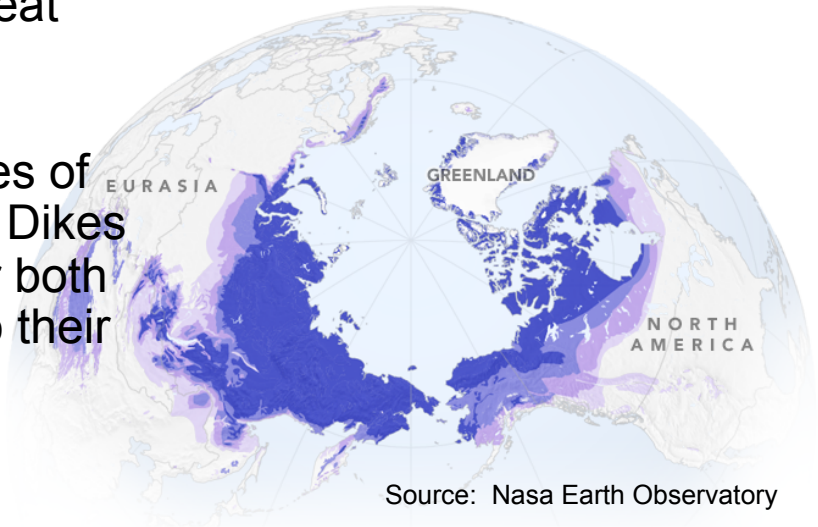
- Northern Arctic Ecozone – dry and cold;
- Mean monthly temperatures vary from a low of -33°C in January to a high of 12°C in July, mean monthly temperatures below 0°C for 8 months of the year;
- Annual precipitation of 310 mm with approximately half falling as snow;
- Prevailing winds are from the northwest with a maximum daily wind gust of 95 km/h recorded in 2009.
- Mean annual temperature of -11°C;



MEADOWBANK OVERVIEW

Permafrost Area

- Located in an area underlain by continuous permafrost, approximately 450 to 550 meters thick;
- Numerous lakes, creating conditions for taliks;
- Creates engineering challenges but also great opportunities.
- Most of the designs for the geotechnical infrastructure at the site uses the advantages of permafrost and extreme cold environment. Dikes around the site as well as the final cover for both TSF and WRSF incorporate permafrost into their design.

