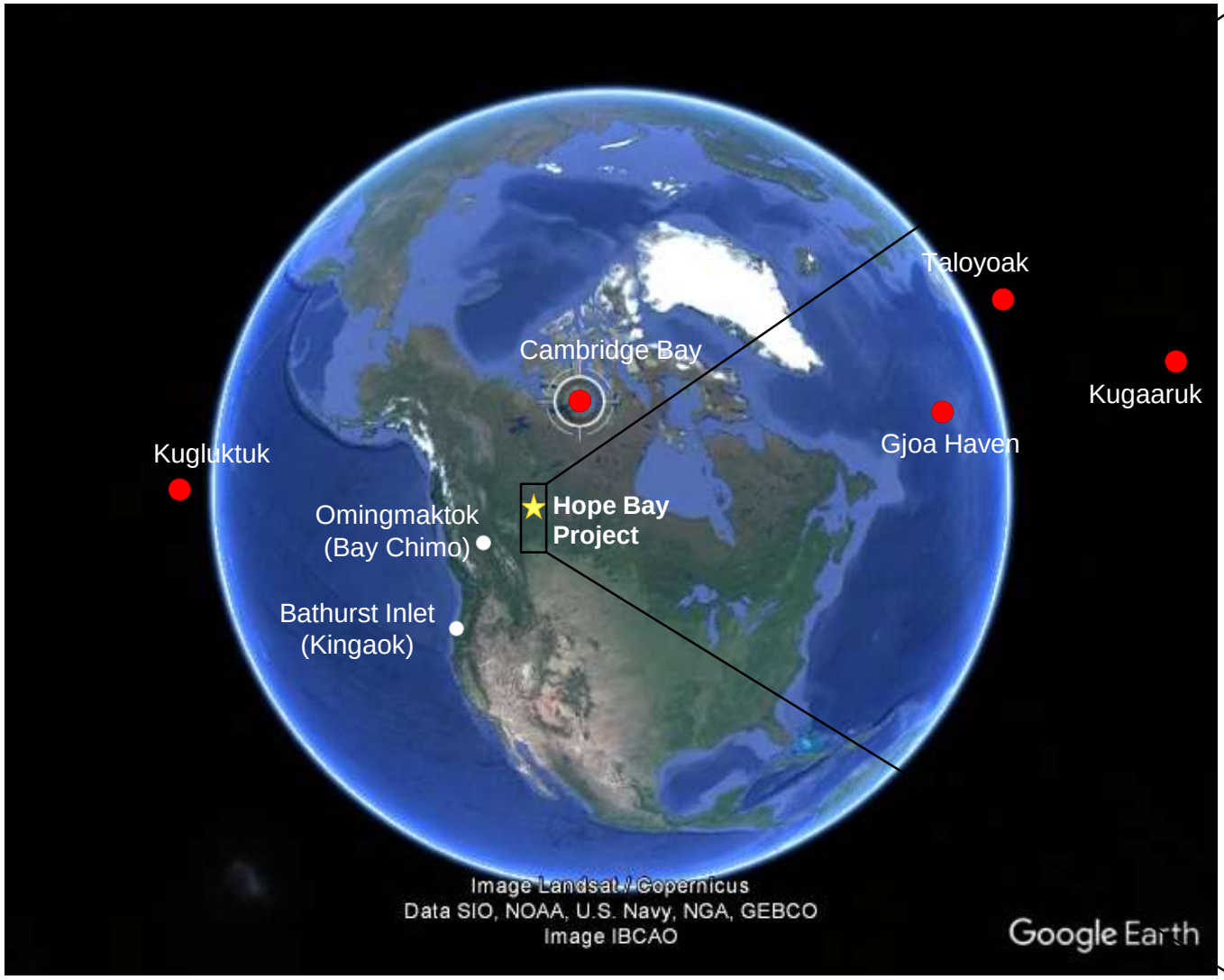
Nunavut Water Board Technical Meeting

May, 2018

Project Location



Approved Doris Project (No.003 and 2AM-DOH1323)

Existing Permits and Licences - Doris

Project Certificate

- **Issued 2006, Amended 2016**
  - **Allows Construction, Development, Production, Closure**
  - **Environmental compliance and protections**
  - **2000 tonnes per day**
  - **Discharge Effluent to Roberts Bay**

Type A Water Licence 2AM-DOH1323

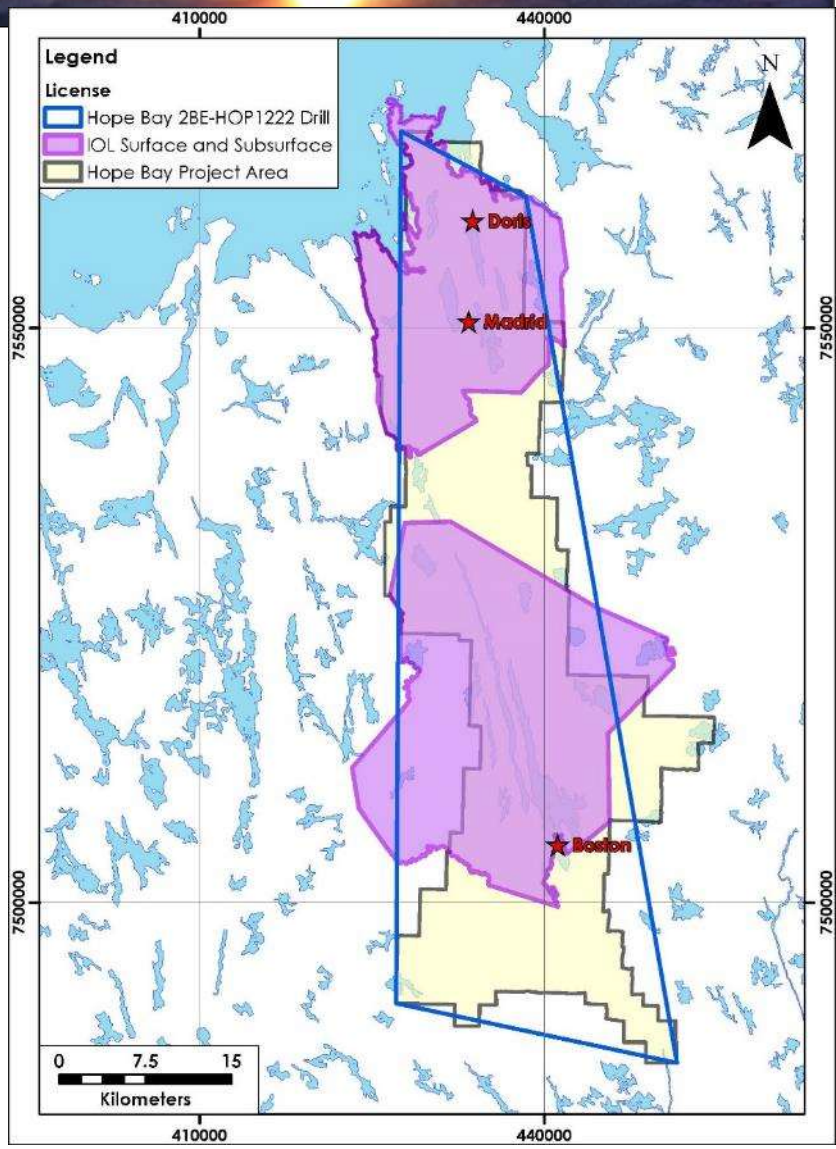
- **Issued 2007, Amended 2016, Applies from 2013 to 2023**
  - **Water Use**
    - **Doris Lake - 480,000 m^3 per year - Mining and Processing**
    - **Windy Lake – 22,000 m3 per year - Domestic**
    - **Reclaim Water – no limit - Processing**
  - **2.5 million tonnes to Tailings Area**
  - **Reclamation Security - $31 Million**

All operations comply with all Federal and Territorial laws and regulations

- **Effluent to comply with Metal Mining Effluent Regulation**

Type BE Water Licence - Exploration

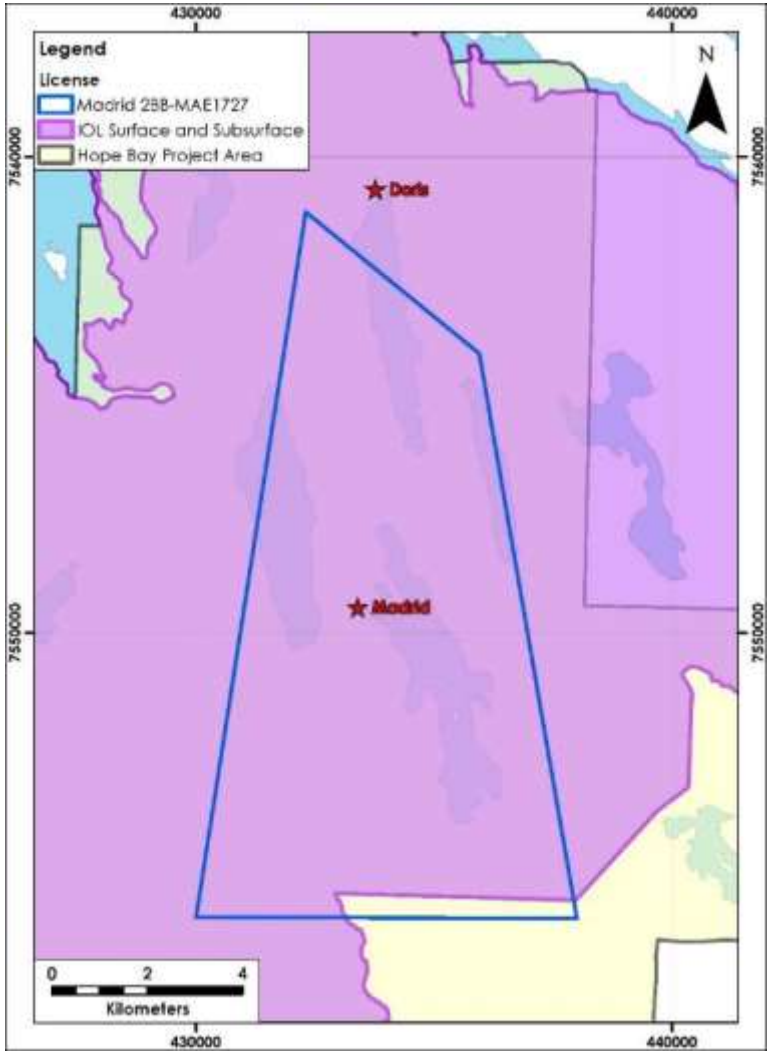
- **Type B Water Licence 2BE-HOP1222**
- **Issued 2012, Expires 2022 (renewable)**
- **Entire Hope Bay Property**
- **Permitted Activities**
  - **<u>Surface Exploration and Drilling</u>**
  - **Water Use – 343 m3 per day.**
  - **Domestic water use at Doris Camp**
  - **Construct new camp (180 persons)**



Madrid Type BB Water Licence

- Type B Water Licence 2BB-MAE1727
- Madrid North and South
- Issued 2017 – Expires 2027 (renewable)
- Permitted Activities
  - Surface and underground exploration
  - Extract 50,000 tonnes bulk sample from each of Madrid North and South
  - Construct surface facilities and roads
  - Haul ore to Doris Plant
  - Water Use
    - 108,000 m3 per annum, 295 m3 per day

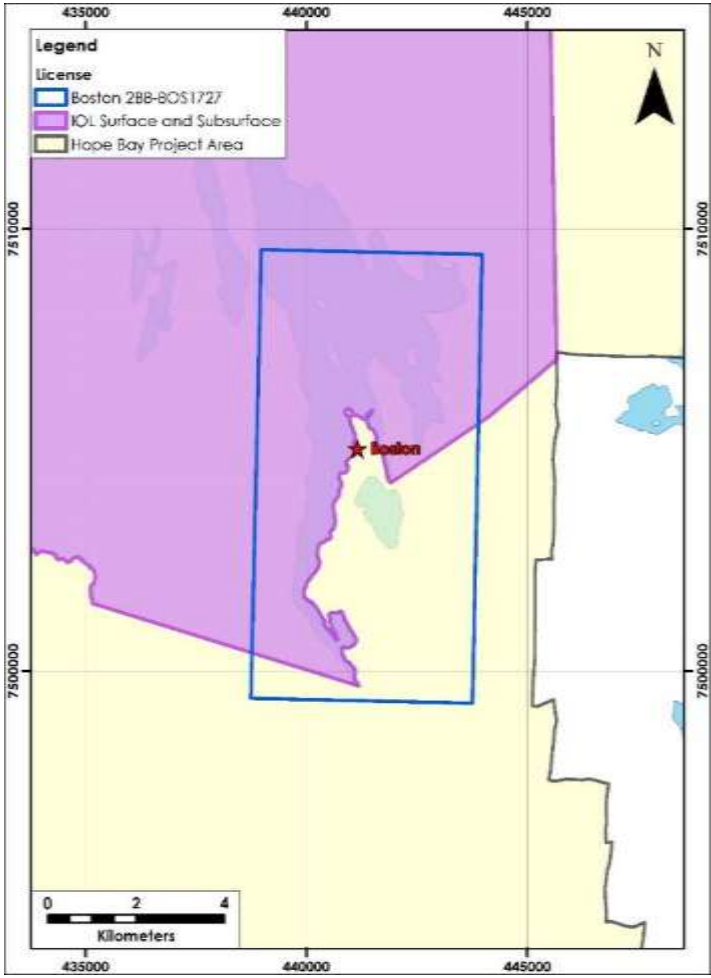
- Reclamation Security Bonds (60 days before activity - proposed)
  - Madrid North - $4 million
  - Madrid South – $3.1 million
  - Roads - $17 thousand



Boston Type BB Water Licence

- **Type B Water Licence 2BB-BOS1217**
- **Renewed 2017, Expires 2027 (renewable)**
- **Permitted Activities**
  - **Surface and underground exploration**
  - **Extract bulk sample**
  - **Construct surface facilities, roads and camp**
  - **Water Use - 100 m3 per day**
  - **Winter road access from Doris**
  - **Scope includes:**

  *"…camping, prospecting, drilling, **bulk sampling, operation of a bulk sampling and crushing and sorting plant, underground development**, the operation of a fuel storage facility, a landfarm facility, and sampling for environmental baseline data collection."*



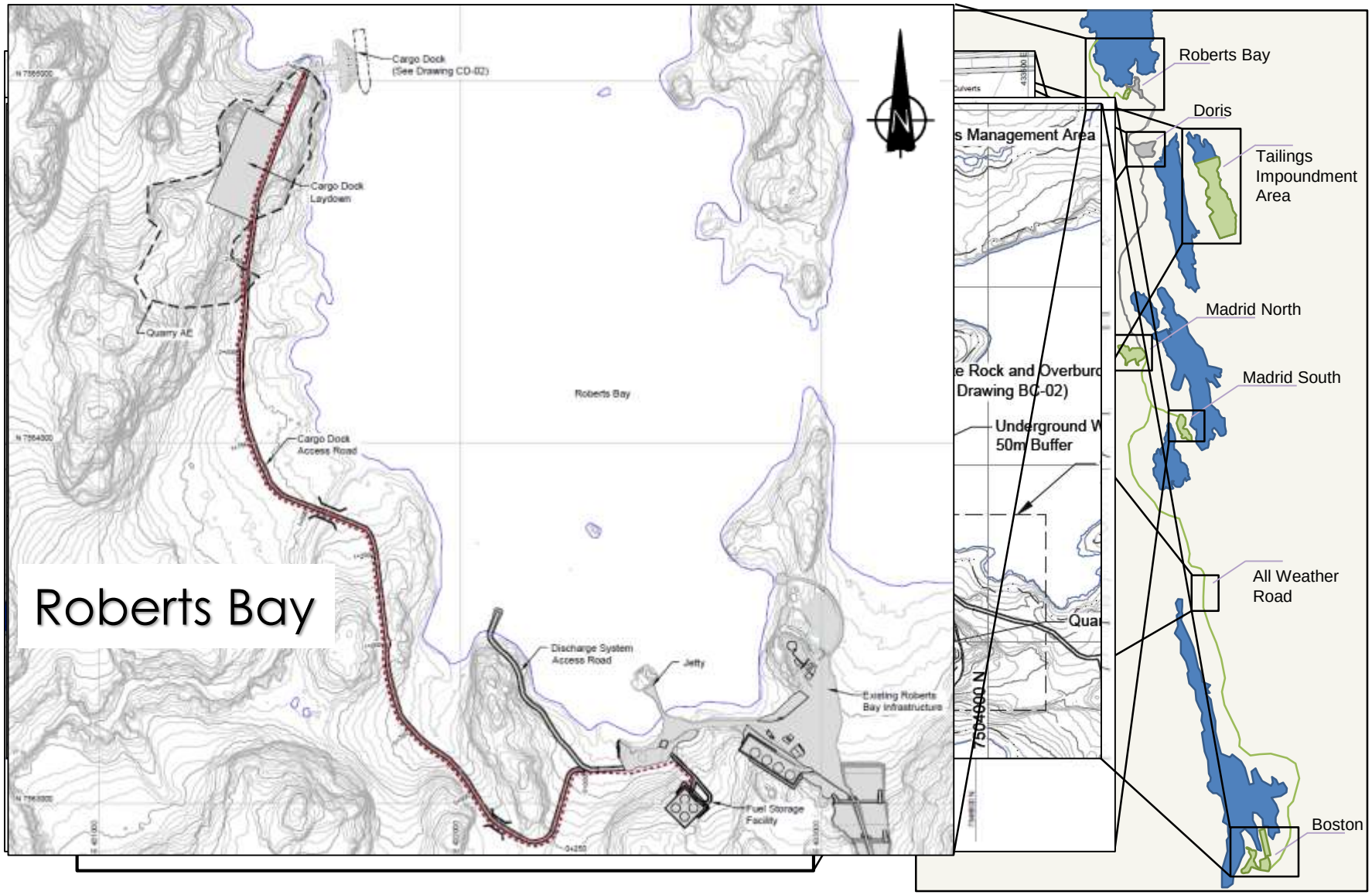
Monitoring and Reporting

- **Aquatic Effects Monitoring Plan**
- **Environmental Effects Monitoring Program**
- **Surveillance Network Program**
  - Type A Water Licence –monthly
  - Type B Water Licence(s)- monthly
- **NWB Annual Reports**
  - Type A and Type B Water Licence
  - Due March 31

Madrid- Boston Project Highlights

Madrid and Boston Highlights	
Mining	• Mining with waste rock stored above ground temporarily and then put back into the underground mines. Some surface excavation to remove ore at and near surface.
Processing	• Approximately 5,600 tonnes of ore processed per day
Gold Production	• Gold production at Doris and Boston. Concentrates produced at Madrid North
Transportation	• Sealift arrives at Roberts Bay and utilize cargo dock and jetty • Gold bars flown out to market from Doris and Boston • Road connecting Madrid and Boston to Doris and Roberts Bay
Employment	• Fly in-fly out operation from Edmonton and Kitikmeot • 870 workers during peak operations (for approximately 14 years)
Economic Benefit	• Royalties, mineral taxes and other payments of approximately $500 million over the life of the Hope Bay Project for Canada, Nunavut, KIA and NTI (excluding Doris)

Hope Bay Project Layout



Roberts Bay

Proposed Amendment No. 2 Type A

- **Scope includes Doris, Madrid Sites and All Weather Road**
  - Expand 2AM-DOH1323 Amendment No. 1 by incorporating into this Licence the scope of all facilities and activities authorized under the Type B Licence 2BB-MAE1727
    - Camp Capacity – 400 persons
    - Expand TIA capacity to 18 million tonnes
    - Water Allowance:
      - Domestic from Windy Lake: 43,800 m3/year
      - Industrial from Doris Lake: 1,930,000 m3/day
    - Concentrator at Madrid
    - AWR to Boston
    - **<u>Allows commercial mining</u>**

Proposed Boston Type A

Project Certificate and Boston Type A Water Licence

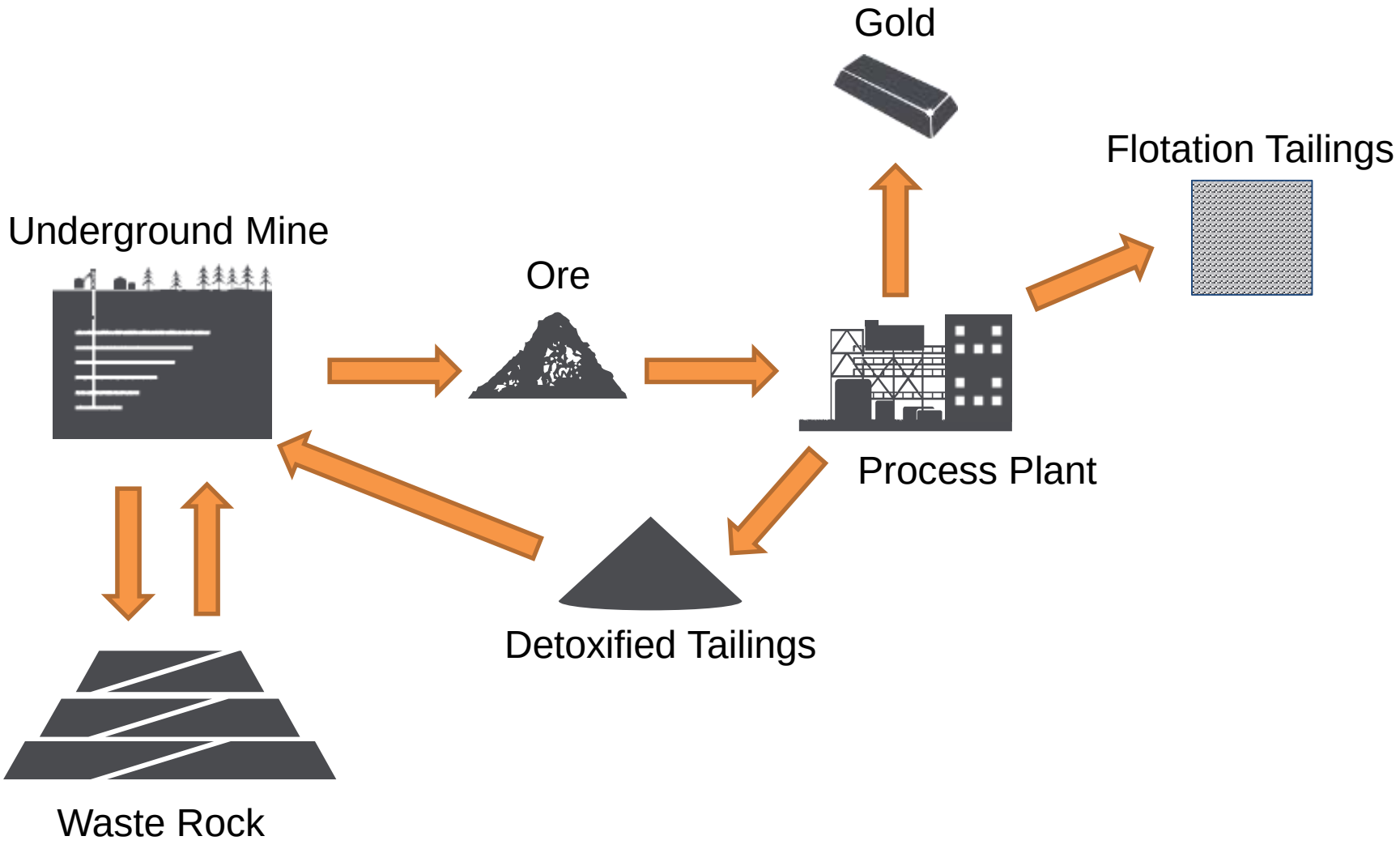
- **Scope:**
- Construct and operate Boston Site
- Camp Capacity – 300 persons
- Tailings Management Area capacity of 5.1 million tonnes
  - Water Allowance:
    - Domestic from Aimaokatalok Lake 33,000m3/year
    - Industrial from Aimaokatlok Lake 450,000m3/year
- 2400 t/d process plant
- Allows water use, waste management and construction of all surface infrastructure
- **Allows commercial mining**

Closure and Reclamation

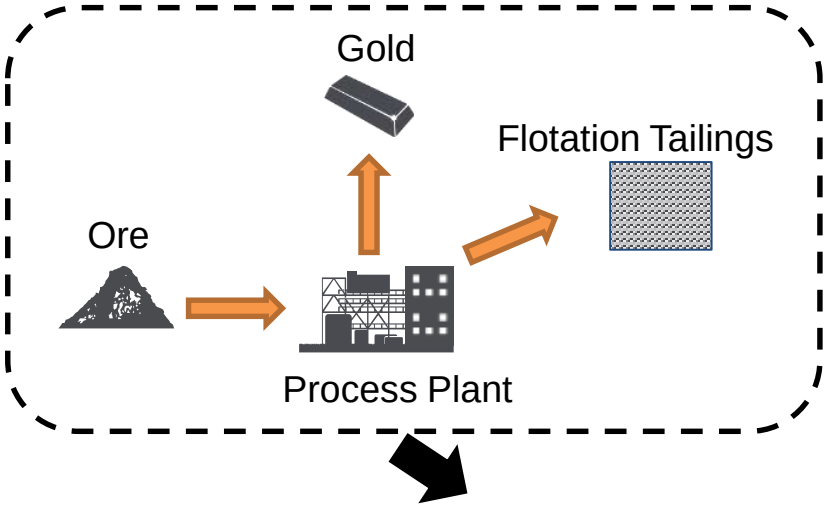
- **Doris-Madrid Interim Closure and Reclamation Plan was updated**
- **Boston Conceptual Closure and Reclamation Plan was developed**
- **Overall objectives of closure planning at Hope Bay:**
  - Physical Stability
  - Chemical Stability
  - Future use and aesthetics
- **Planning provides basis to estimate financial security**

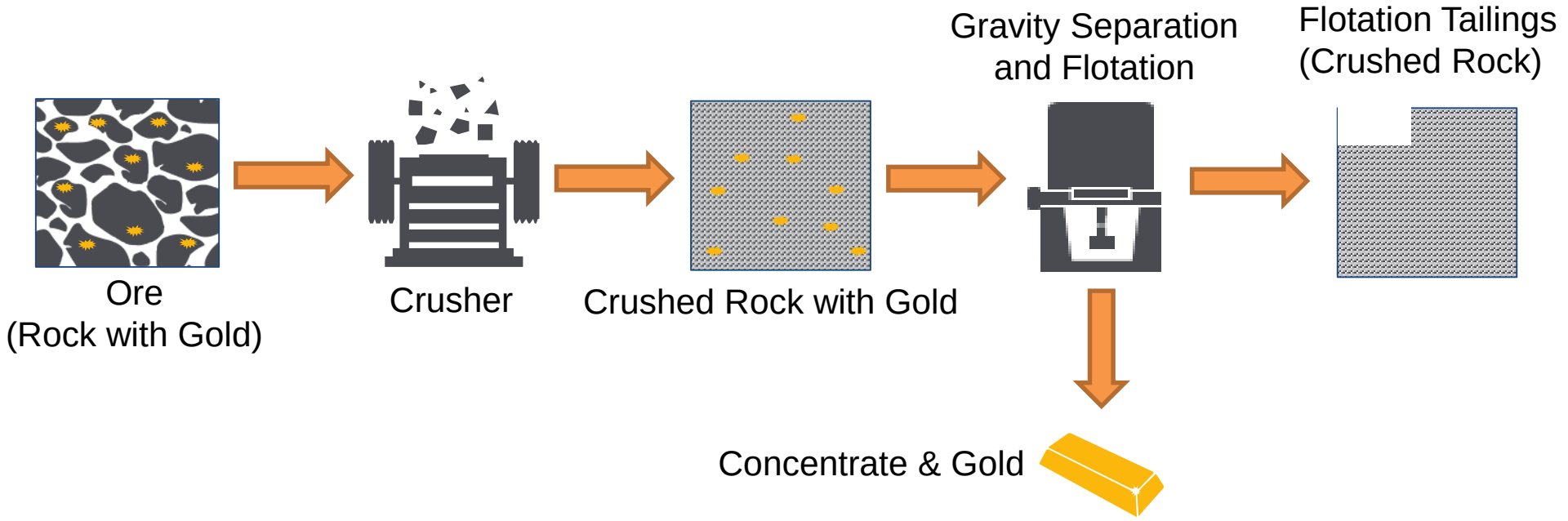
Tailings and Waste Rock Mangement

Tailings and Waste Rock

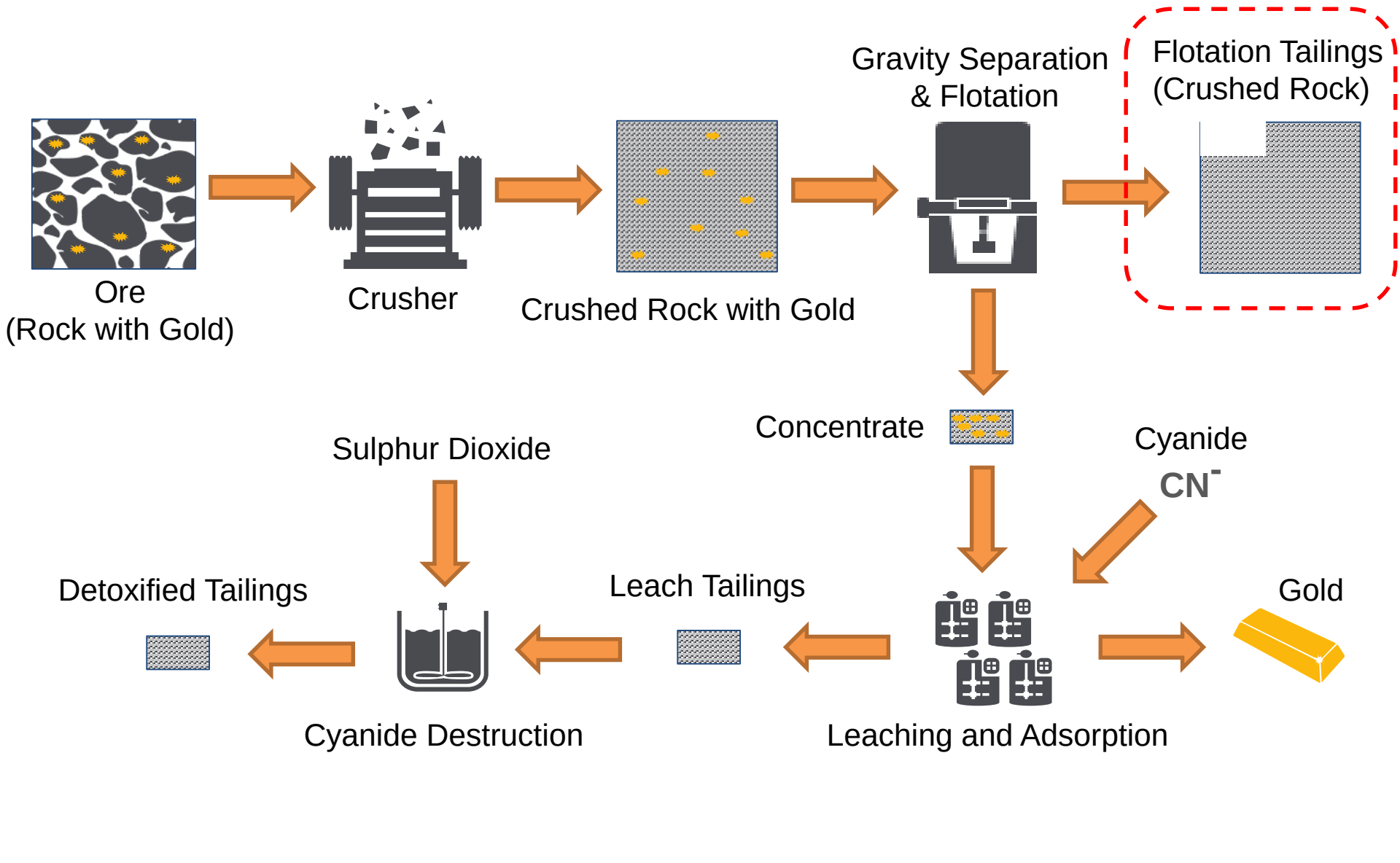


Flotation Tailings

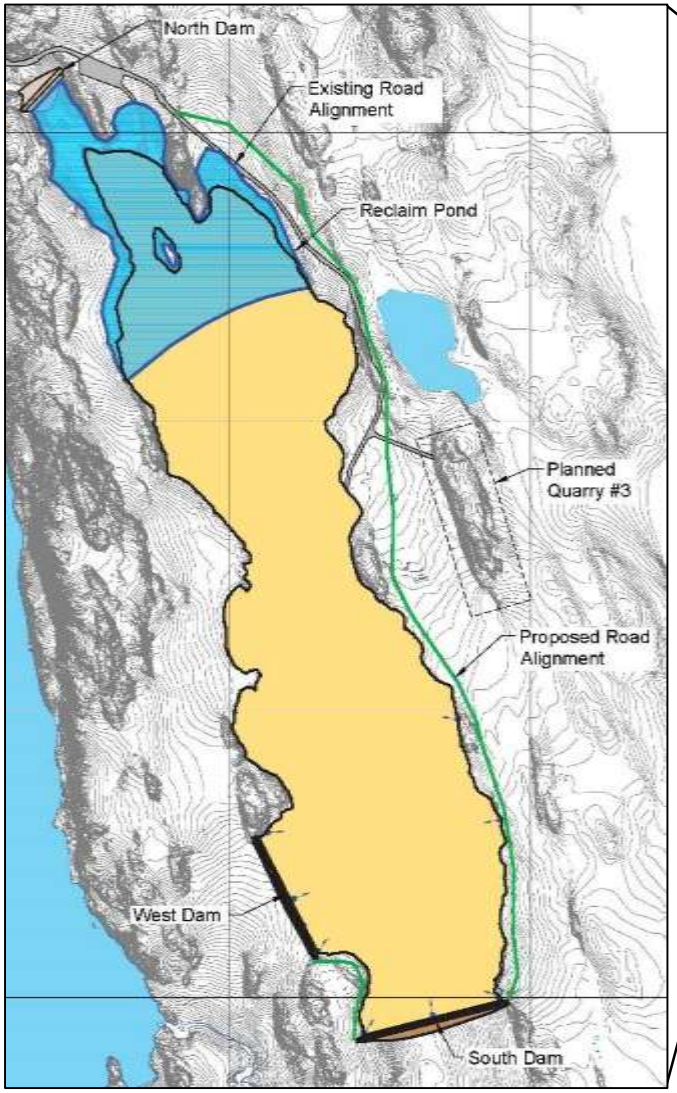


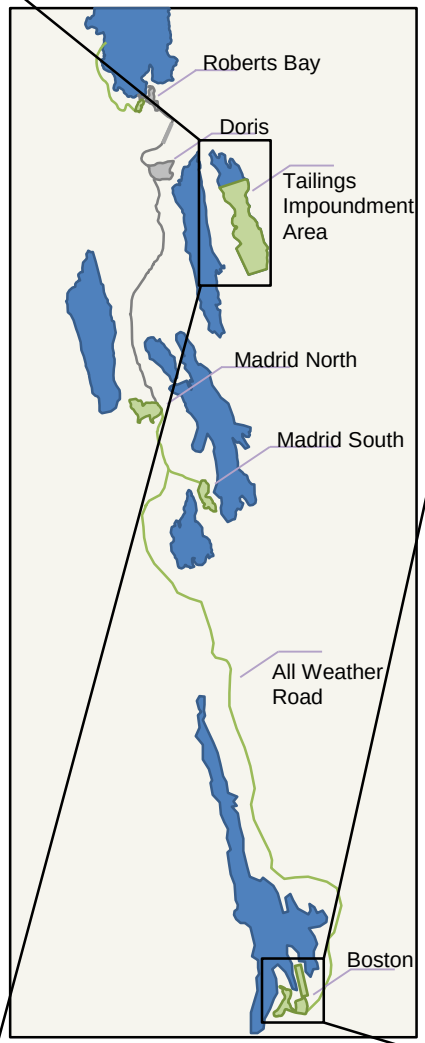


Detoxified Leach Tailings

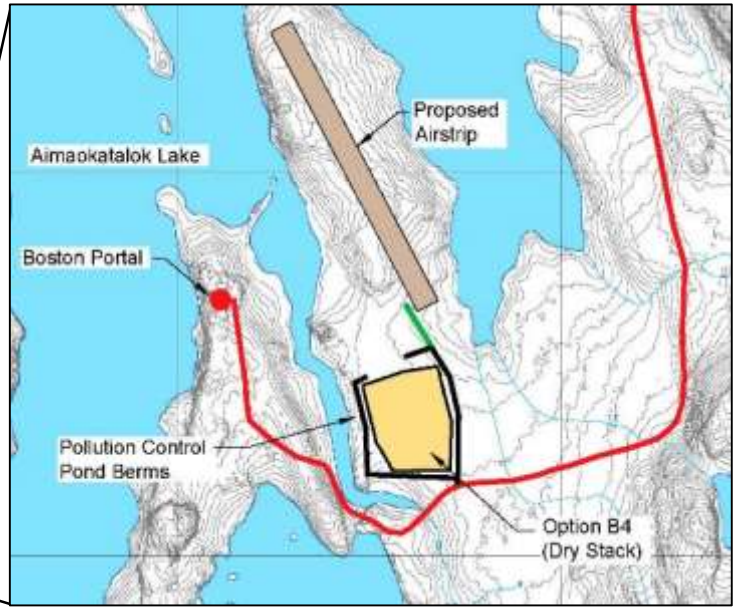


Overview of Tailings Management



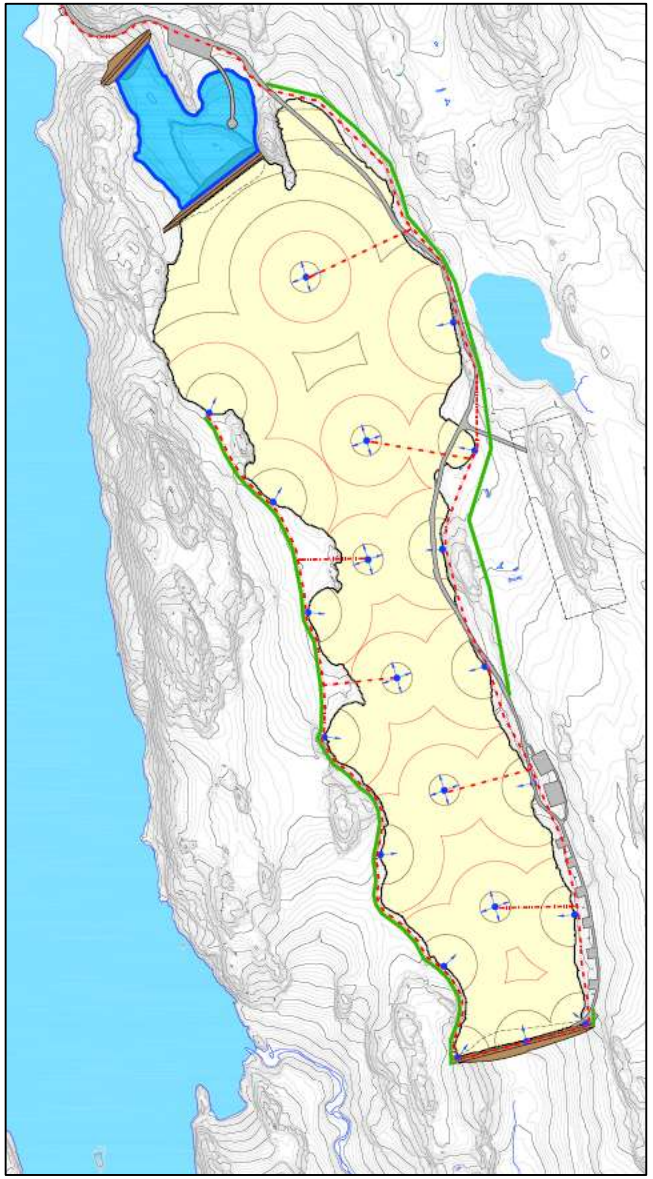


- Doris – Conventional Tailings Impoundment Area
- Boston – Dry Stack Tailings Management Area