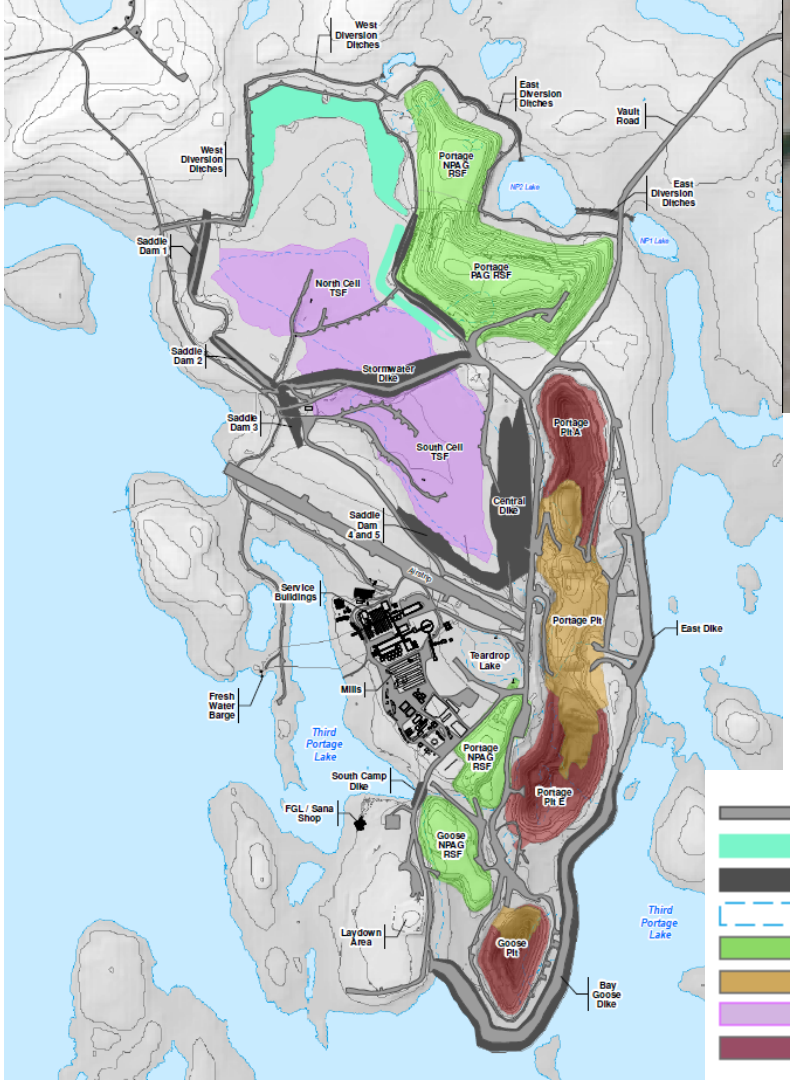


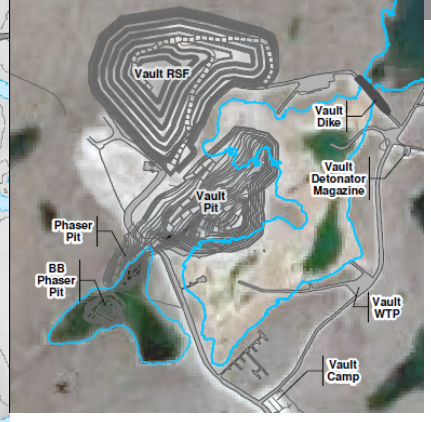
Source: Nasa Earth Observatory

MEADOWBANK OVERVIEW

Production Facts

Mining Method: Open Pits
Mine Throughput: ~ 10,000 tones/day
Tons Moved: 100k day
Numbers Employees: ~700





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- **3 Open Pits** (Goose, Portage and Vault);
- **2 WRSF** (Portage and Vault);
- **2 TSF Cell** (South and North);
- **2 Dewatering Dikes** (Baygoose and East Dike).


Vault Area
Portage WRSF
TSF – North Cell
TSF – South Cell
Portage Pit
East Dike
Goose
Pit
Baygoose Dike

WASTE ROCK MANAGEMENT

Geochemical Properties of Waste Rock

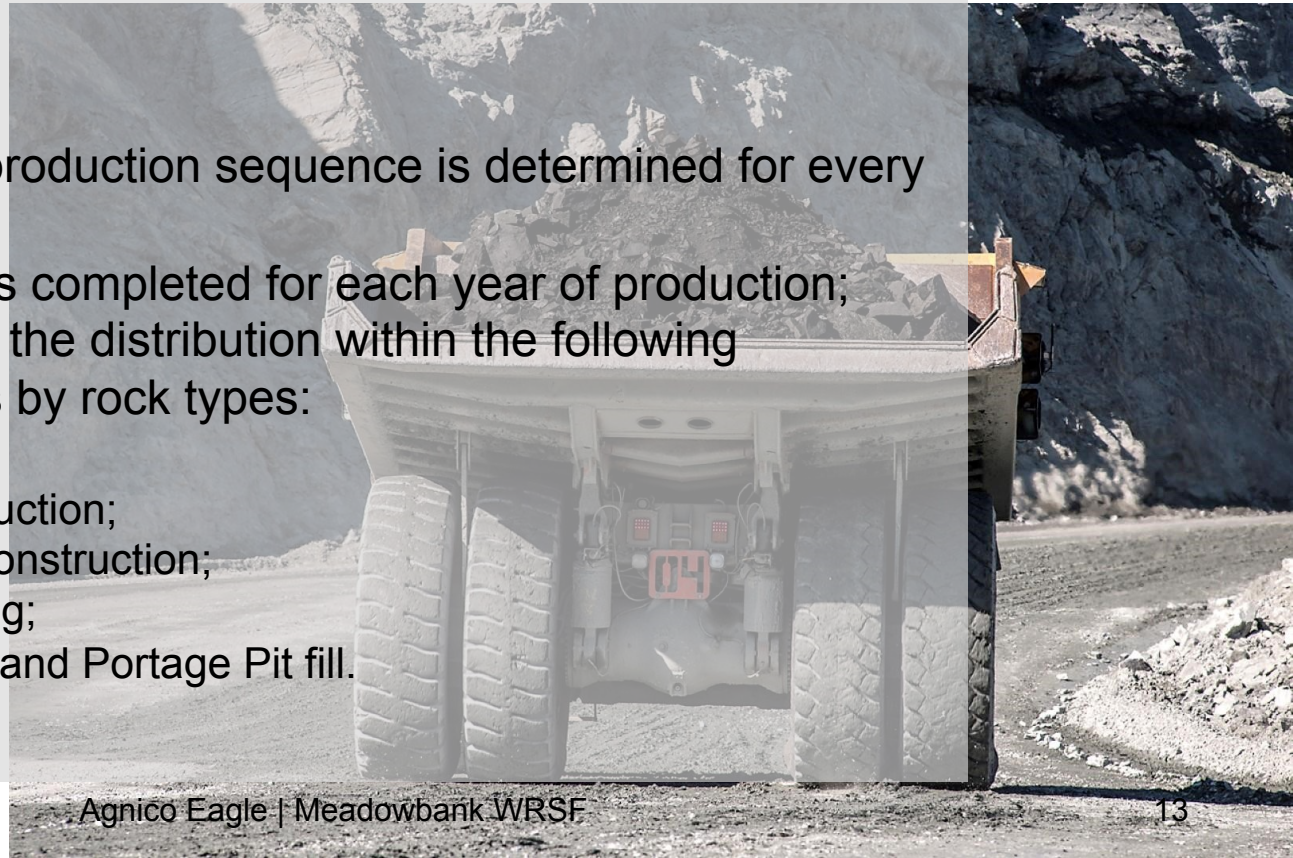
- Three main rock types with distinct geochemical properties;
- Variable ARD characteristics;
- Main usage for each type of rock depending on their geochemical properties.

Area Lithology	Portage and Goose			Vault
	UM	IF	IV	IV
Proportion of Pit Rock Waste	36%	37%	28%	100%
ARD Potential	2% PAG 96% NAG 2% Uncertain	67% PAG 20% NAG 13% Uncertain	20% PAG 66% NAG 14% Uncertain	14% PAG 75% NAG 11% Uncertain
Main Use	Construction NAG Cover	TSF Construction RSF PAG	Construction	Construction

WASTE ROCK MANAGEMENT

Definition of Quantities and Timing of Waste Rock Availability

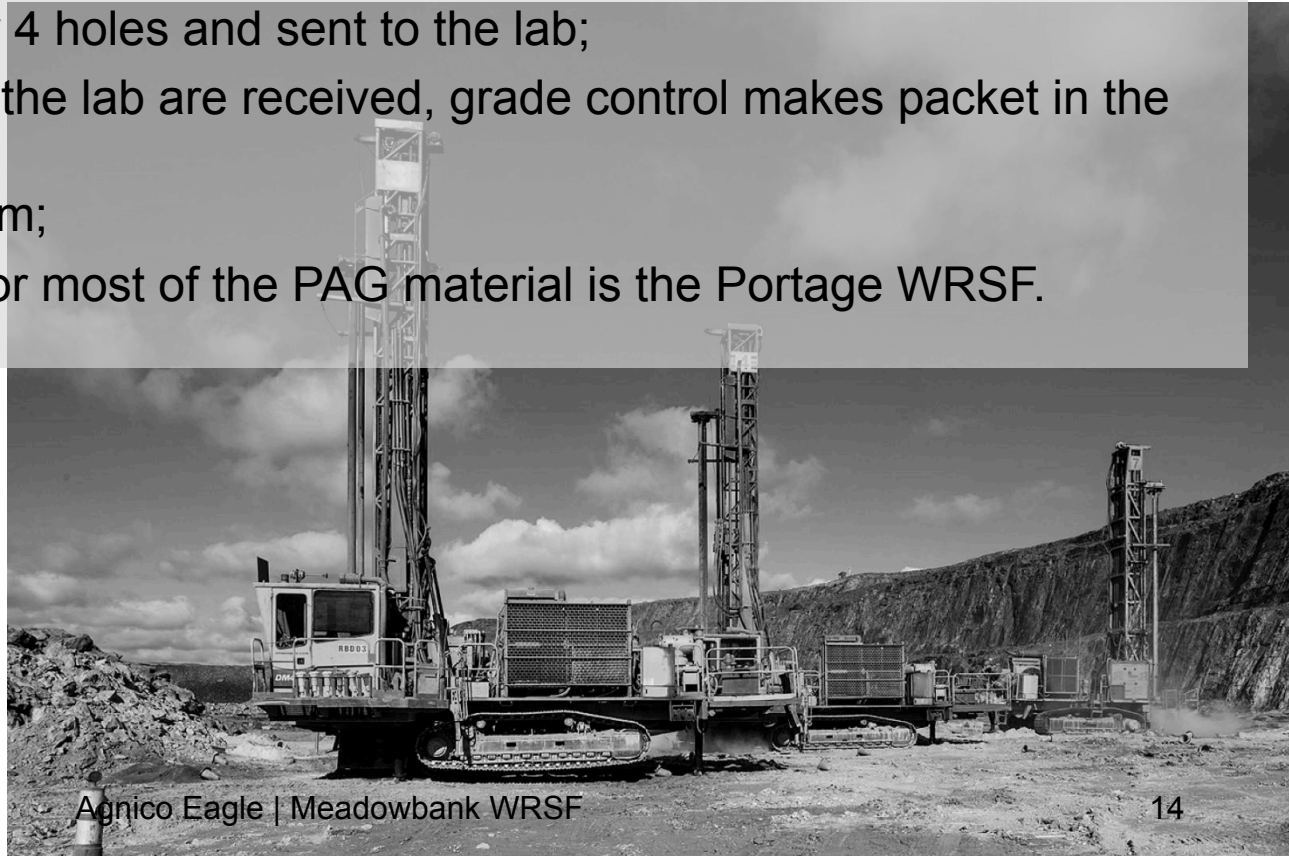
- The mine waste rock production sequence is determined for every mine plan;
- The material balance is completed for each year of production;
- This balance indicates the distribution within the following categories of materials by rock types:
  - Mine rock for construction;
  - Mine rock for dam construction;
  - Mine rock for capping;
  - Mine rock to WRSF and Portage Pit fill.