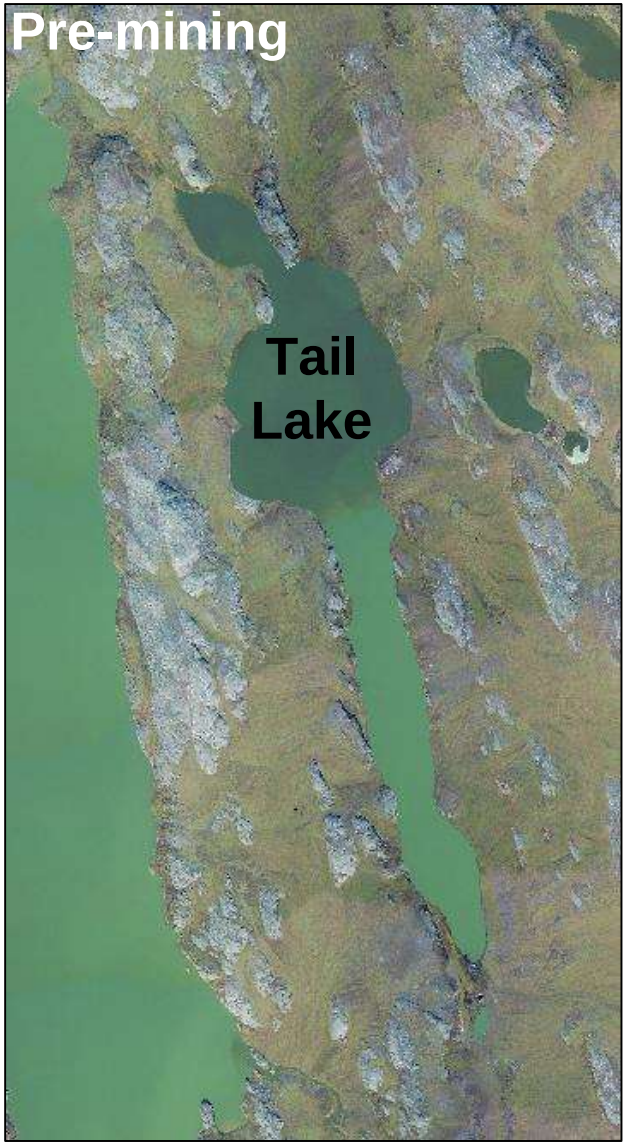
Alternative Analysis - Doris

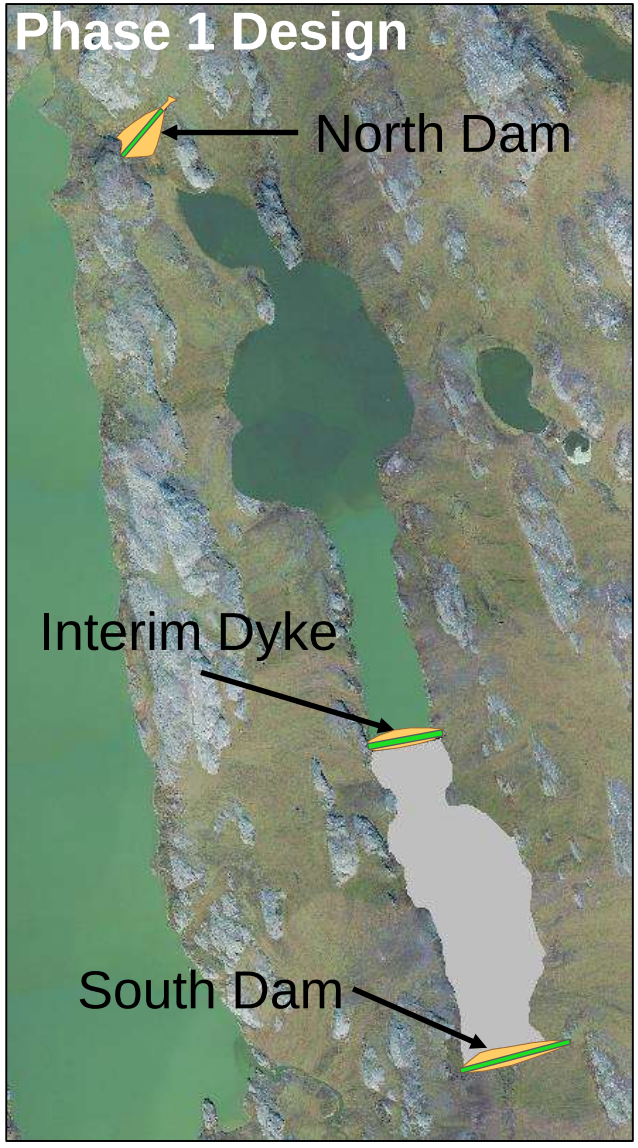
Siting Options

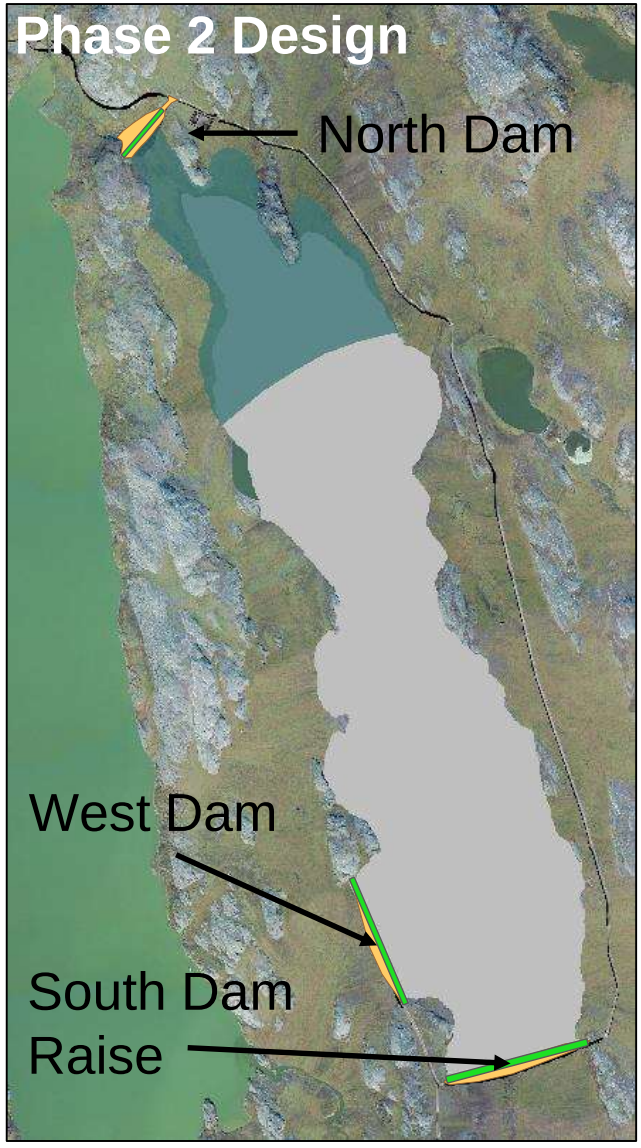


Deposition Options

Tailings Impoundment Area - Doris



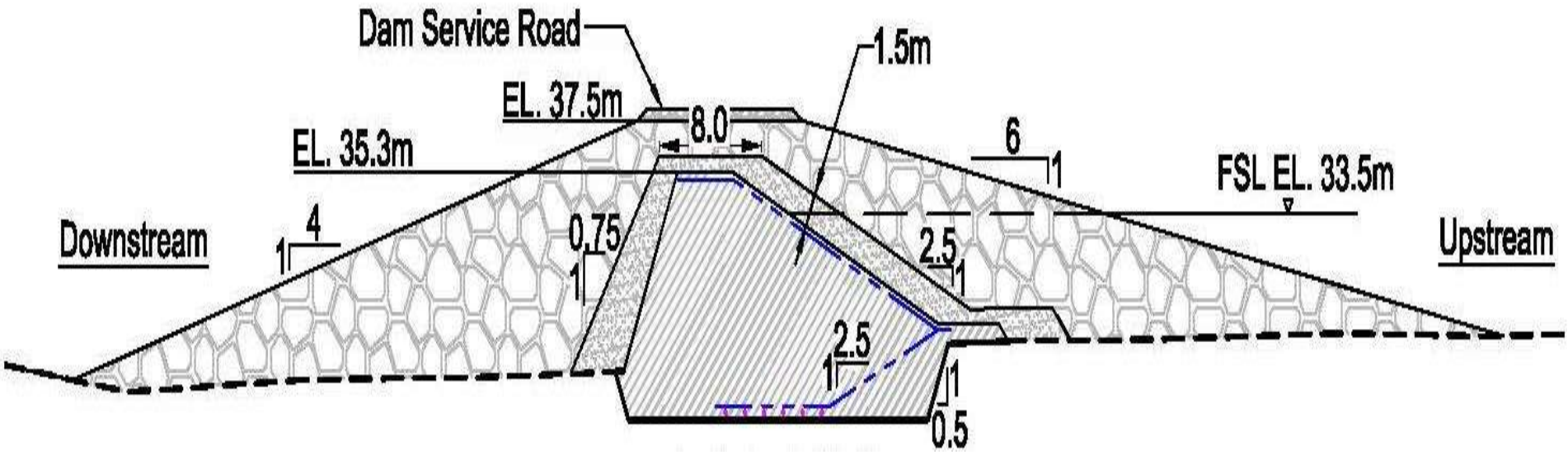




Tailings Impoundment Area - Doris

- Slurry tailings
- Low solids content
- Pumped
- Similar to:
- Meadowbank
- Nanisivik

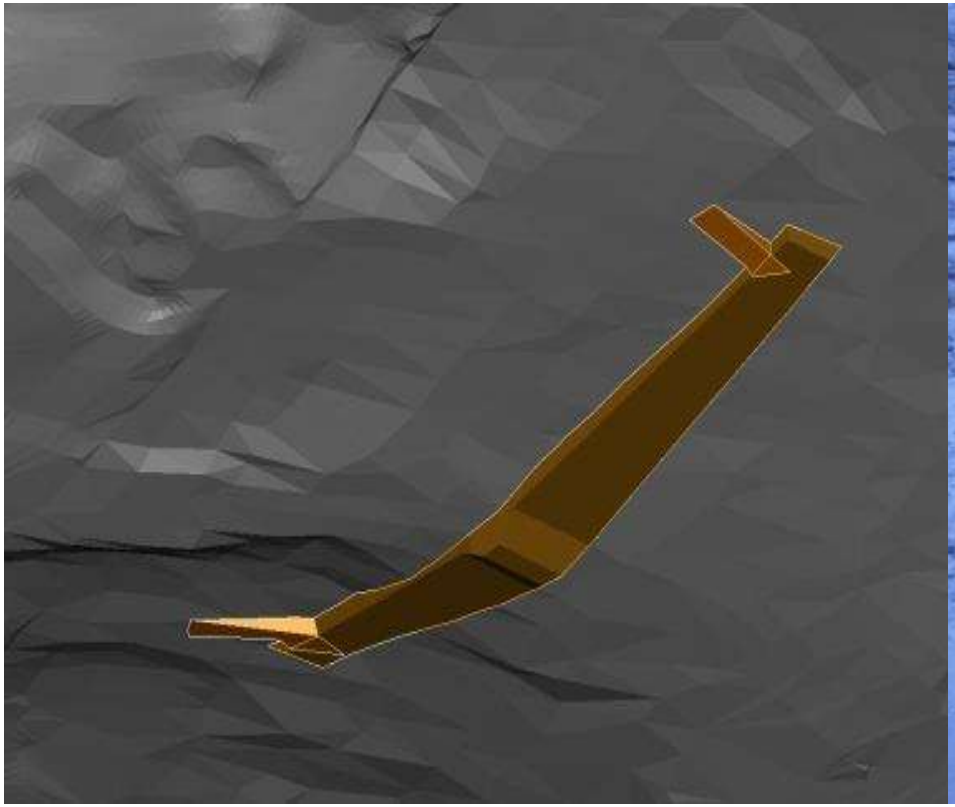
North Dam : Frozen Core Dam



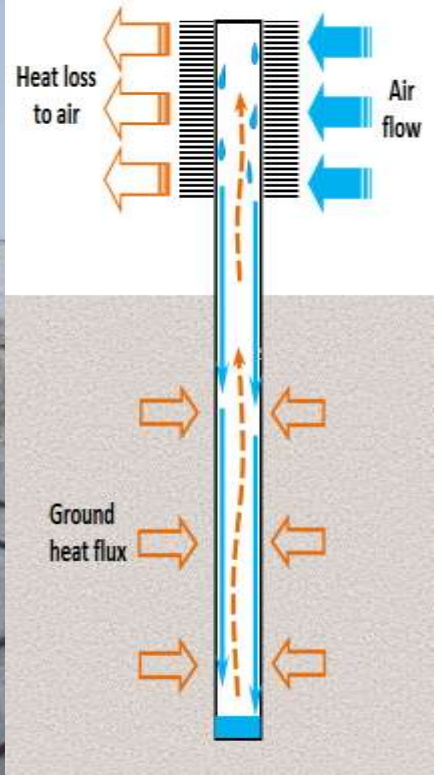
- Seepage Analysis
- Stability Analysis
- Creep Analysis
- Thermal Analysis
- Settlement Analysis
- Frost Heave Assessment
- Freeboard Hydraulic Assessment