WASTE ROCK MANAGEMENT

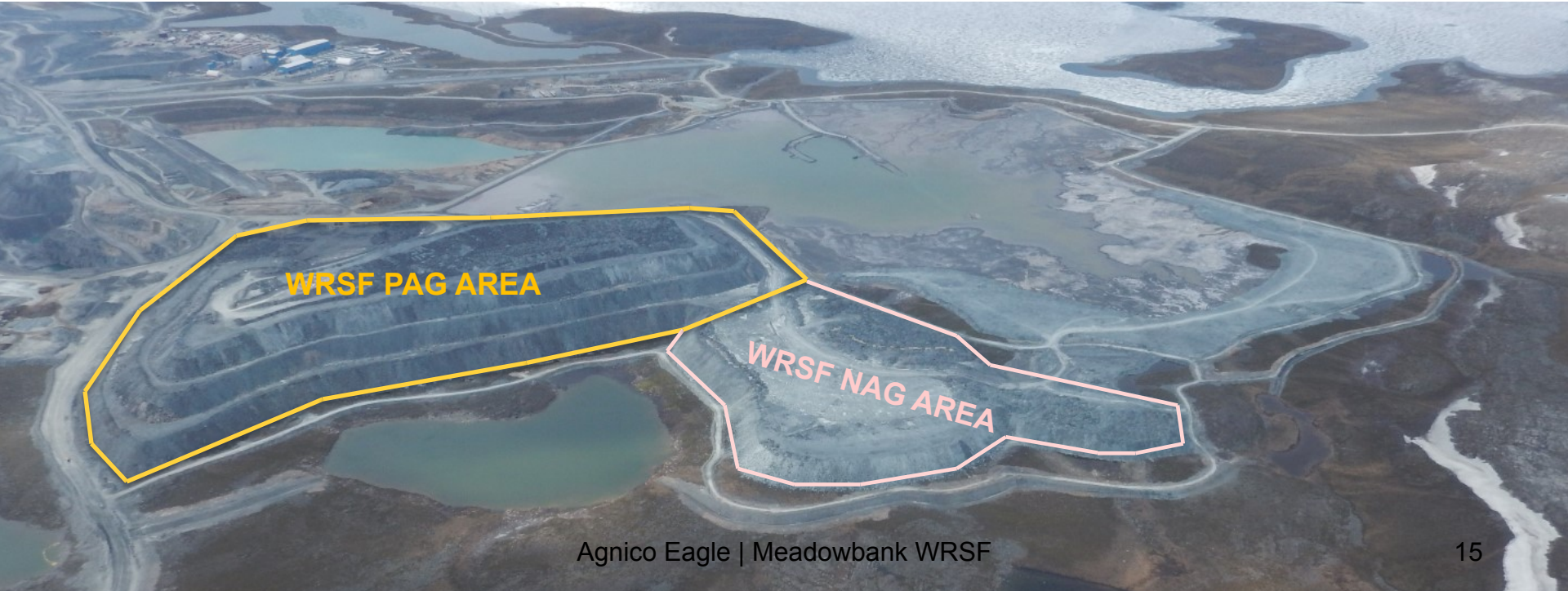
In-field NAG and PAG segregation

- Sample is taken every 4 holes and sent to the lab;
- Once the results from the lab are received, grade control makes packet in the field for each blast;
- Wenco dispatch system;
- The final destination for most of the PAG material is the Portage WRSF.



PORTAGE WRSF – GENERAL CONFIGURATION

Permafrost foundation – Lift of 5 meters with final benches configuration of 20H by 20V – Slope 1.3/1 – 2 main areas: WRSF PAG and WRSF NAG.



PORTAGE WRSF – RECLAMATION

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AEM intends to leave behind a positive legacy with communities and environment. This commitment is in agreement with the objectives listed in the INAC (2007) guidelines for mine closure:

- **Physical stability**: The components of the reclaimed site should be built or modified at closure so that they **do not erode, subside or move under extreme design events**, and therefore **do not pose a health and safety threat** to humans, wildlife, or environment;

- **Chemical stability**: The components of the reclaimed site should be **chemically stable as to prevent adverse soil, water and air quality effects** that might pose a risk to humans, wildlife or environment;

- **Future use and aesthetics**: The reclaimed site should be **compatible with the surrounding land areas** at the completion of the reclamation activities.

PORTAGE WRSF – RECLAMATION

WRSF Closure Objectives:

- Minimize erosion, thaw settlement, slope failure, collapse or the release of sediments or contaminants (ARD and ML);
- Build to blend in with current topography;
- Build to minimize the overall project footprint.

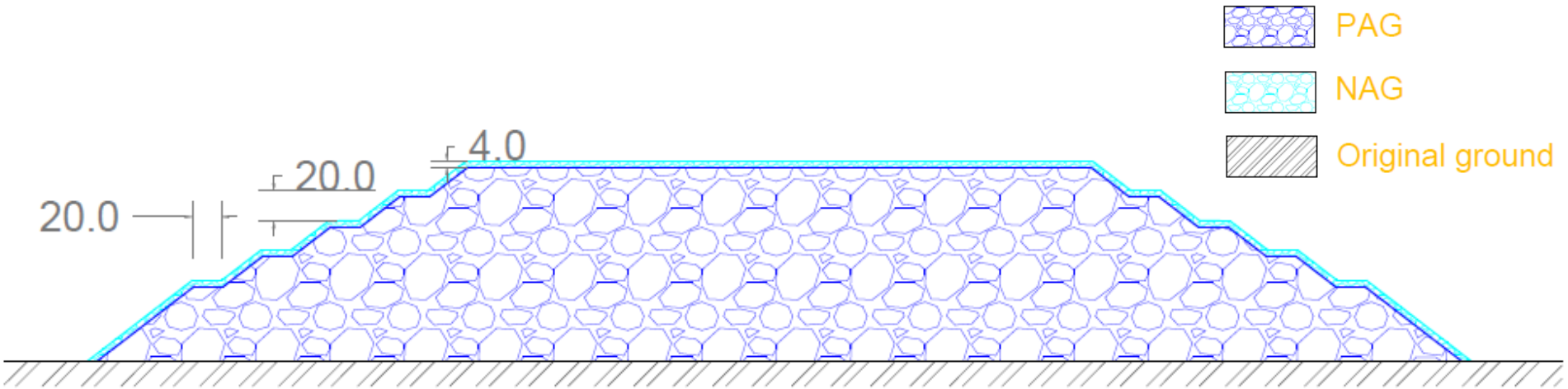
Considerations:

- Geochemistry of the rock in the pile (ML/ARD);
- Quantity of chemically stable rock available.

PORTAGE WRSF – RECLAMATION

Portage WRSF Cover Design:

- Encapsulation of the potential acid generating and metal leaching waste rock with a 4 meters NAG thermal cover in order to:
  - Maintain the active layer zone into NAG cover;
  - Prevent ML-ARD by keeping the WRSF in frozen state all year round.