North Dam

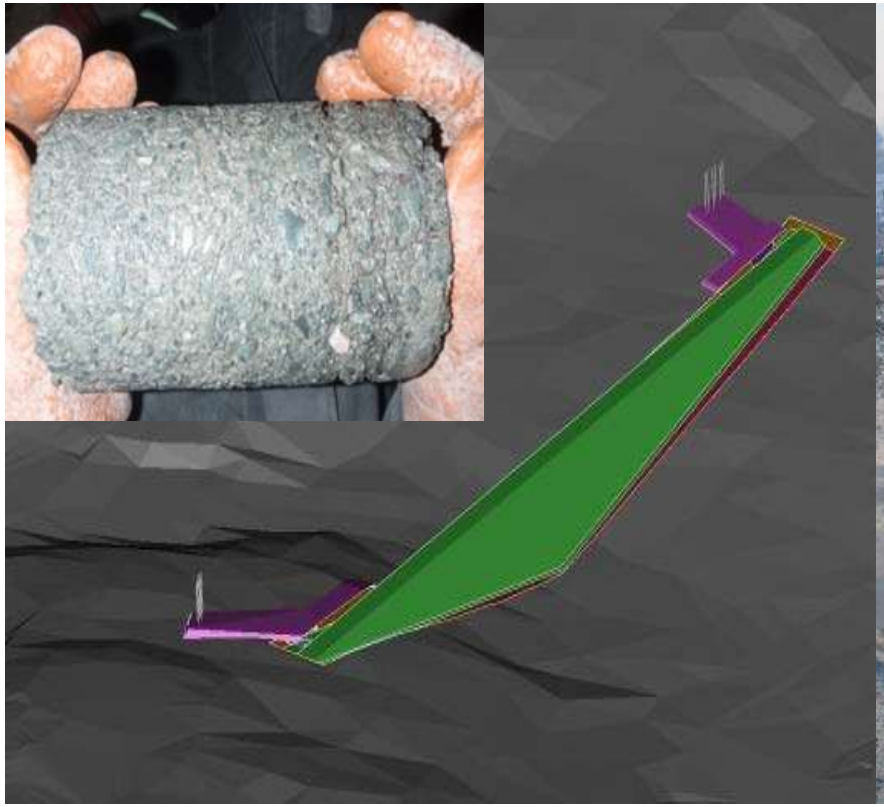
Key Trench Excavation

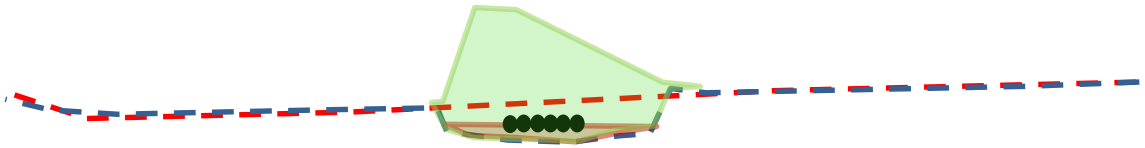


Thermosyphon Installation

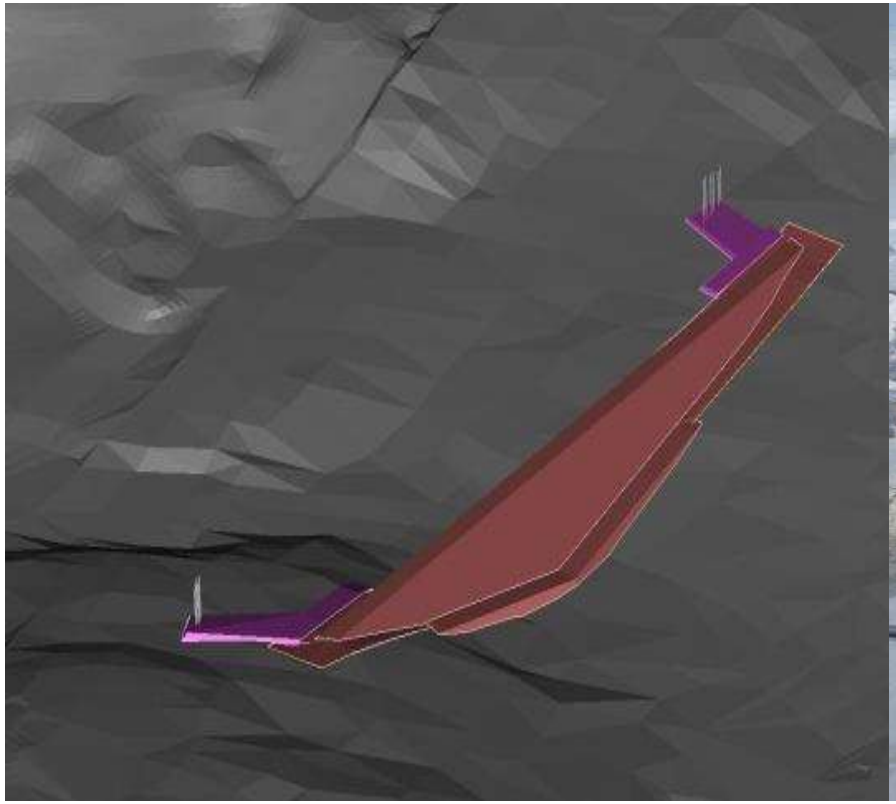


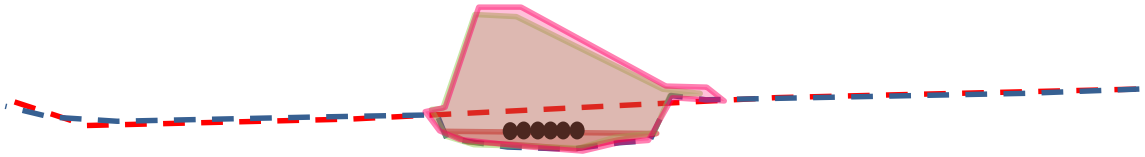
Frozen Core Construction



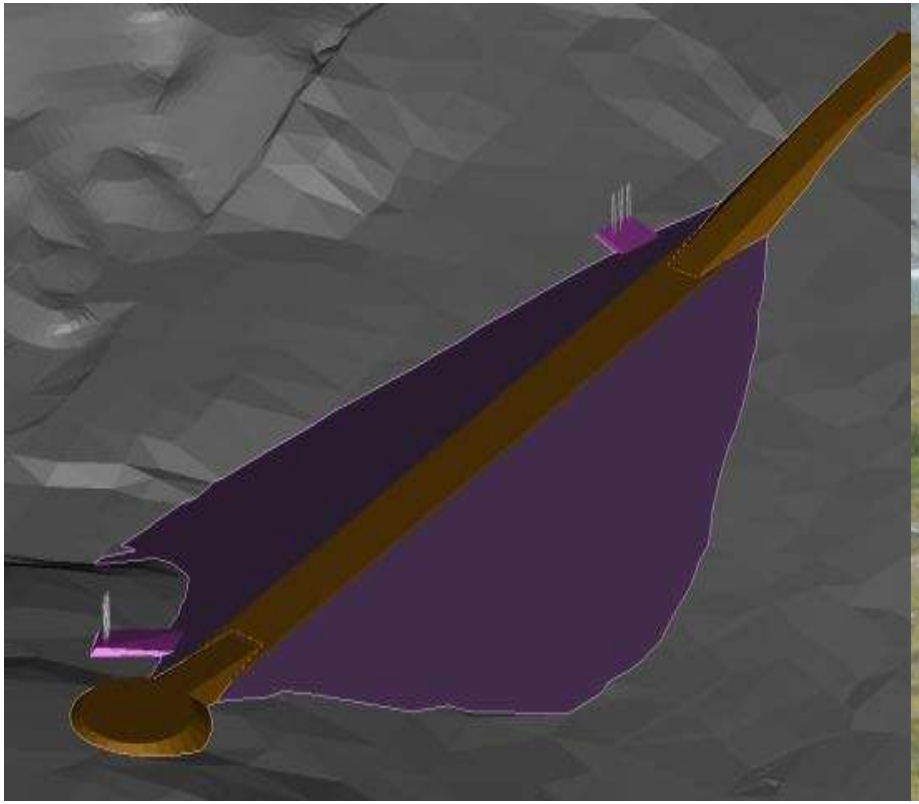


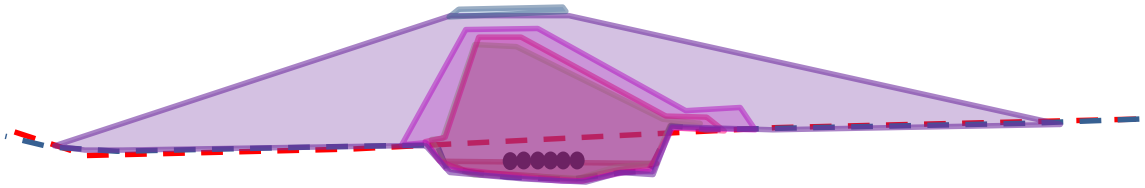
Liner (GCL) Installation



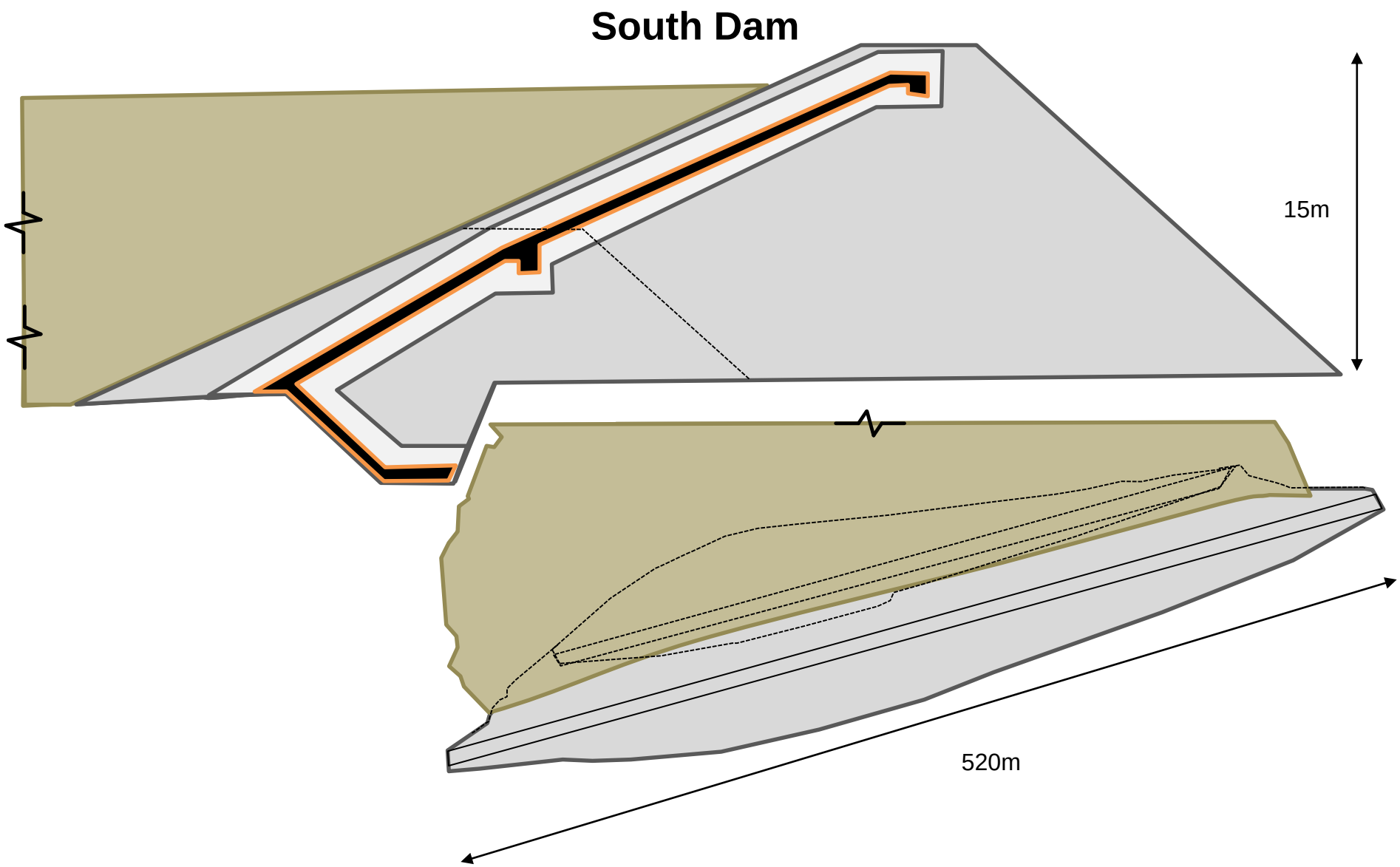


Transition & Shell Construction

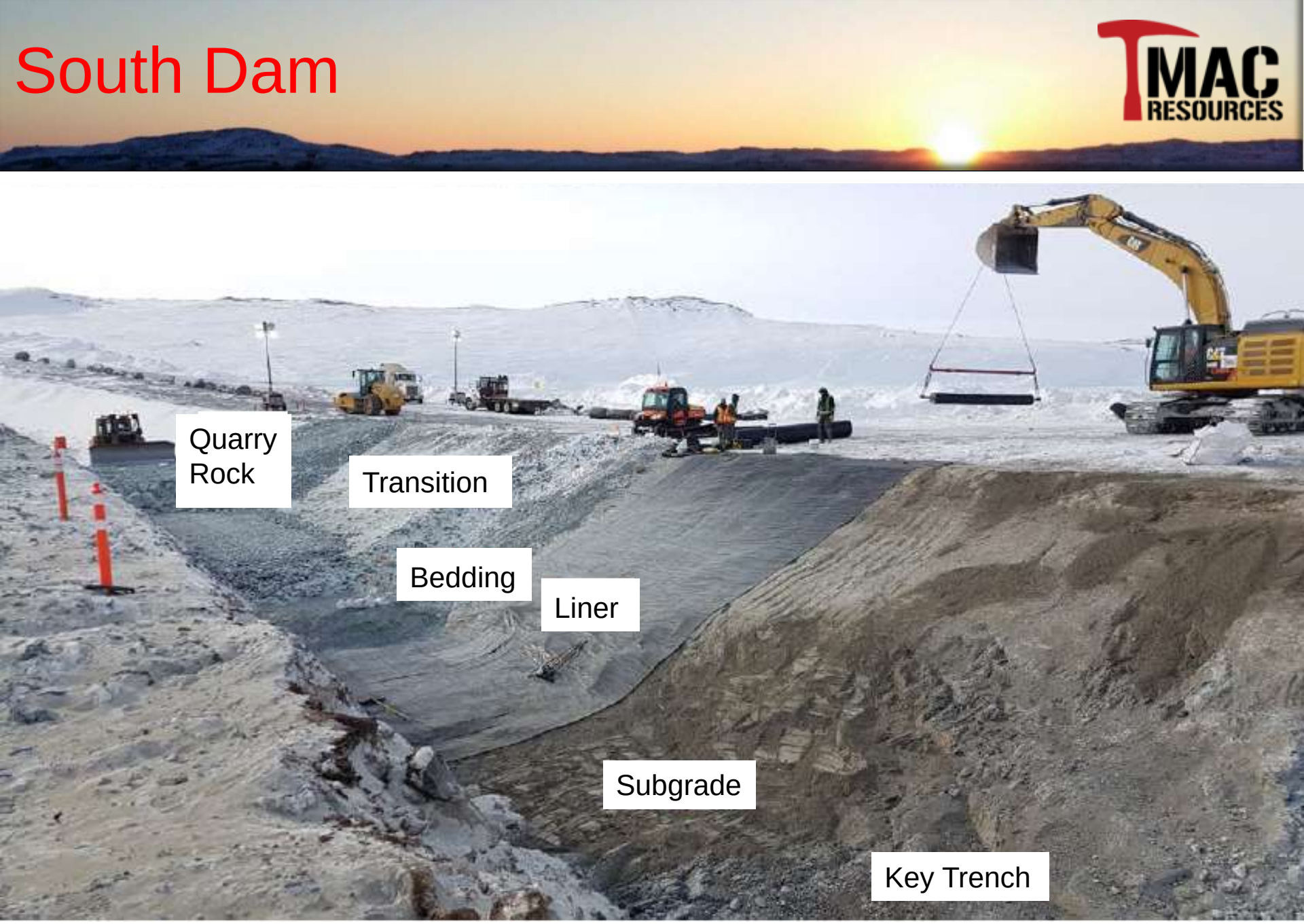




Tailings Impoundment Area - Doris

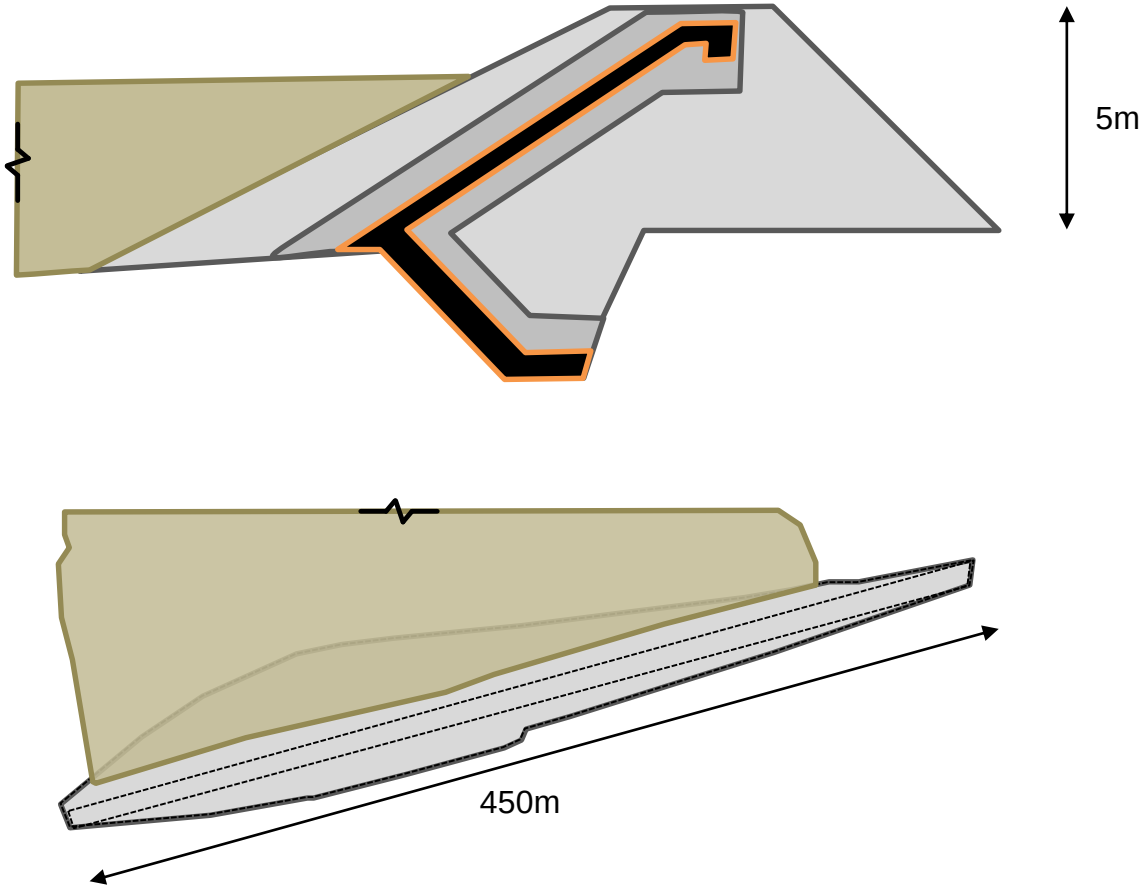


South Dam

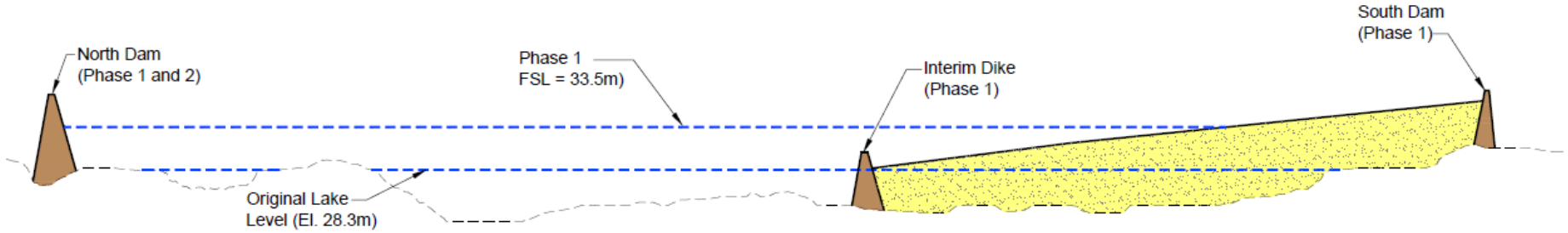


Tailings Impoundment Area - Doris

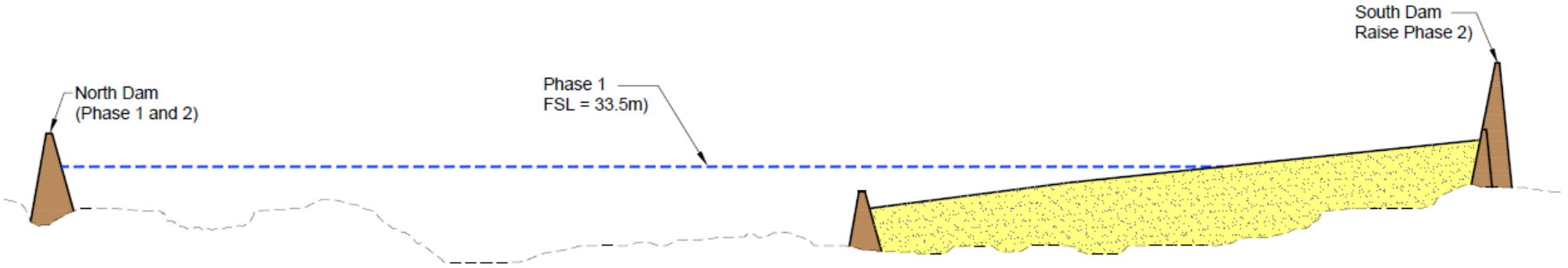
West Dam



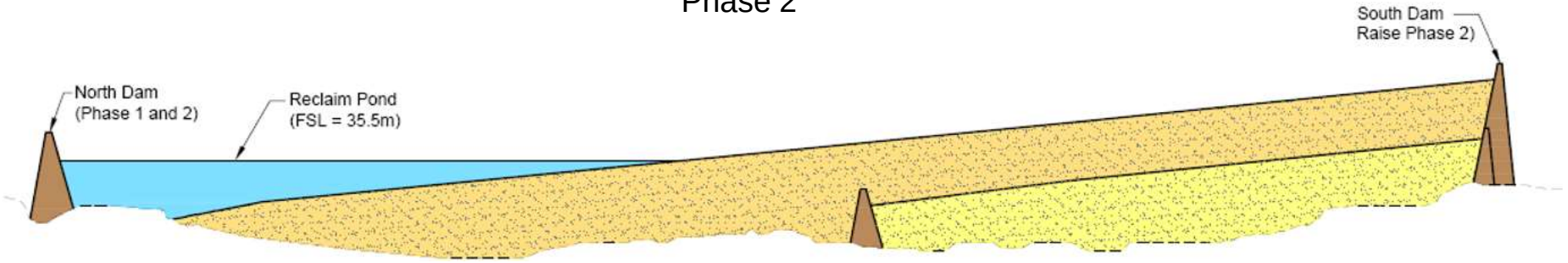
Tailings Impoundment Area - Doris



Phase 1

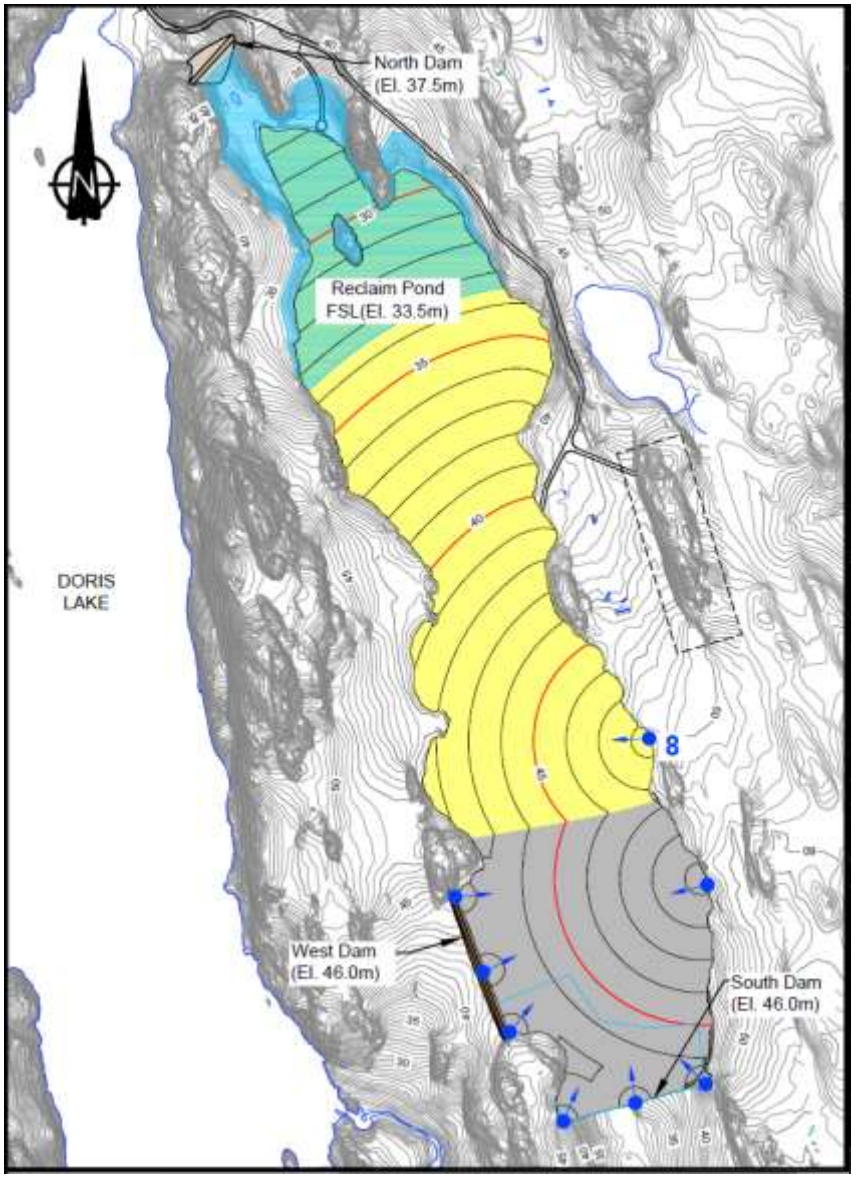


Phase 2



Phase 2 Final

Tailings Impoundment Area – Doris Operations



Tailings Impoundment Area - Doris

Summary of proposed changes

Component	Phase 1	Phase 2
Tailings Volume (tonnes)	2.5 million	Additional 15.5 million
Tailings Production Rate	Maximum nominal 2,000 tonnes per day	Maximum nominal 3,600 tonnes per day
Tailings Make-up	Only flotation tailings	No change
Deposition Method	Subaerial	No change
TIA Discharge Strategy	Seasonal discharge to Roberts Bay	No change
Closure Strategy	Breach North Dam; 0.3 m thick dry cover over tailings	No change

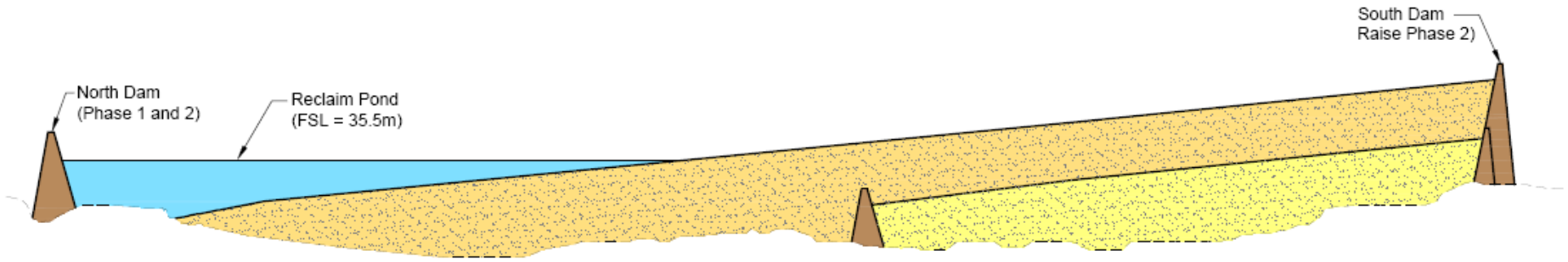
Tailings Impoundment Area - Doris

Summary of proposed changes

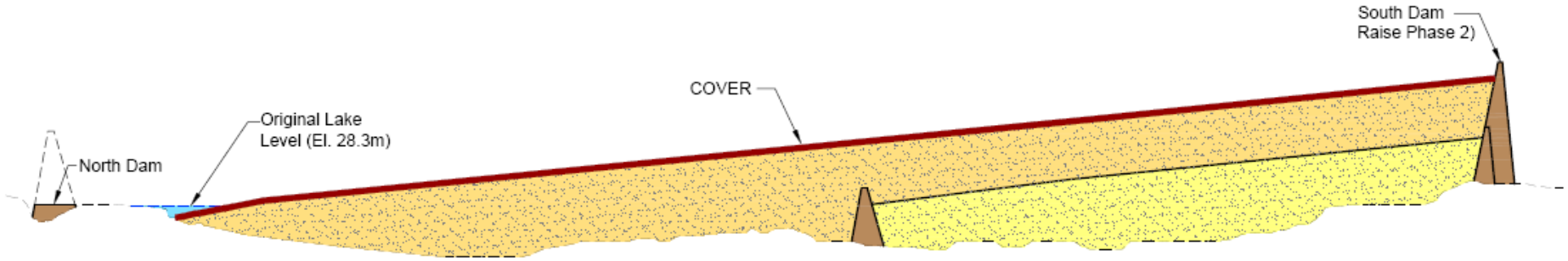
Component	Phase 1	Phase 2
North Dam	Frozen core dam	No change
North Dam Spillway	Includes spillway	No change
South Dam	Frozen foundation with liner	Dam raised by 8 m
Interim Dike	New containment structure	Not required
West Dam	Did not exist	Frozen foundation with liner
Tailings Geochemistry	Non acid generating; Neutral metal leaching	No change

Tailings Impoundment Area - Closure

Tailings Impoundment Area - Closure



PHASE 2 FINAL

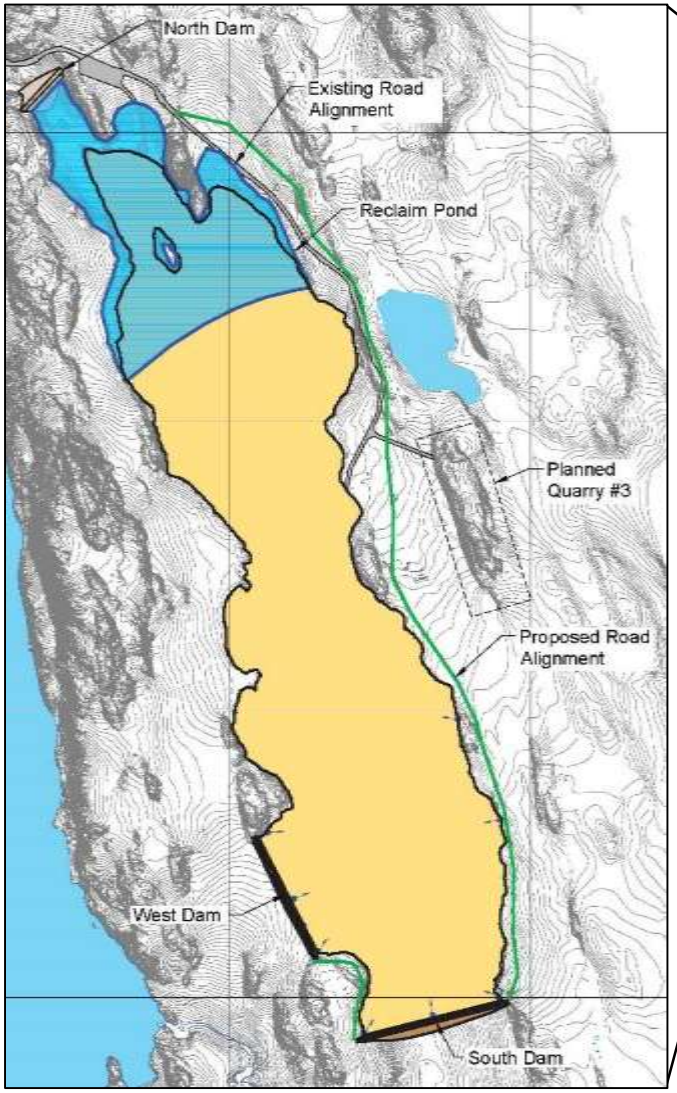


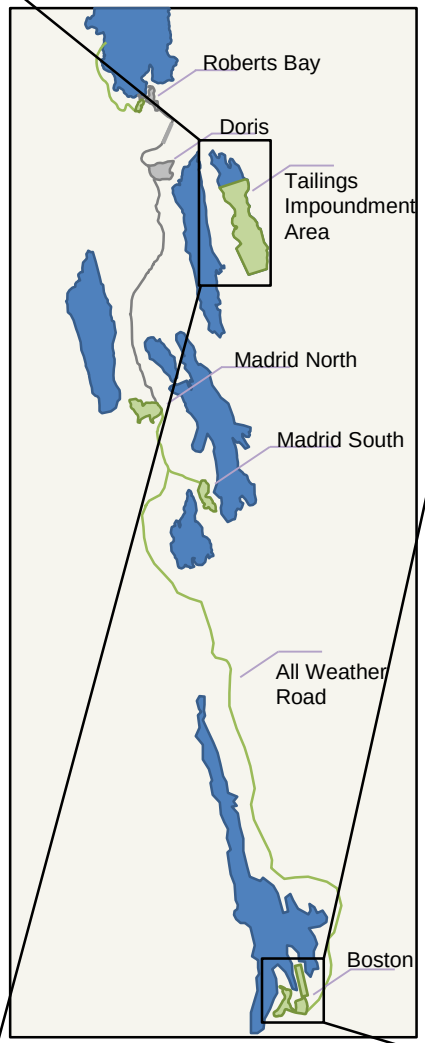
CLOSURE

LEGEND

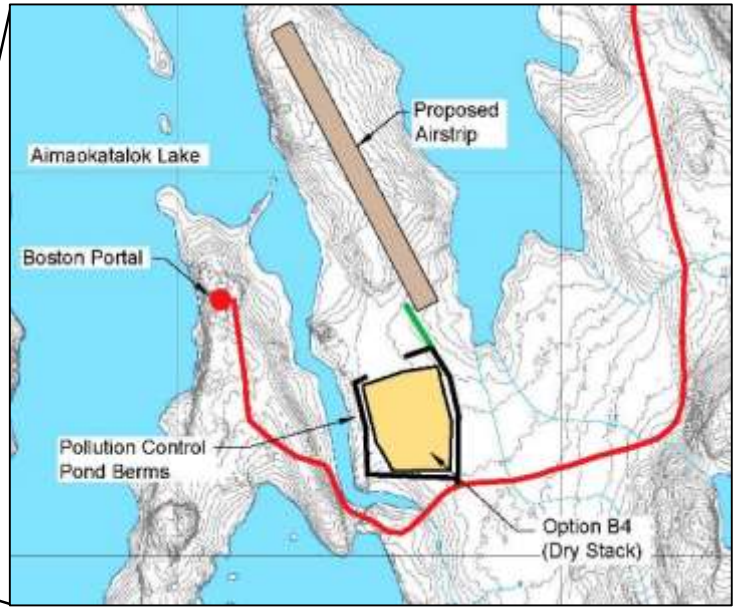
- Existing Ground Surface
- Deposited Tailings (Phase 1)
- Deposited Tailings (Phase 2)
- Dam