PORTAGE WRSF – RECLAMATION

Monitoring Program

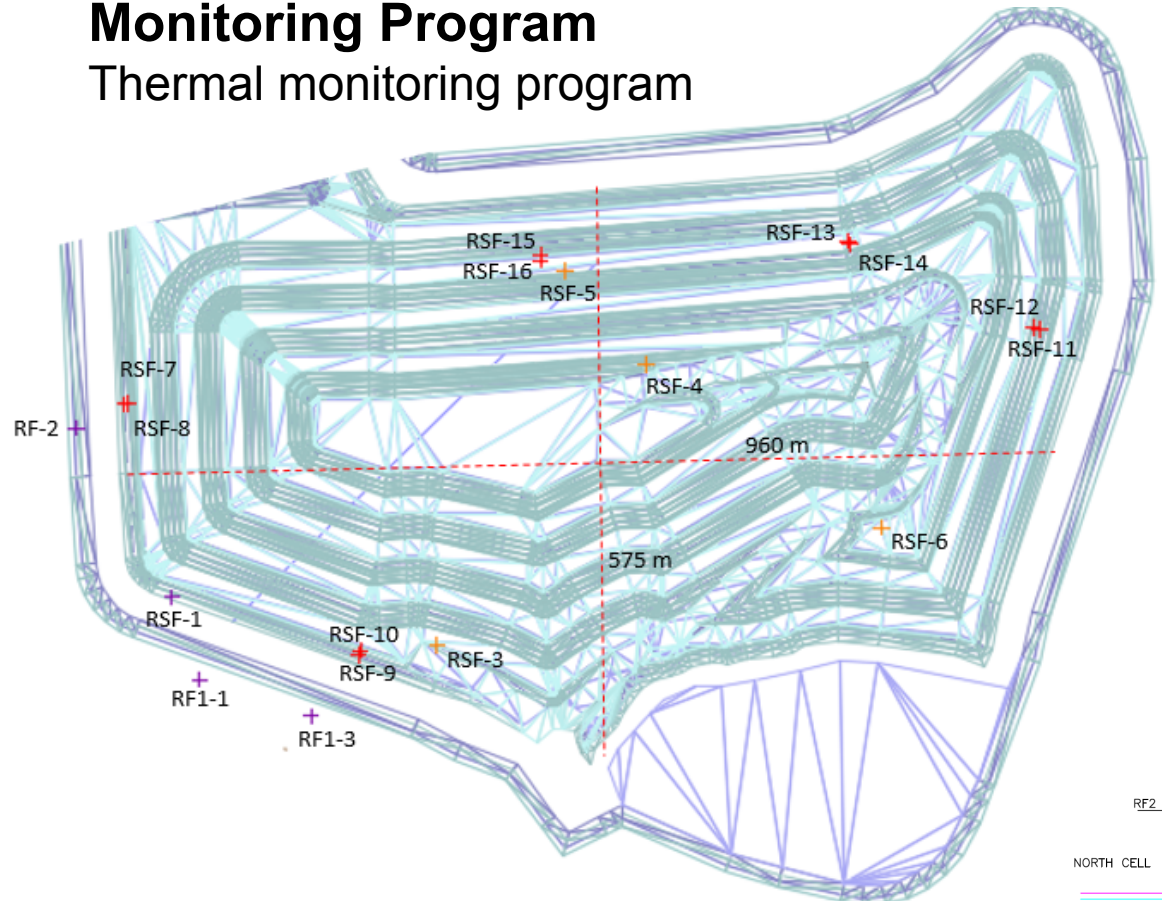
Thermal monitoring program (Thermistors)

- Thermistors are installed in the WRSF;
- Purpose of thermistors: to monitor the WRSF temperature as freezing progress;
- Monitoring throughout the operational, closure and post closure period;
- Collect data for modelling;