Summary of Tailings Management



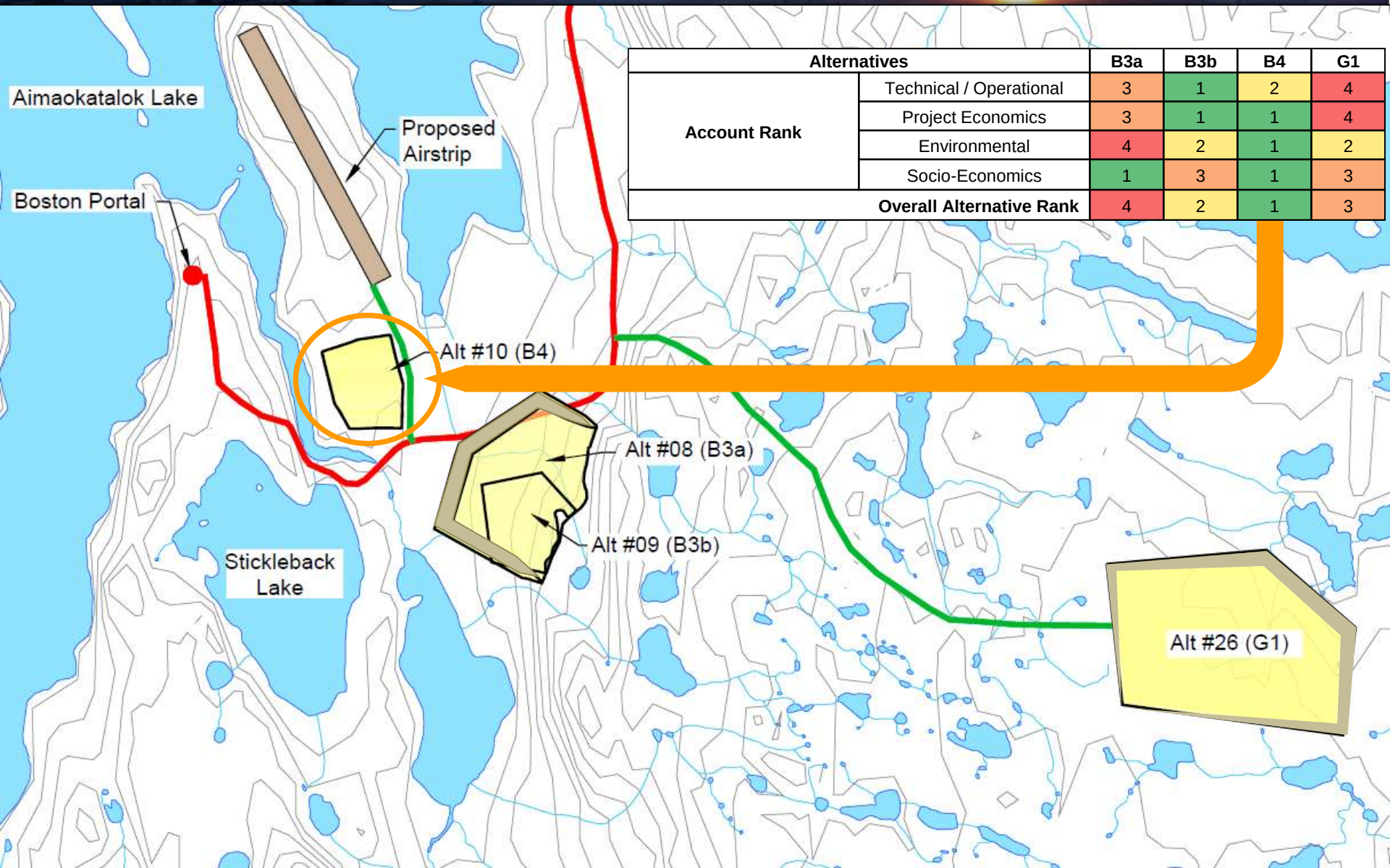


- Doris – Conventional Tailings Impoundment Area
- Boston – Dry Stack Tailings Management Area



Alternative Analysis - Boston

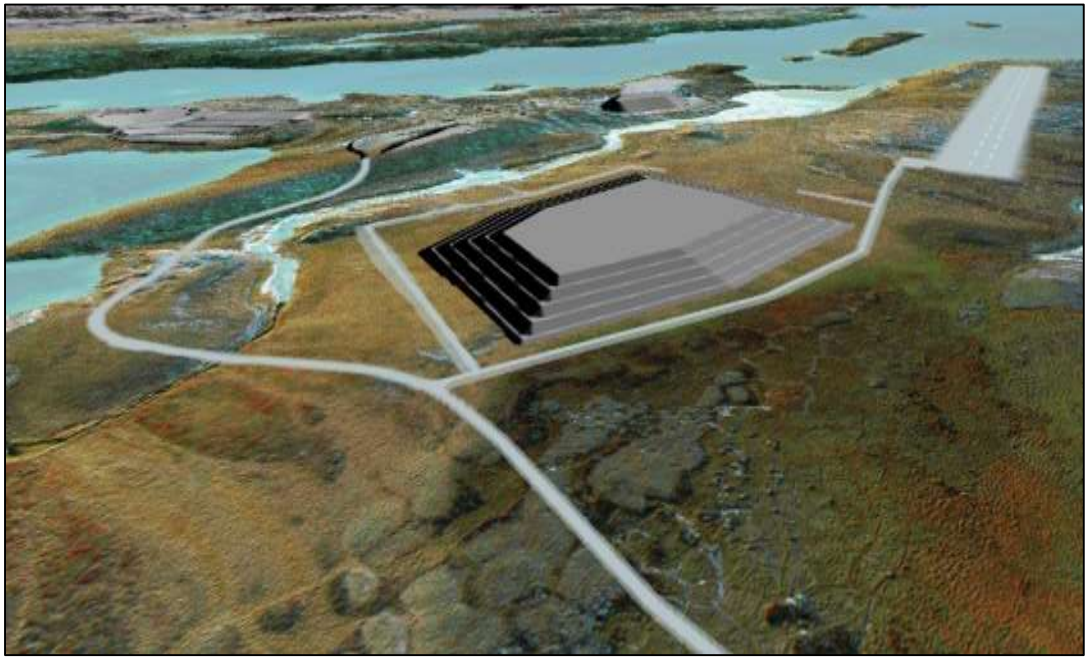
Alternatives		B3a	B3b	B4	G1
Account Rank	Technical / Operational	3	1	2	4
	Project Economics	3	1	1	4
	Environmental	4	2	1	2
	Socio-Economics	1	3	1	3
Overall Alternative Rank		4	2	1	3



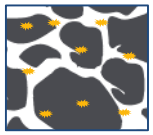
Tailings Management Area - Boston

Tailings Management Area - Boston

- Filtered tailings
- Trucks, Dozers, Compactors
- Stackable and compactable
- Similar to:
  - Raglan
  - Fort Knox
  - Pogo

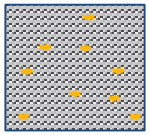


Tailings



Ore
(Rock with Gold)

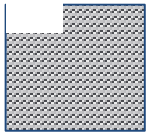
Crusher



Crushed Rock with Gold

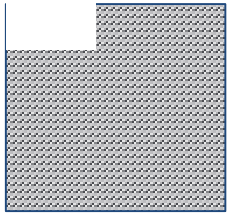
Gravity Separation
& Flotation

Flotation Tailings
(Crushed Rock)

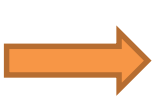


At Doris & Madrid

Flotation Tailings
(Crushed Rock)



Thickener



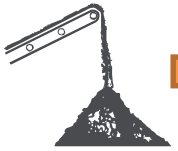
Doris TIA

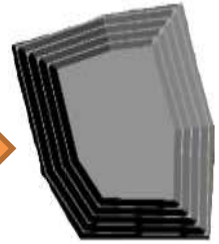
At Boston

Filter Press

Processing

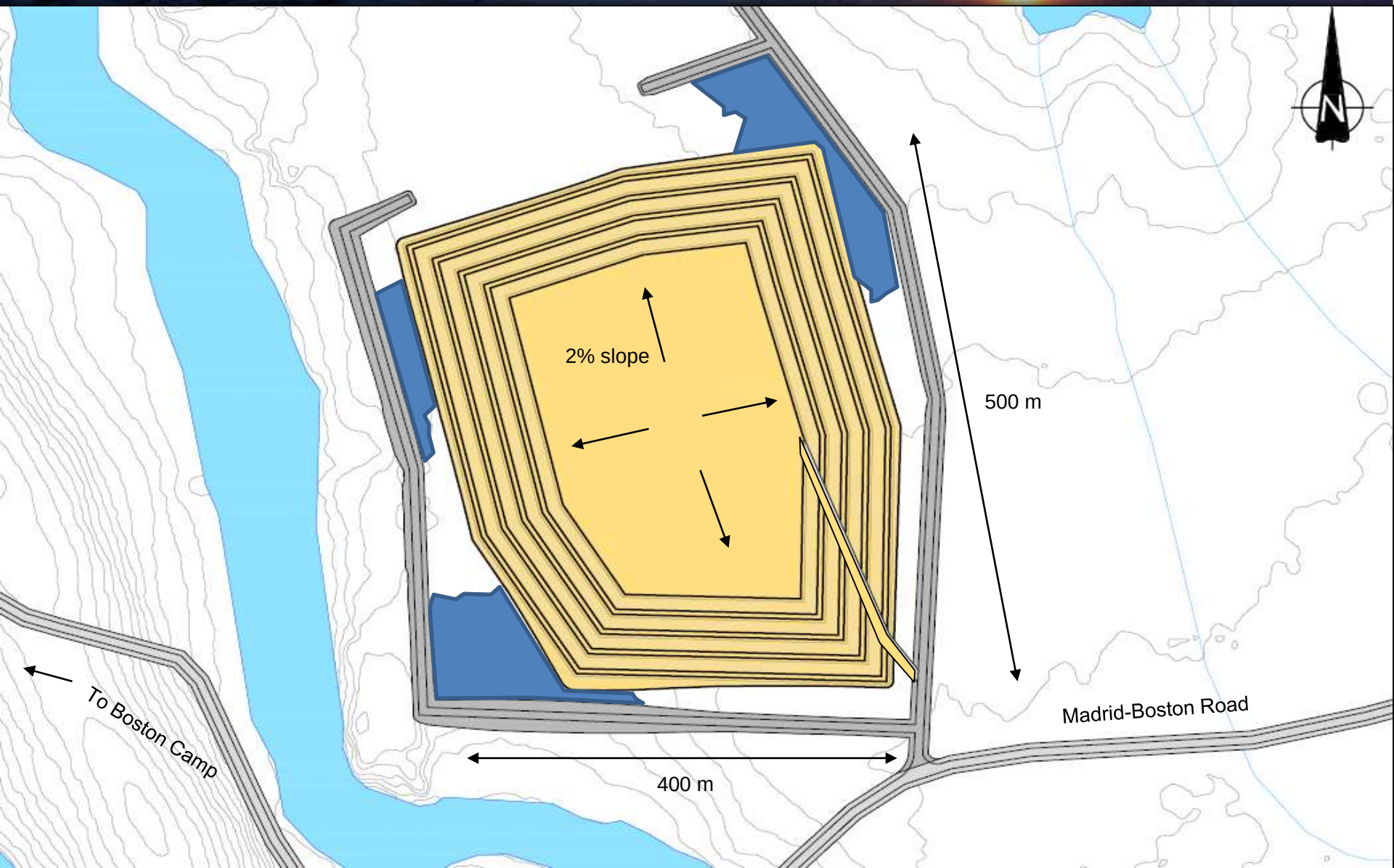
Water





Boston TMA

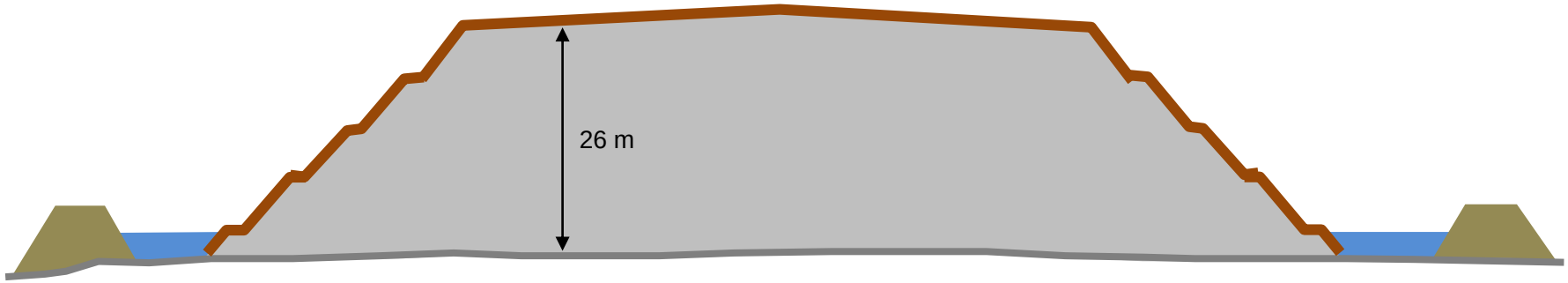
Tailings Management Area - Boston



Tailings Management Area - Boston

- Stability Analyses
- Geomembrane Leakage Assessment

- Thermal Analyses
- Deformation and Settlement Analysis



- Water collection
- Erosion Protection
- Dust Management

- Compaction and grading
- Lined Protective Cover
- Stable landform

Tailings Management Area - Boston

Summary of key criteria

Component	Criteria
Dam Hazard Classification	Significant
Design Life • **Active deposition period** • **Assumed Post-closure monitoring period** • **Long-term design basis**	 • 8 years • 10 years • Up to year 2100
Tailings Production Rate	2,400 tonnes per day
Tailing Moisture Content	20.5% (by weight)
Tailings Dry Density	1.8 t/m^3
Tailings Storage Requirement • **By mass** • **By volume**	 • 5.1 Mt • 2.8 Mm^3
Tailings Deposition Method	Load, haul, dump, place, and compact filtered tailings

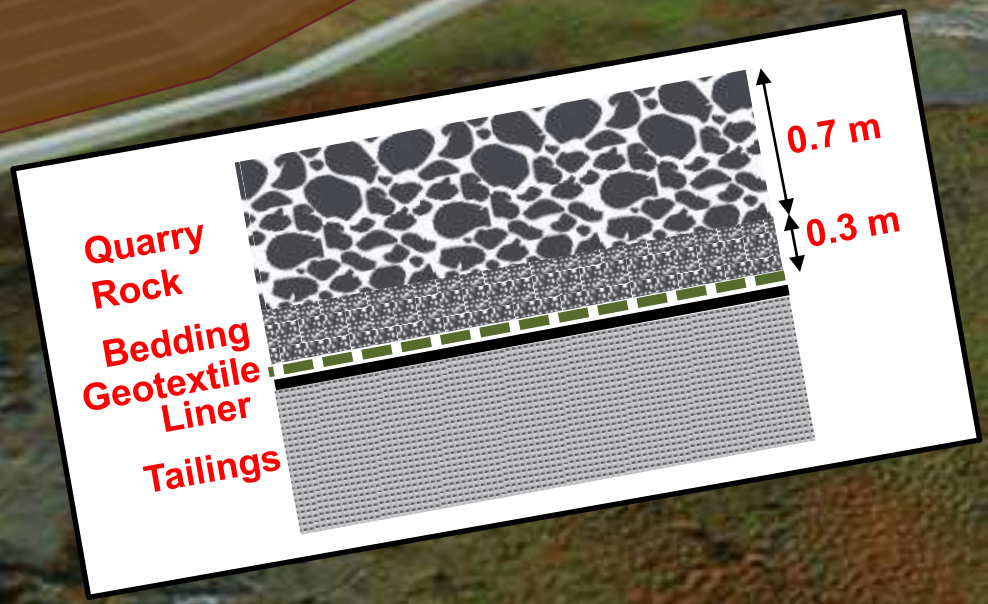
Dust Management

https://www.polymerinnovations.com.au/solutions/road-stabilisation/

http://www.monitoringagency.net/PhotoGallery/tabid/93/Default.aspx

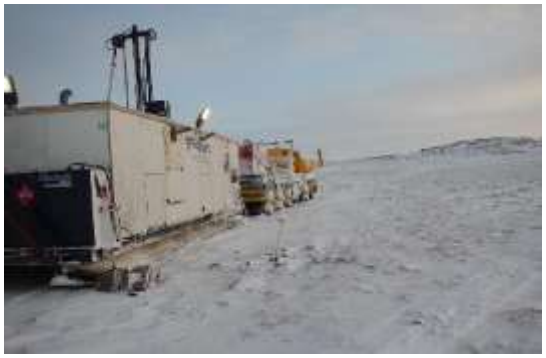
https://www.cooperfluidsystems.com.au/index.php/products/dust-suppression

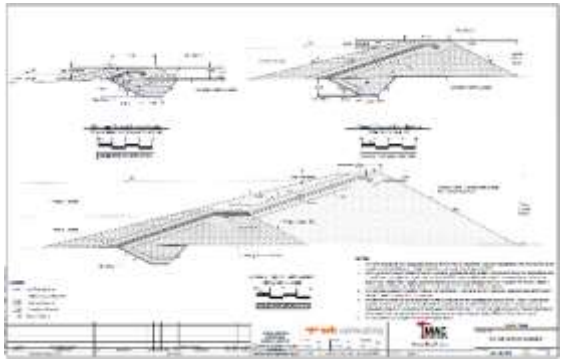
Tailings Management Area - Boston Closure