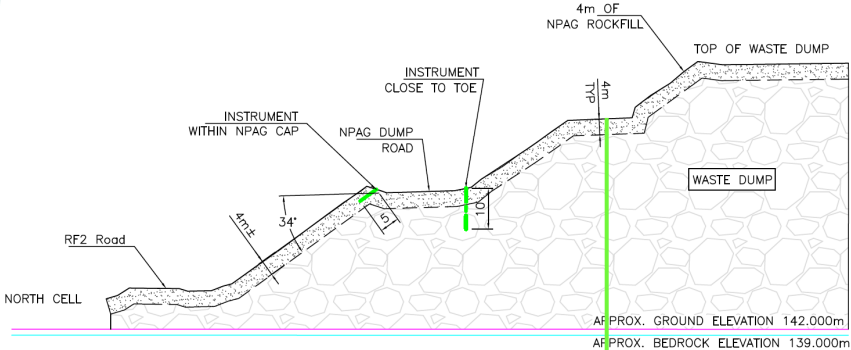
PORTAGE WRSF – RECLAMATION

Monitoring Program

Thermal monitoring program



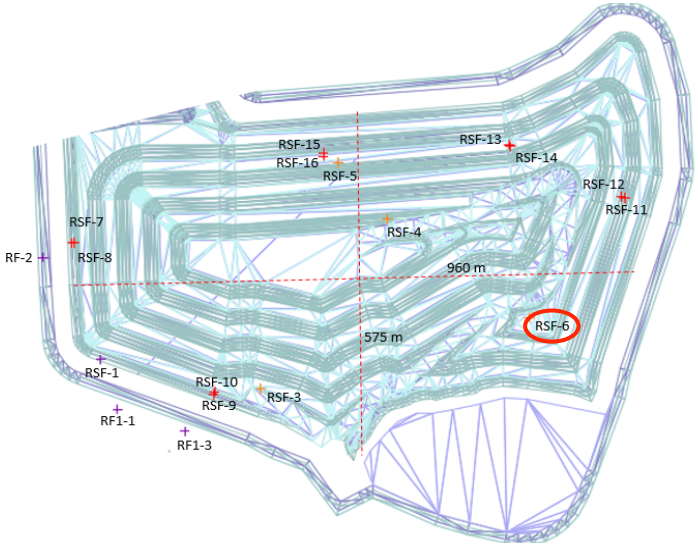
- 18 thermistors strings of different length;
- Installed at different years since 2012.

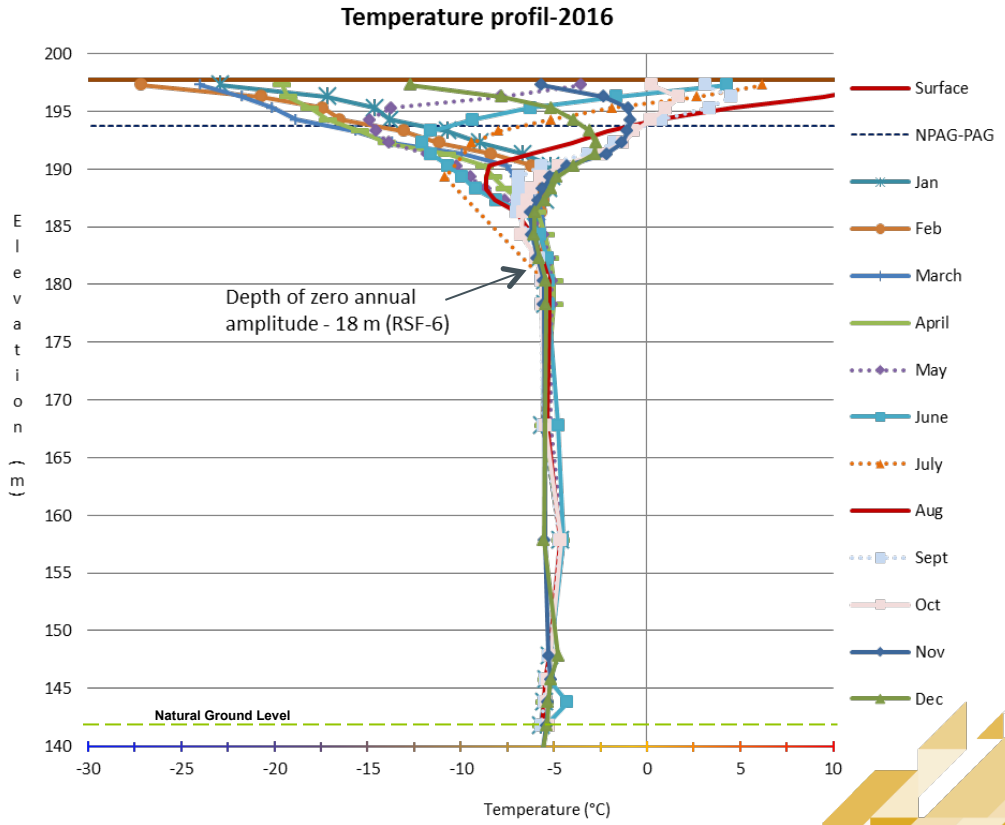


PORTAGE WRSF – RECLAMATION

Monitoring Program

Thermal monitoring program





PORTAGE WRSF – RECLAMATION

Thermal modelling – Objective and Approach

- AEM retained O'Kane Consulting to performed thermal modelling of the Portage WRSF;
- The main objective of the numerical modelling is to estimate the depth of the active layer within the Portage WRSF and to confirm that the PAG waste rock will remain frozen for the next 150 years under agreed climate change scenarios;
- For this project the climate change scenarios used were RCP4.5 and RCP6. These scenarios were used to create two 150-year climate change databases for temperature and precipitation;

PORTAGE WRSF – RECLAMATION

Thermal modelling – Preliminary Results and Next Step

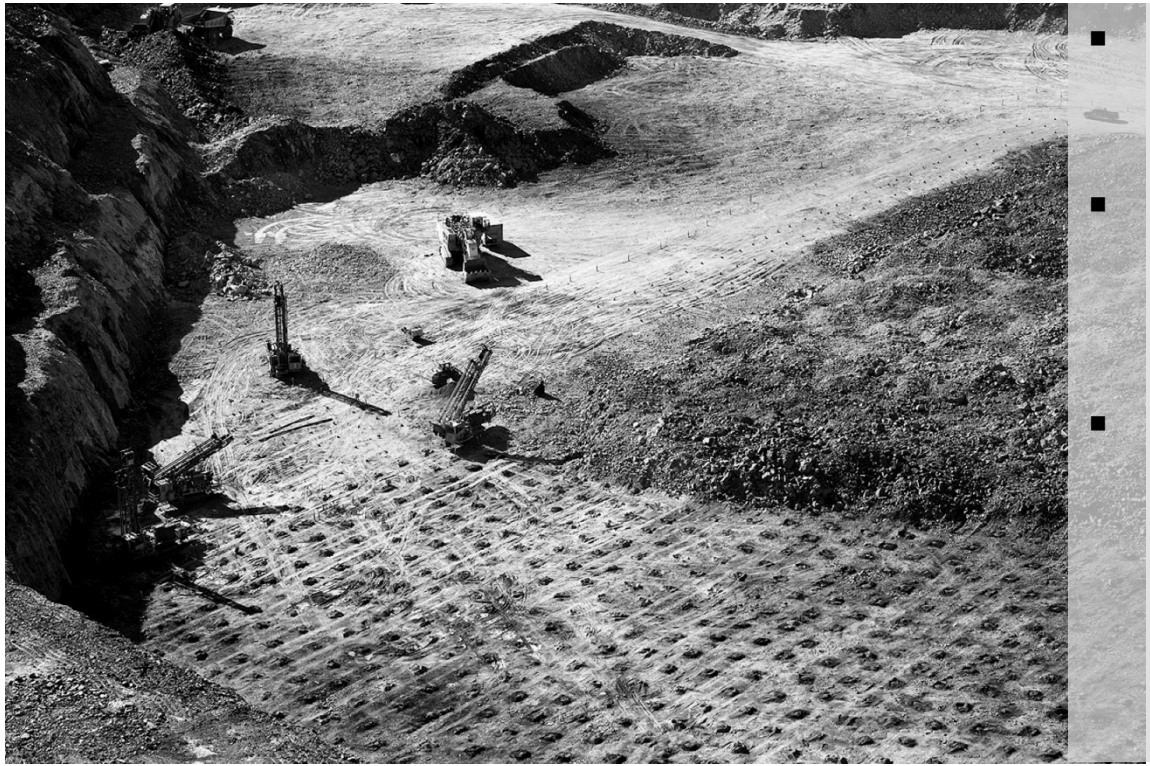
- Preliminary results are encouraging;
- Once calibrated, the modelled temperature profile was shown to be an good match to the measured temperature data over the entire profile of the selected thermistor;
- Continue monitoring program to increase data base for the thermal behavior of the Portage WRSF facility;
- Evaluate if further thermal modelling work is required;
- Continue to work with O'Kane in order to evaluate performance of thermal cover;

PORTAGE WRSF – RECLAMATION

Research Program

- We collaborate with researchers for Portage WRSF in order to increase the knowledge behind permafrost encapsulation vs ML/ARD;

CONCLUSION



- Meadowbank activities will continue with the Whale Tail pit and the Amaruq mine site;
- Lessons learned from Portage, Goose and Vault facilities will be used to improve practice at the Amaruq mine site;
- Site monitoring is ongoing and will continue for the Portage WRSF in order to verify anticipated conditions and the validity of the proposed closure plan;

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THANK YOU!