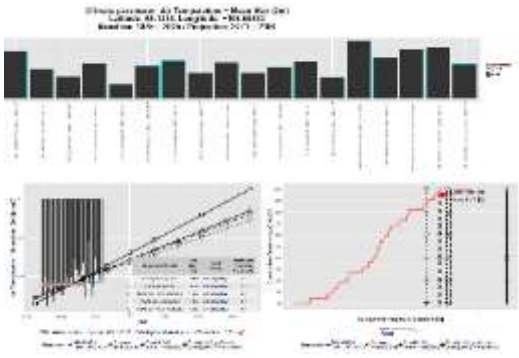
Tailings Facility Designs

Additional geotechnical investigation and detailed design prior to construction





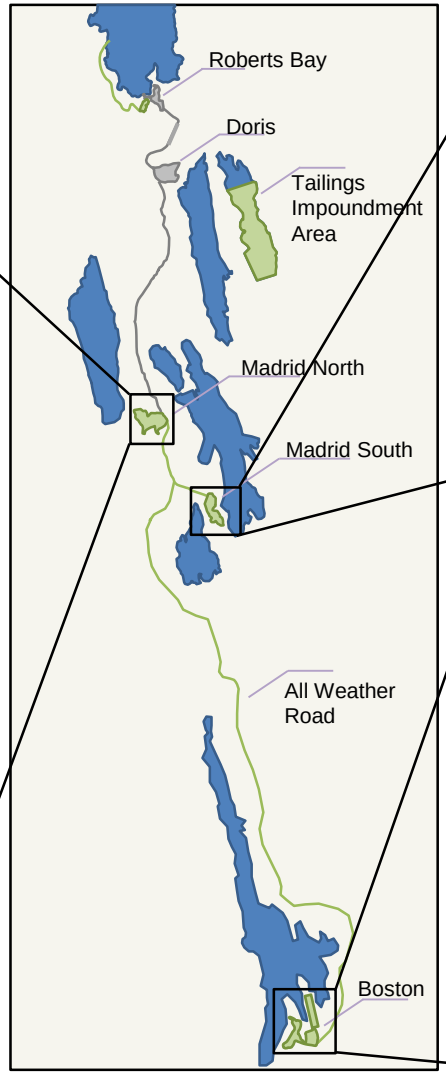
Consider Climate Change



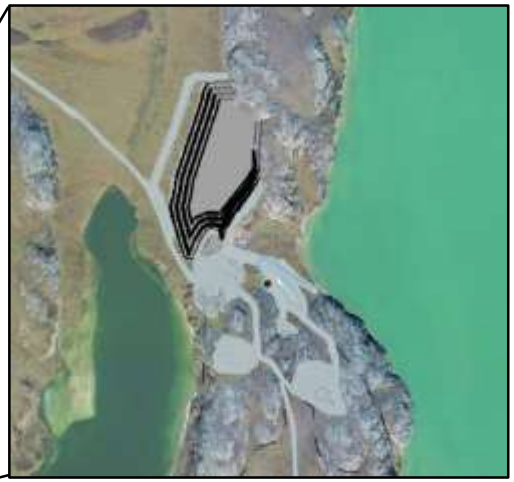
Summary of Waste Rock Management

Temporary Waste Rock Piles

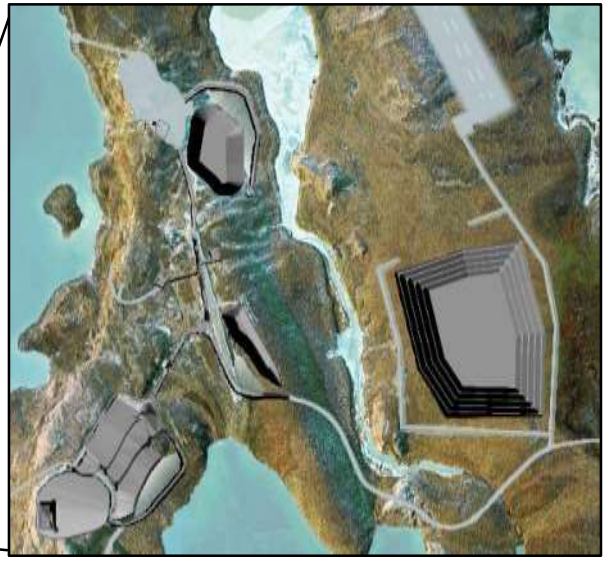
Madrid North



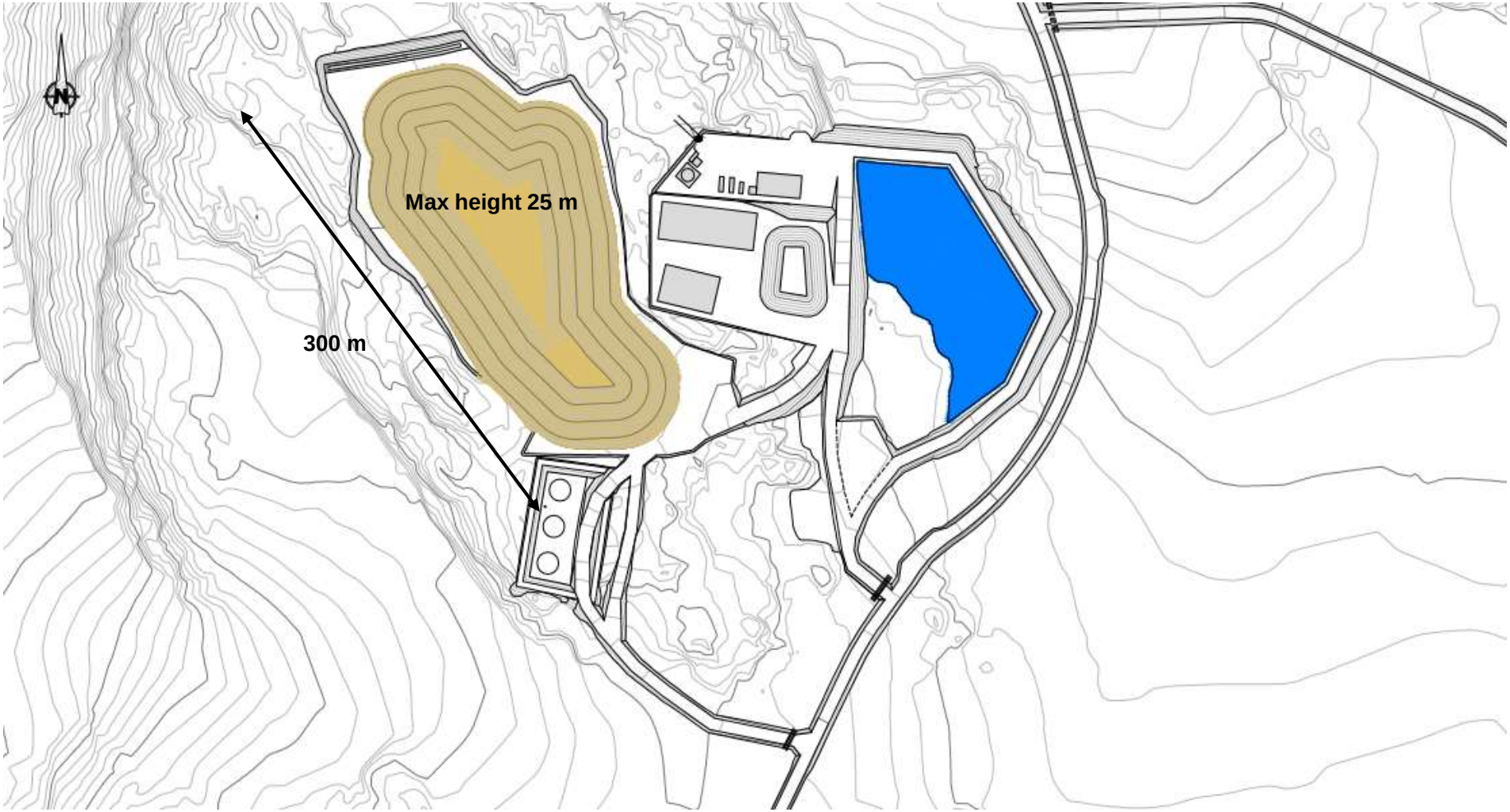
Madrid South



Boston

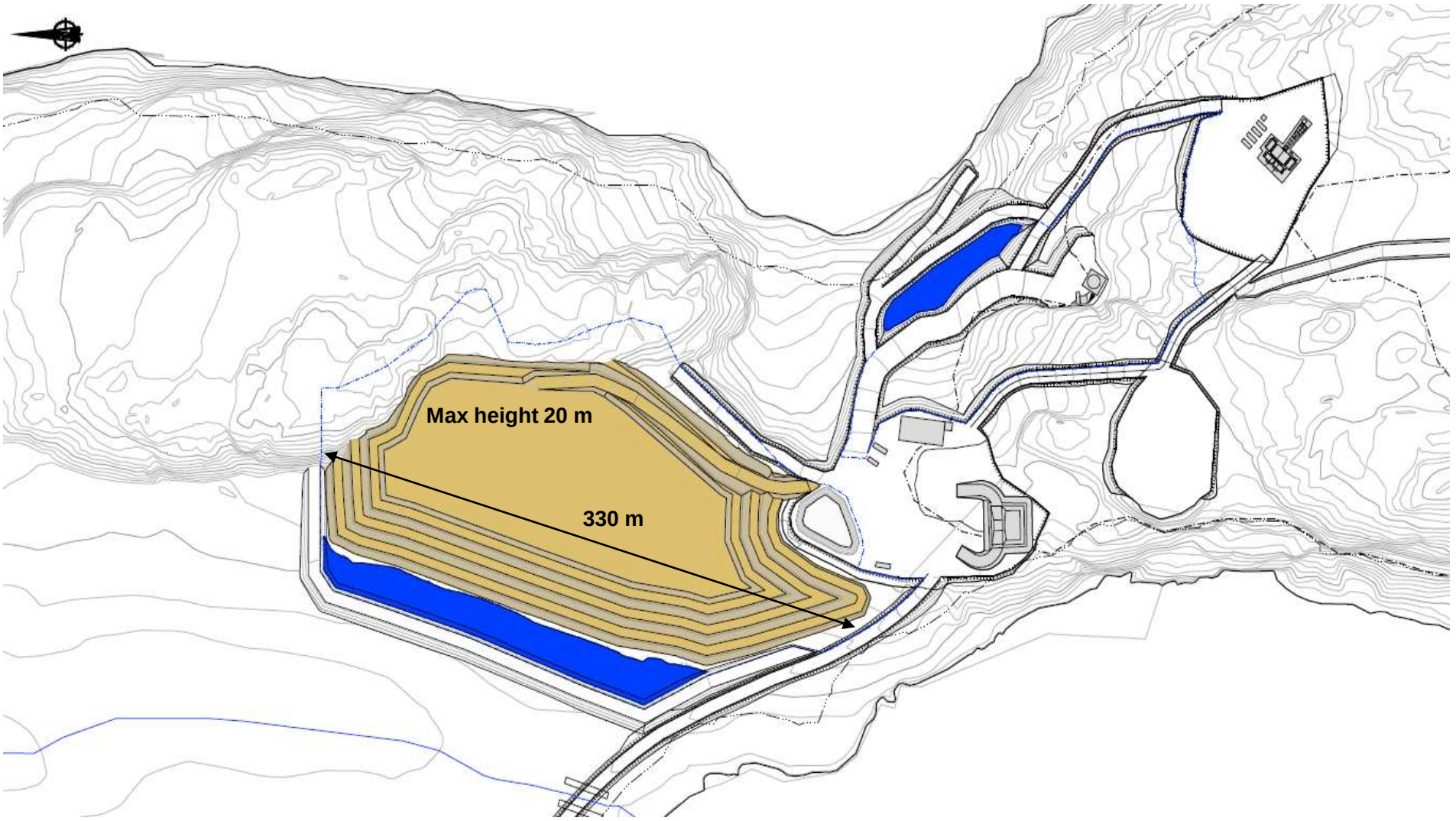


Summary of Waste Rock Management



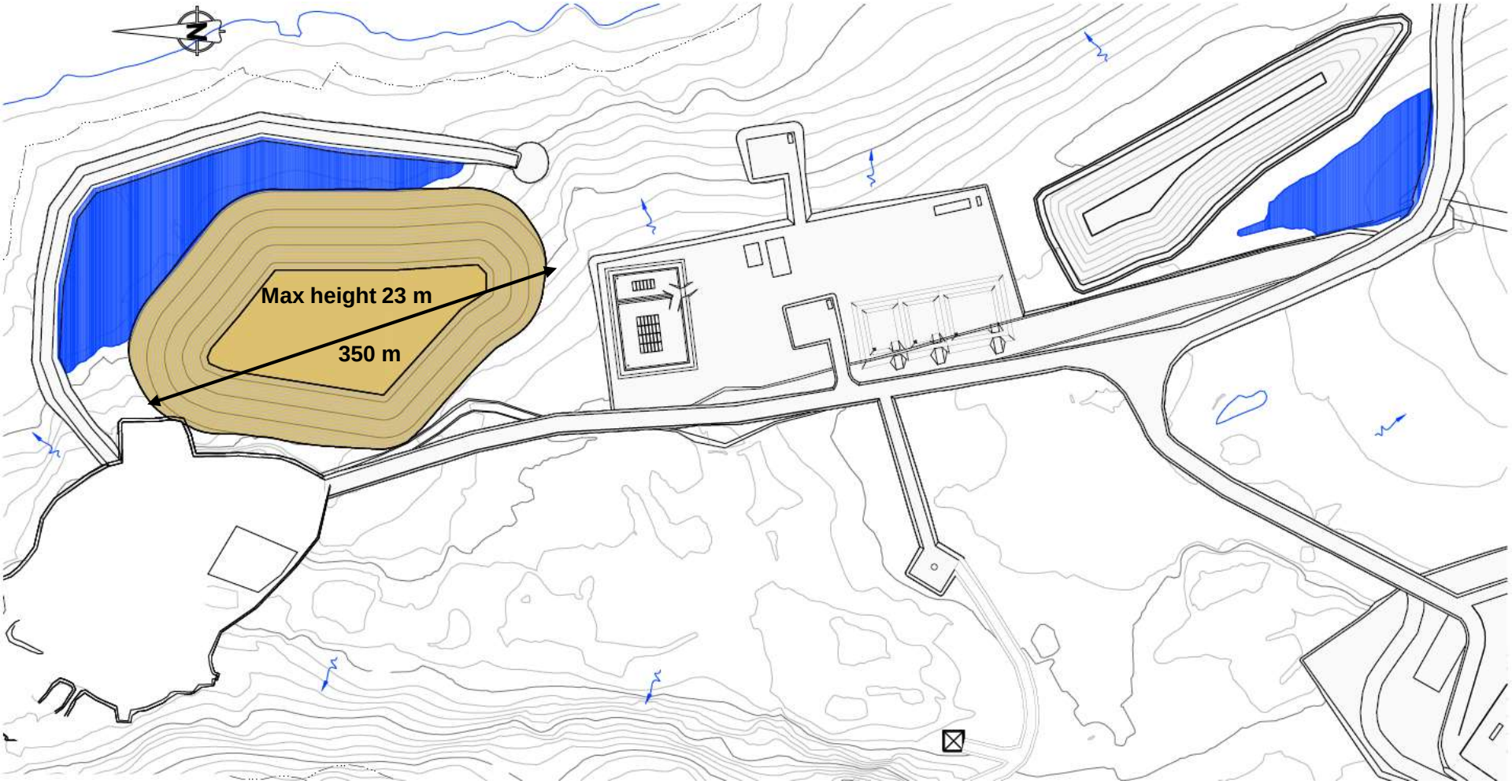
Madrid North

Summary of Waste Rock Management



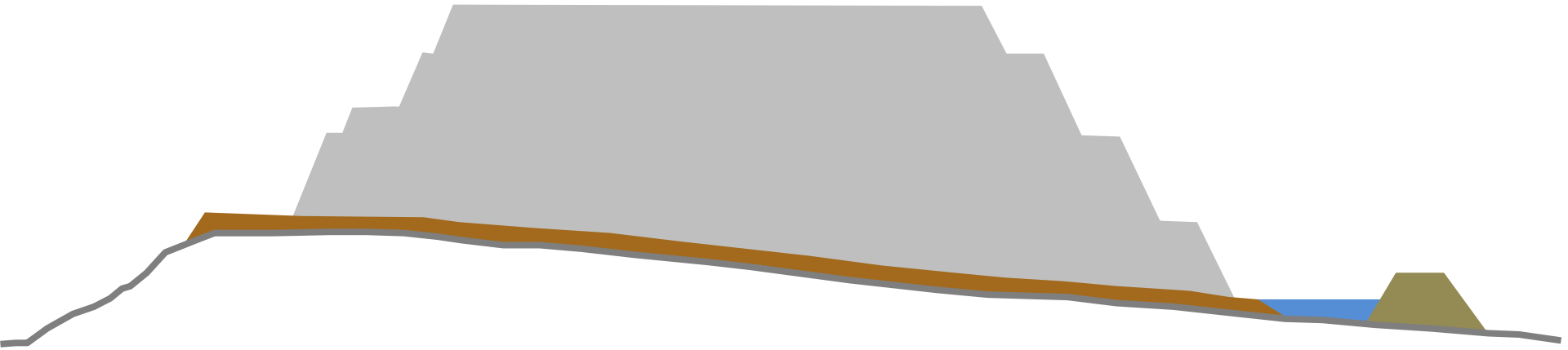
Madrid South

Summary of Waste Rock Management



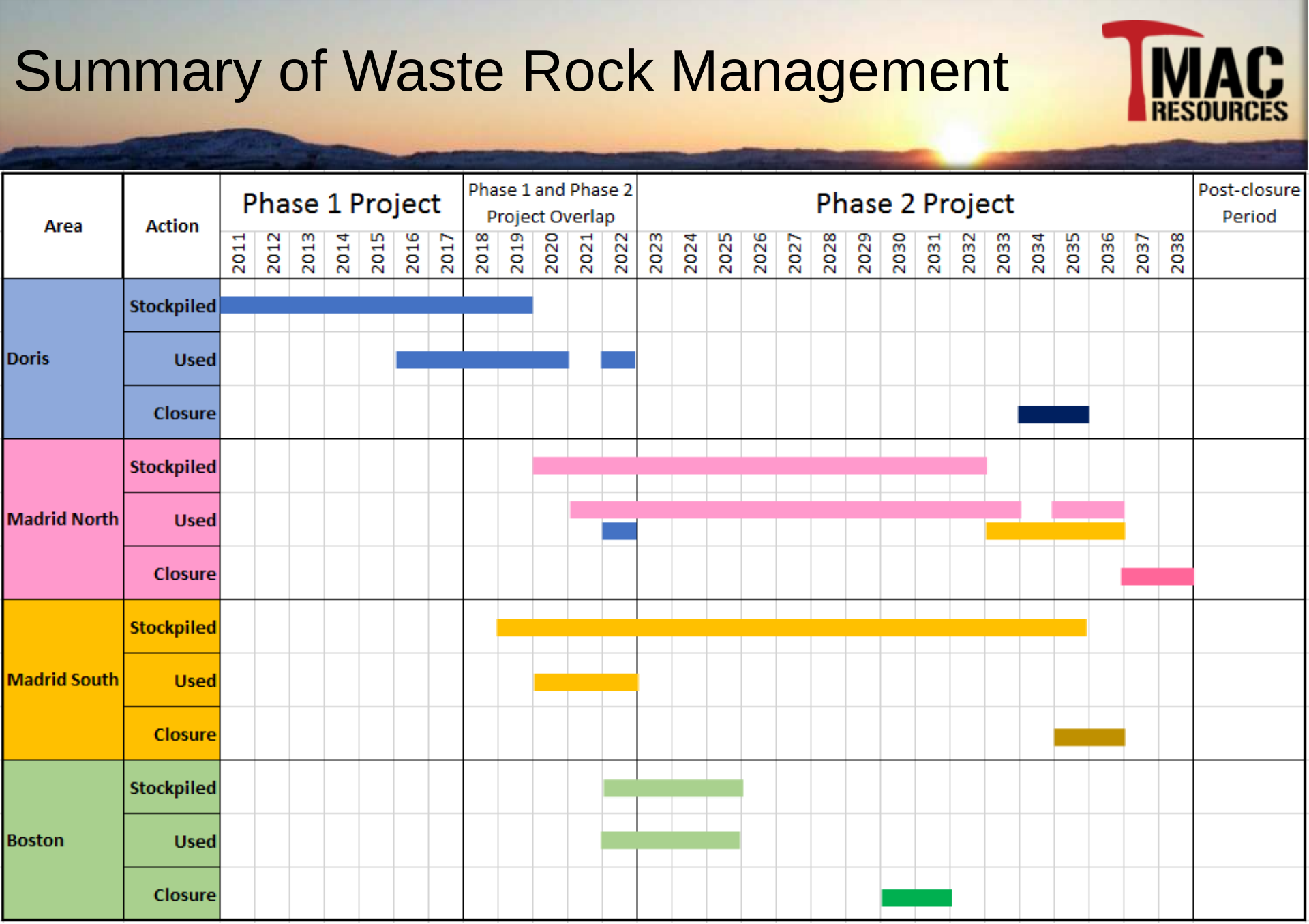
Boston

Summary of Waste Rock Management



- Stability Analyses

Summary of Waste Rock Management



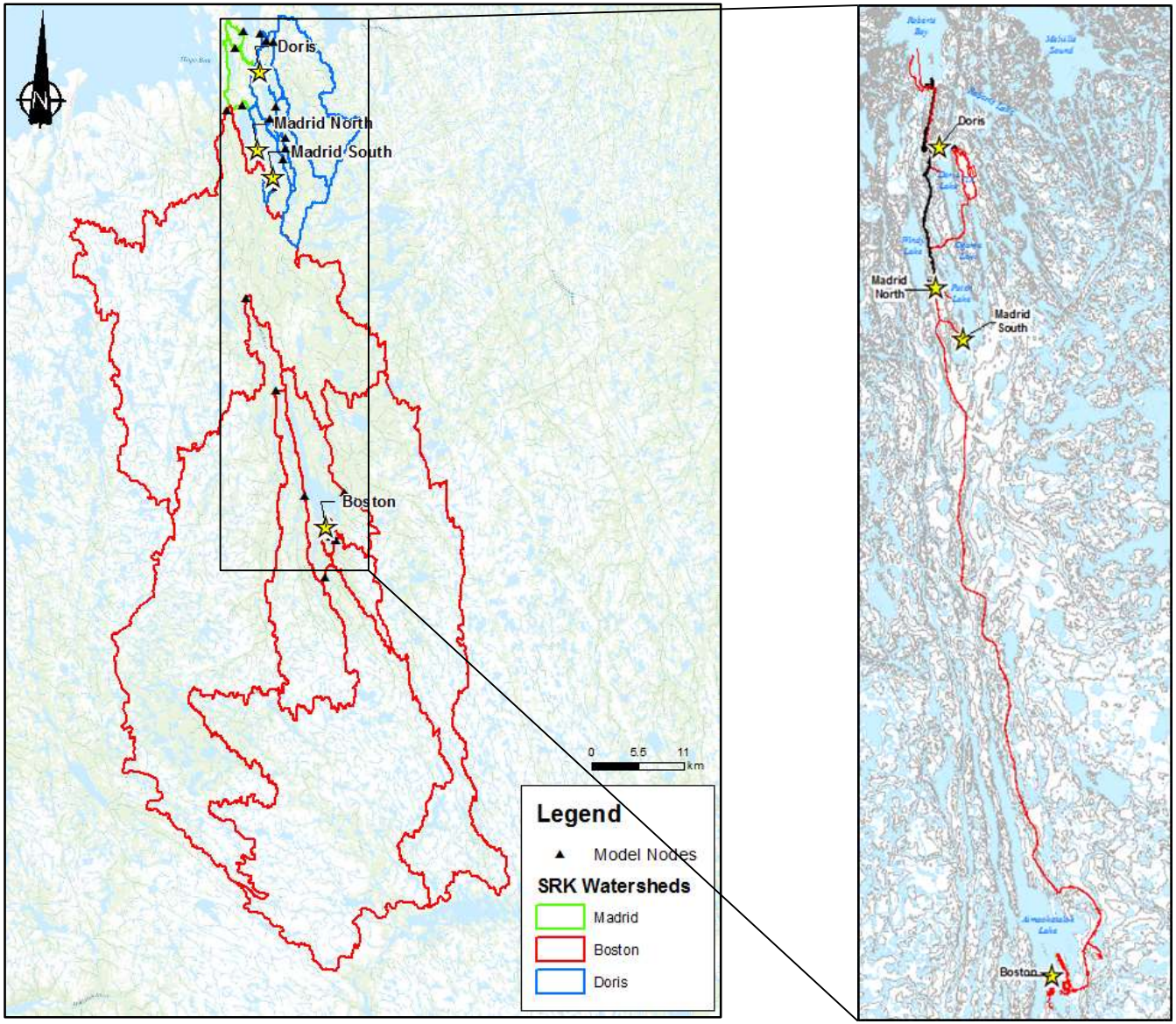
Tailings and Waste Rock Management

- State of practice tailings management
  - Doris Tailings Impoundment Area
  - Boston Tailings Management Area

- No waste rock left on surface post closure

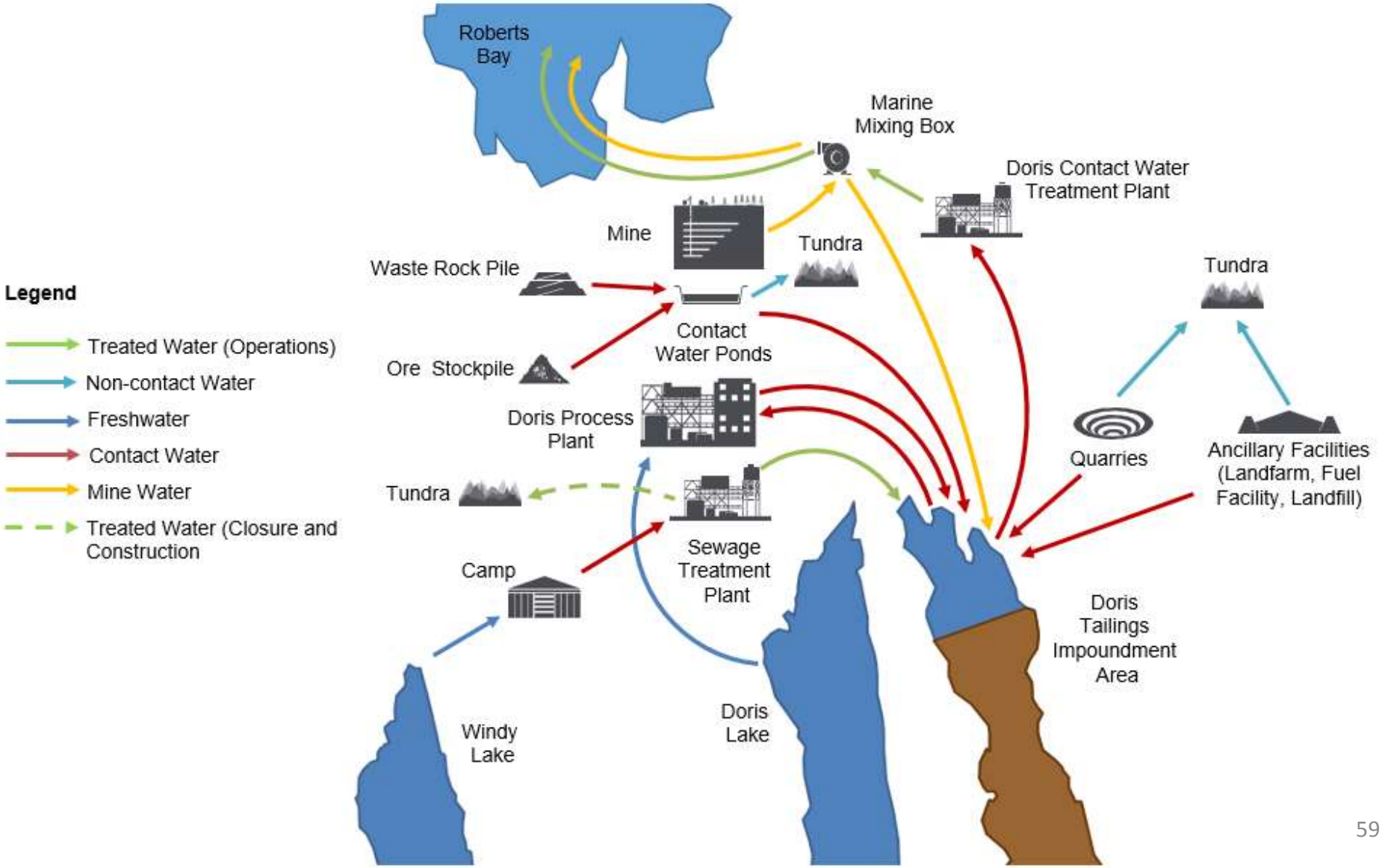
Water Management

Hydrological Setting

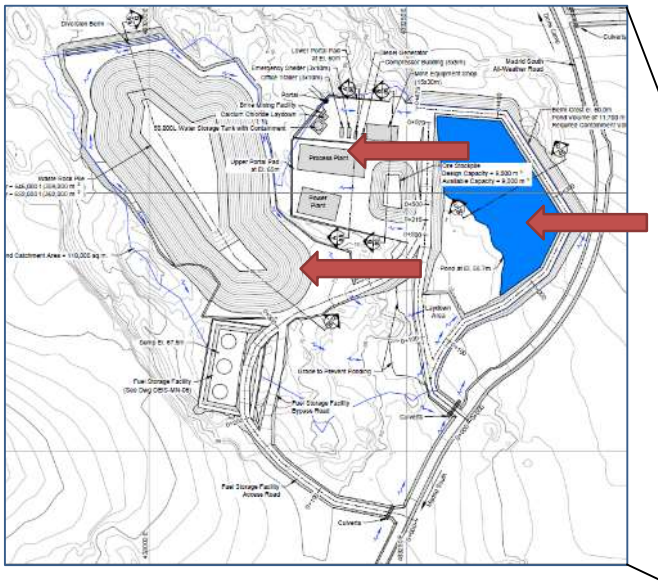


Doris Water Management

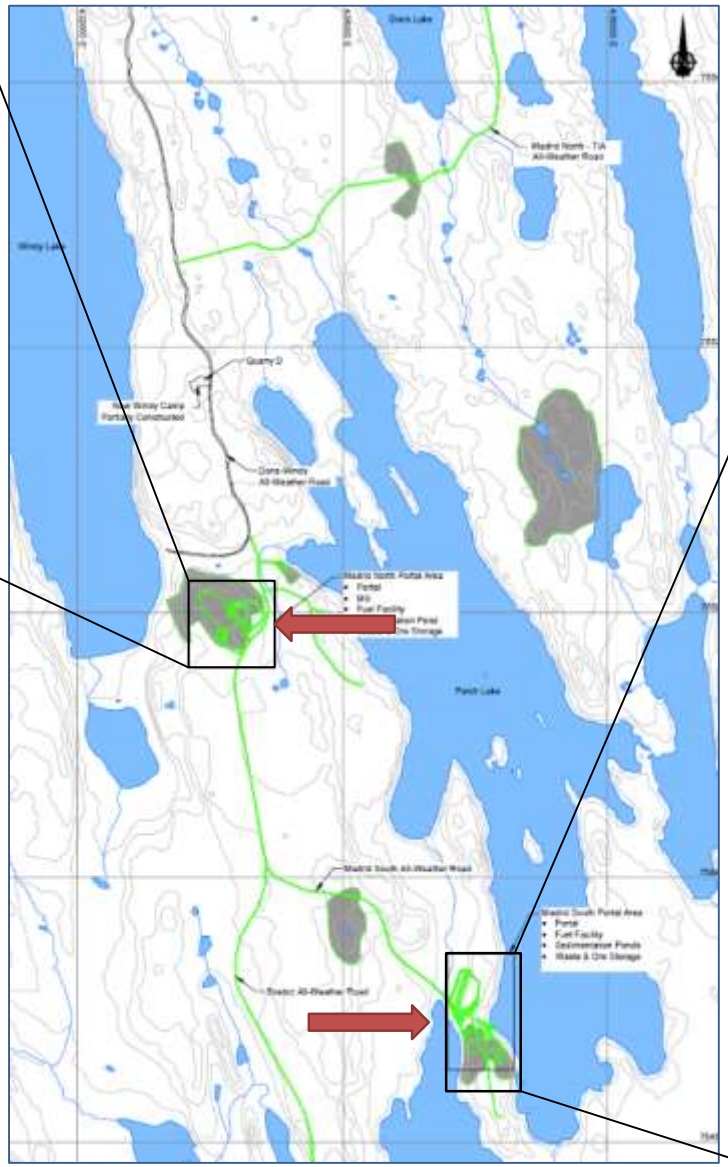
Doris Water Management



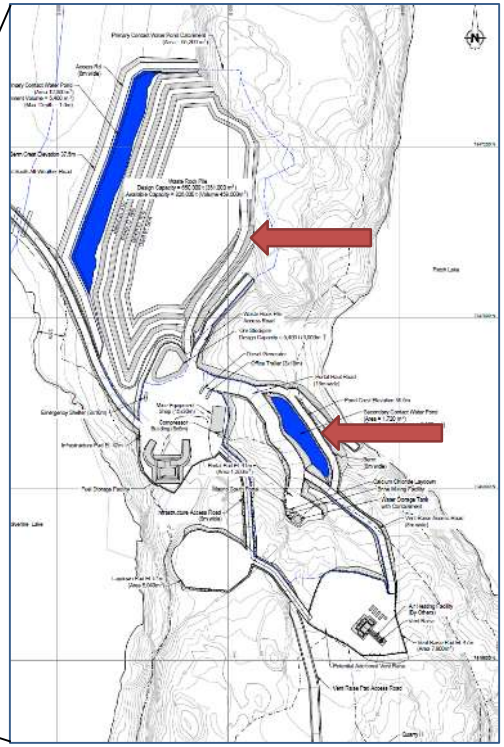
Madrid Site Layout



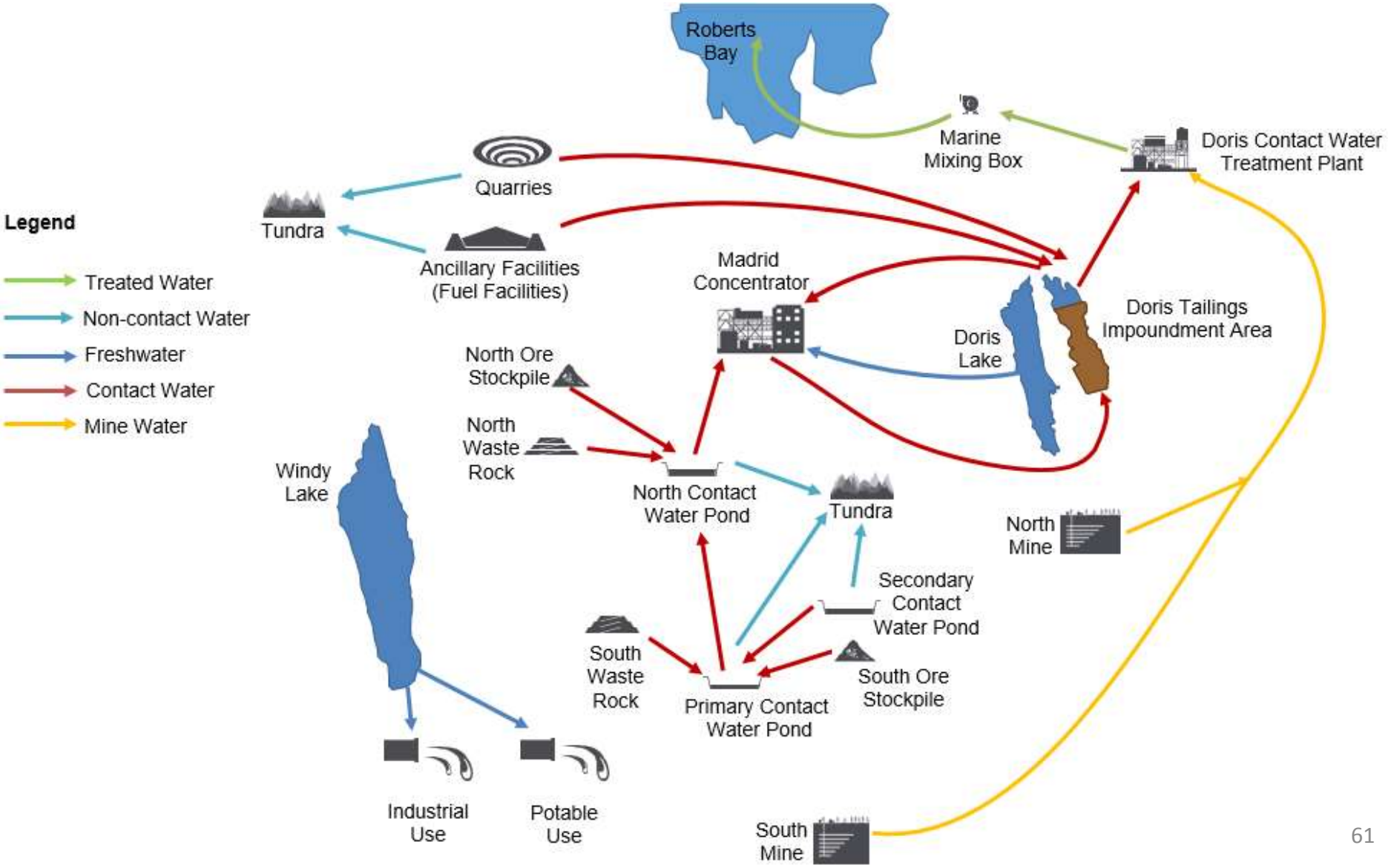
Madrid North



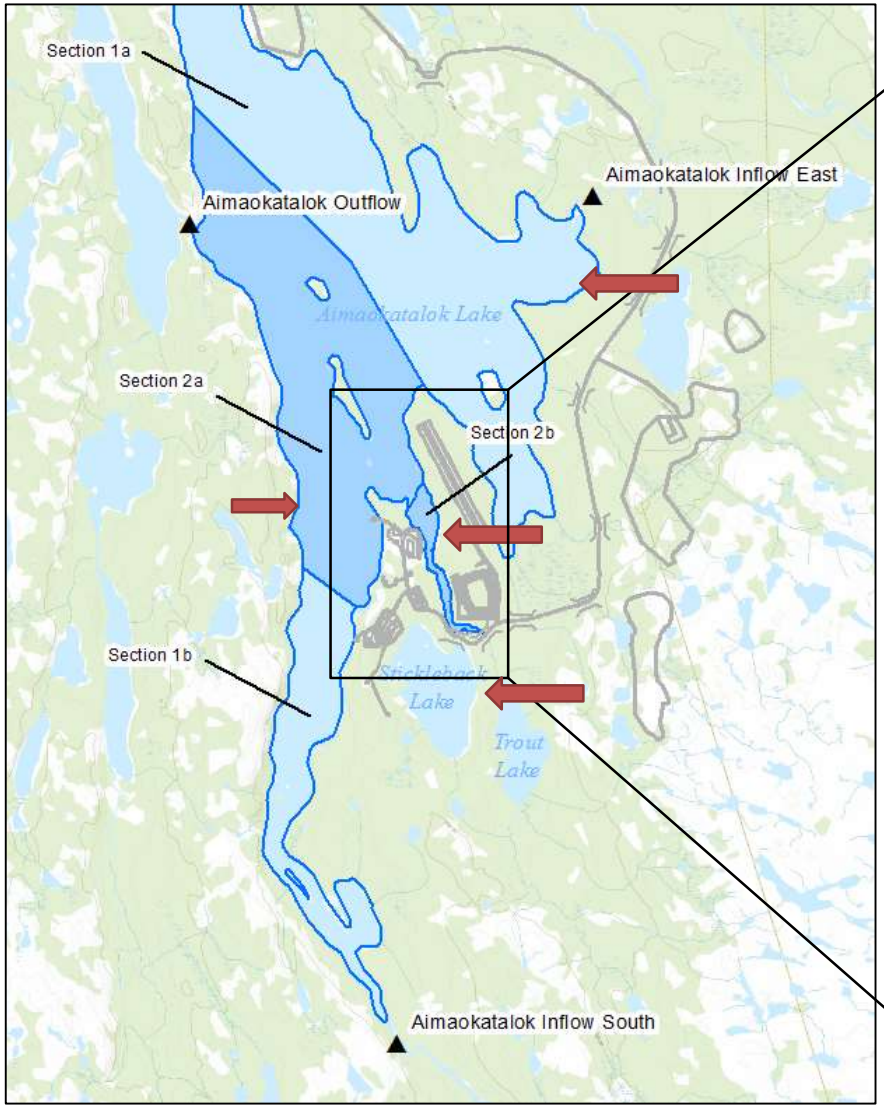
Madrid South

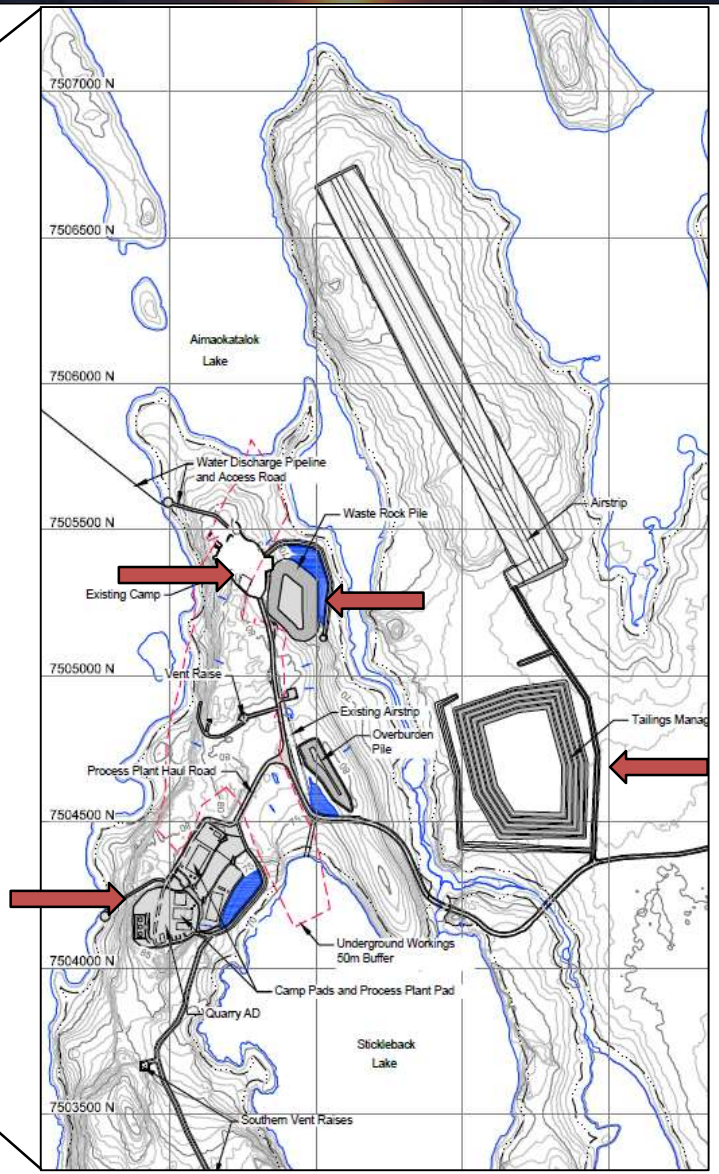


Madrid Water Management

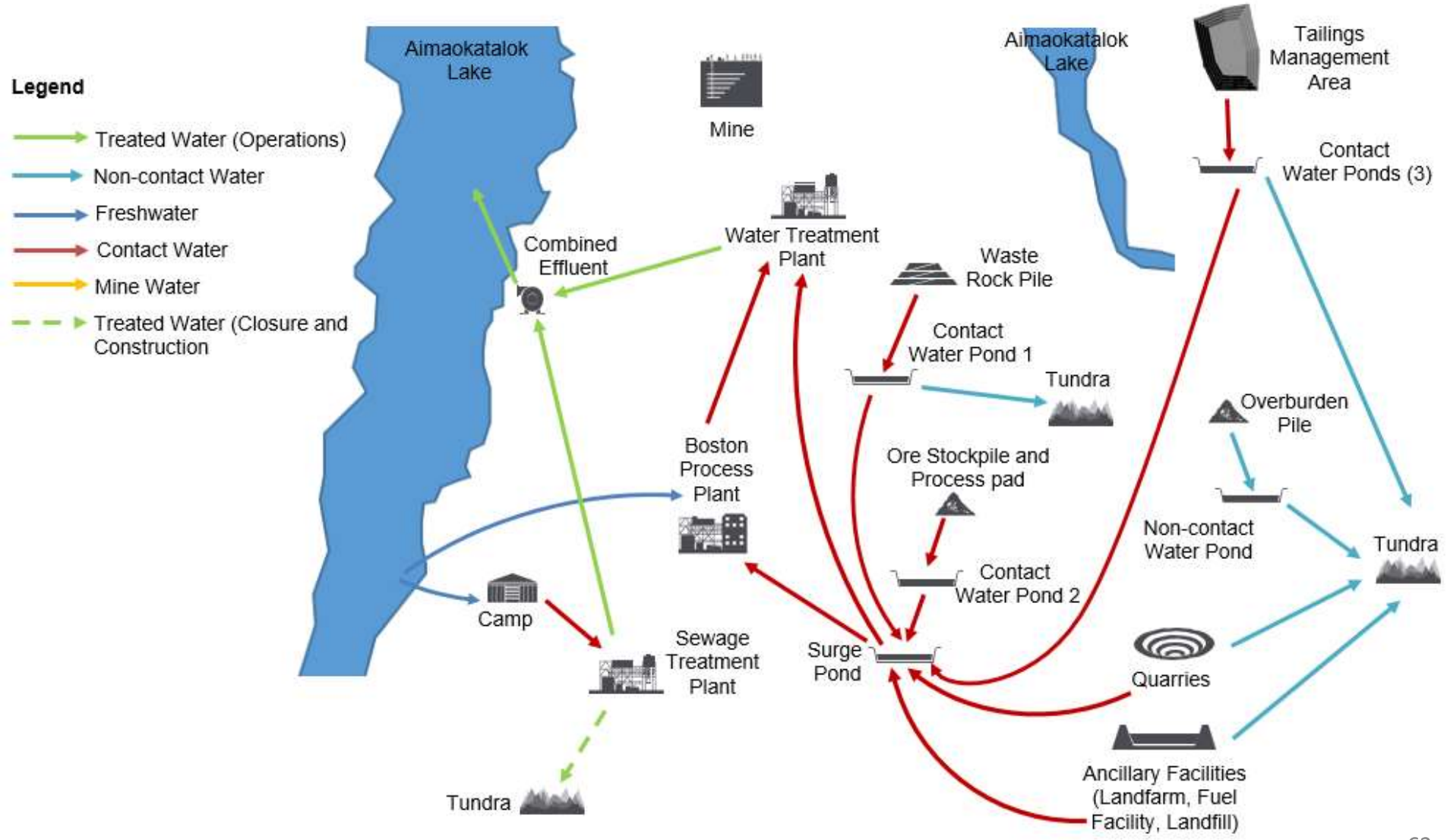


Boston Site Layout and Aimaokatalok Lake



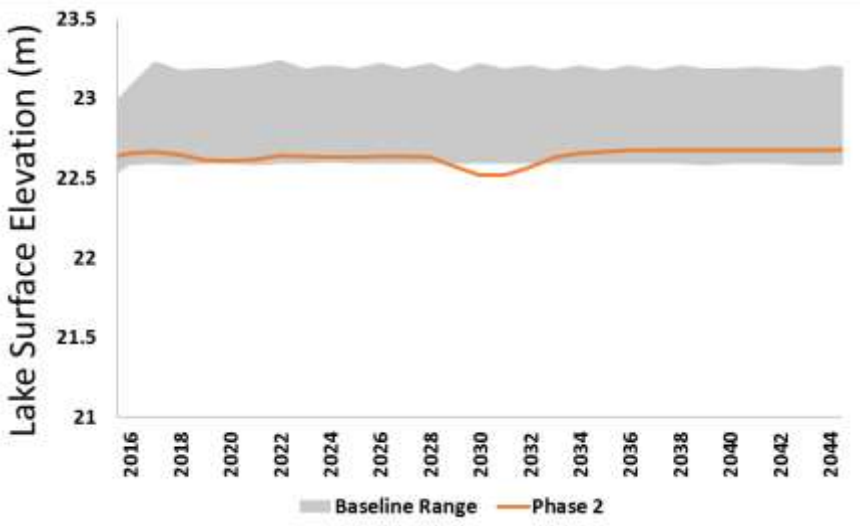


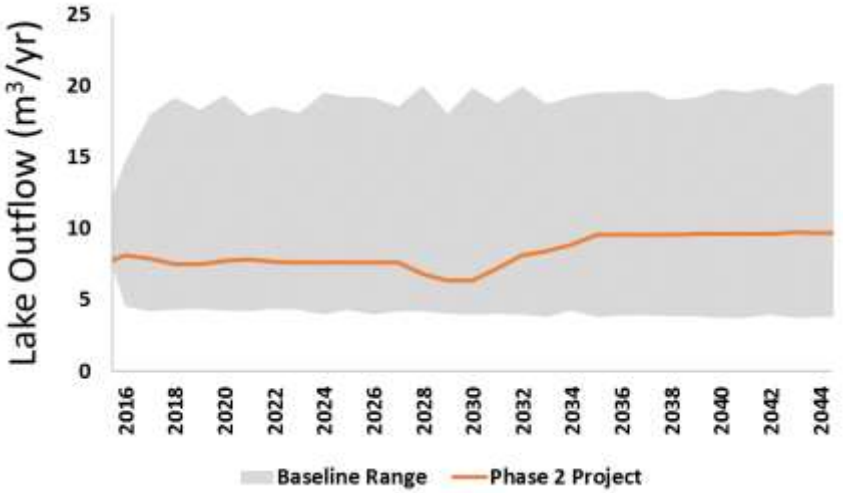
Boston Water Management

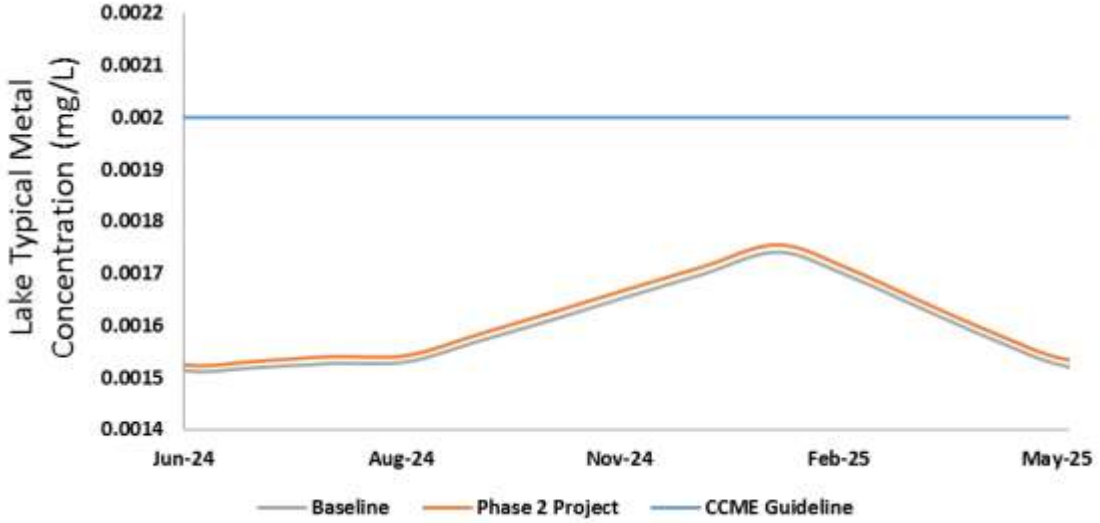


Modelling Approach and Methods

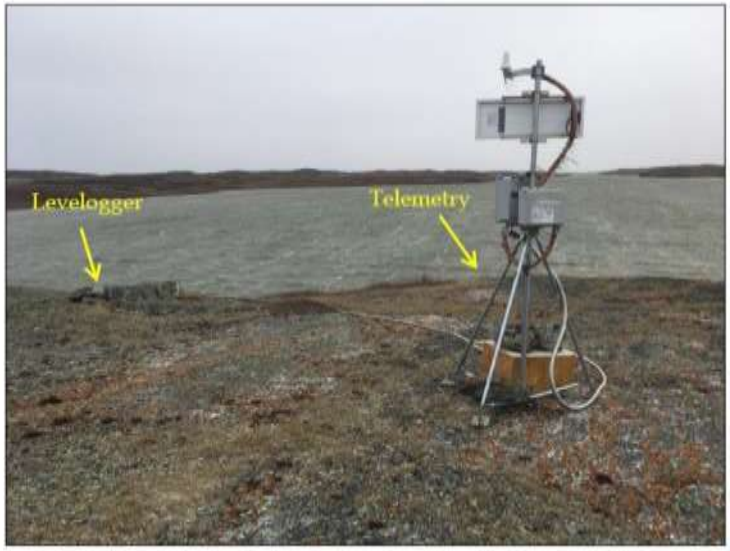
Purpose of Modelling







Water Balance Approach – Same as for Doris Amendment

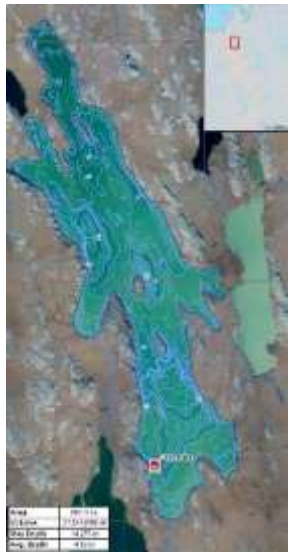


Model Inputs – Quantity

Catchments

Site Footprint

Hydrology
(Precipitation, Evaporation, Climate Change, and Runoff Coefficients)

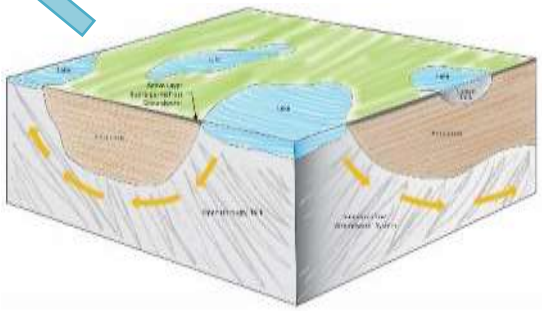


Water Storage and Bathymetry

Model

Mining and Milling Quantities

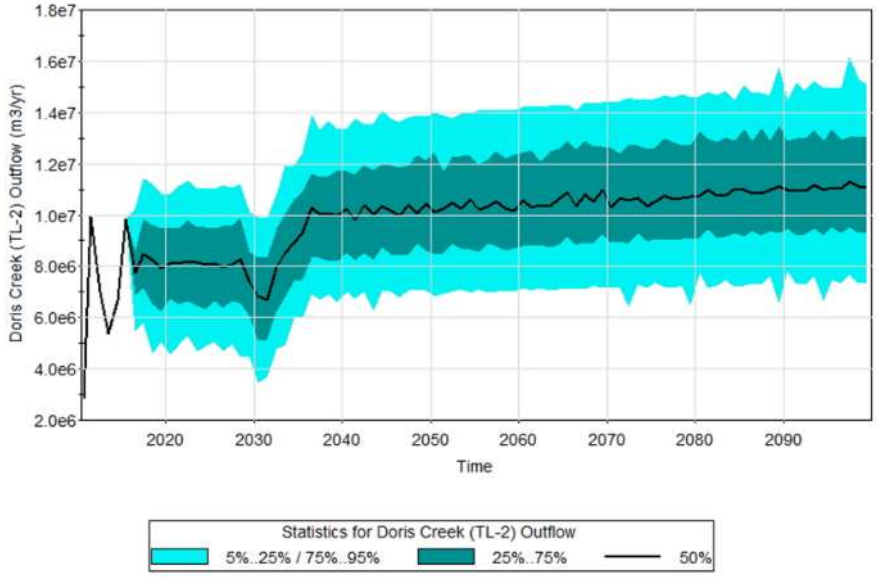
Water Consumption



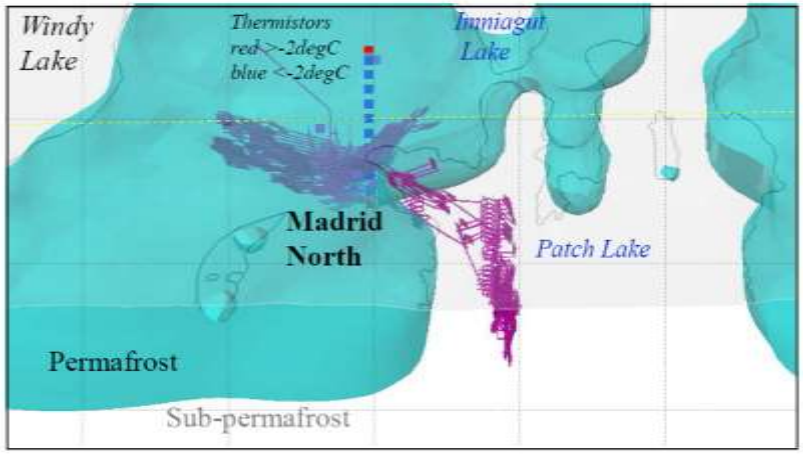
Groundwater Inflows

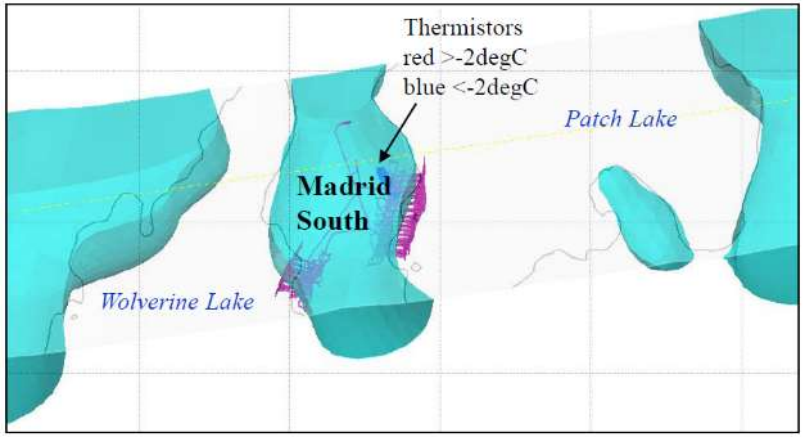
Model Inputs – Climate Change

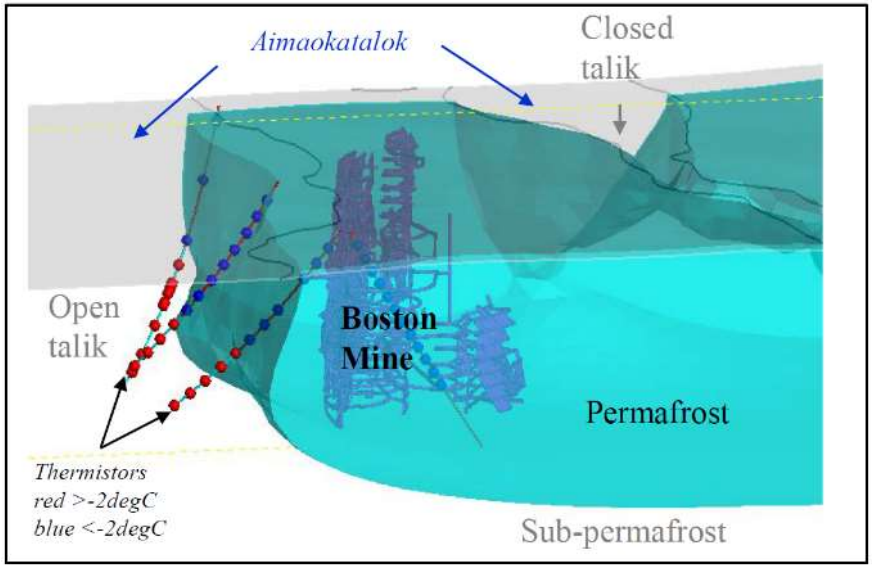
Initial Annual Precipitation Statistic → Apply Climate Change Factor → Annual Precipitation Applied in Model



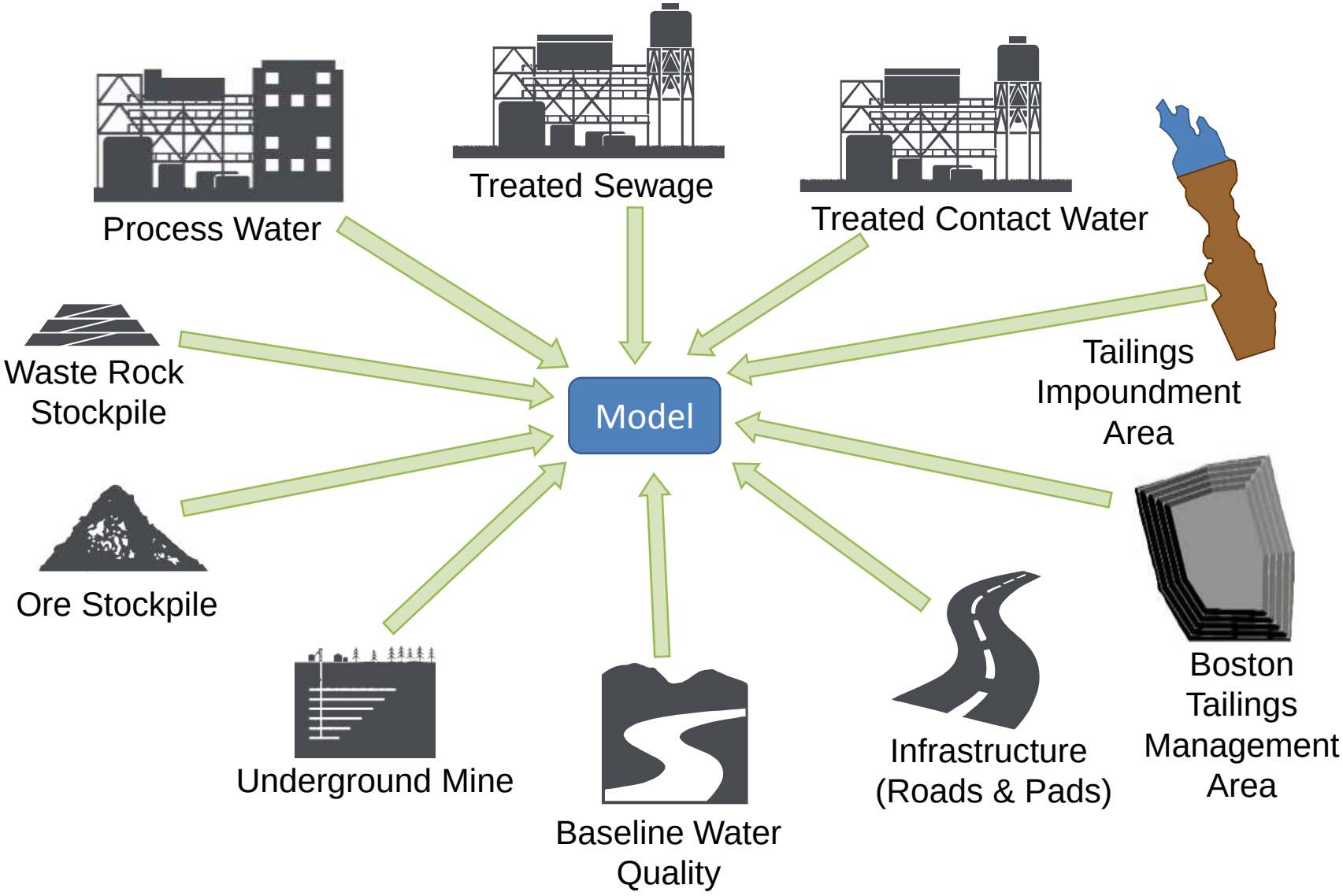
Model Inputs - Groundwater





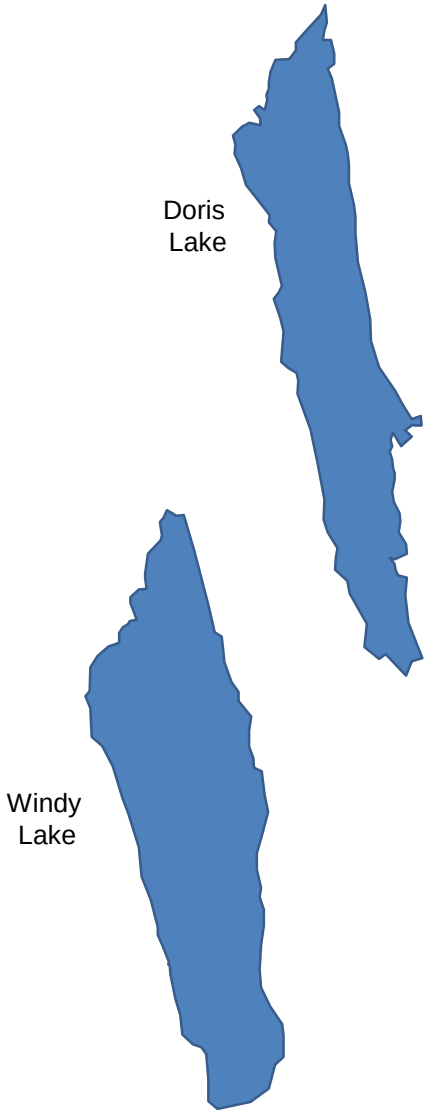


Model Inputs – Quality



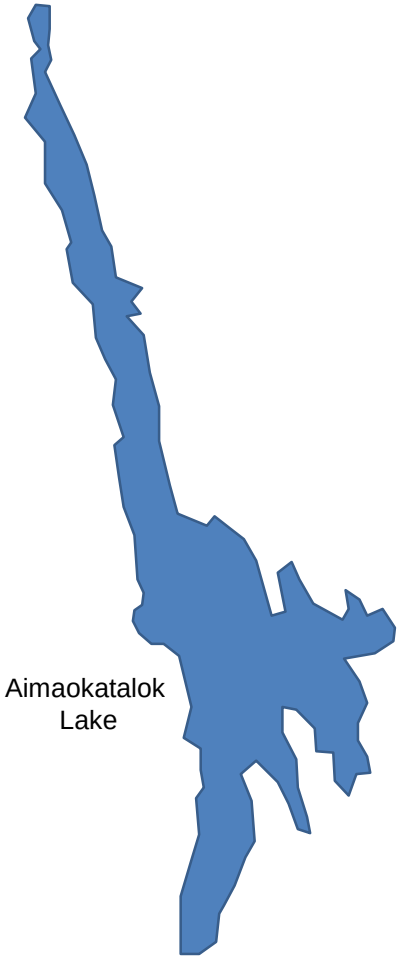
Model Results

Doris/Madrid Water Use



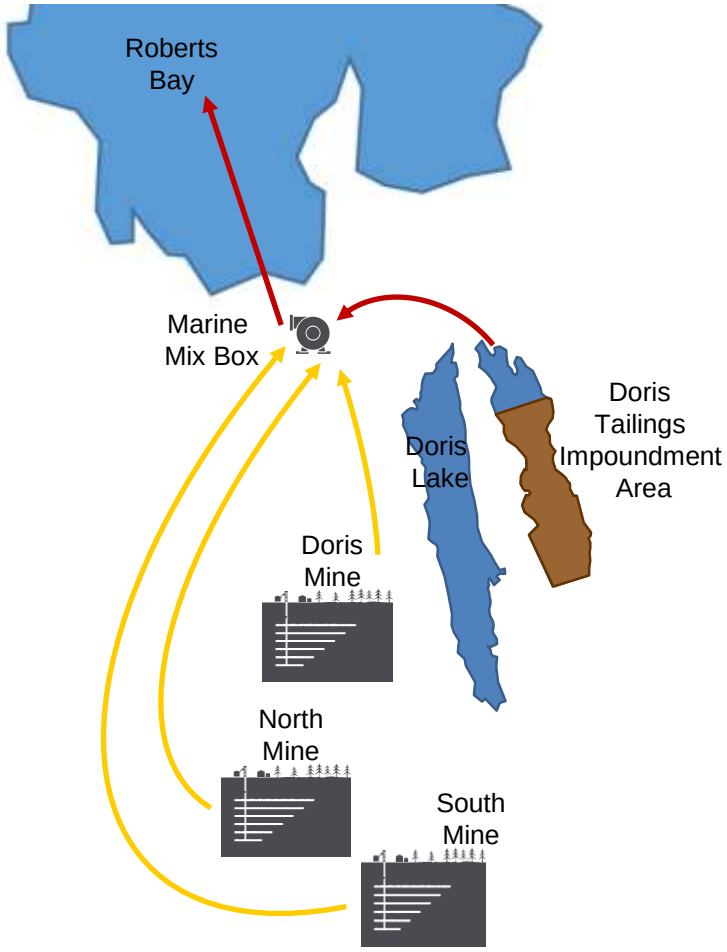
Water Demand	Lake Withdrawal (m^3/day)	
	Doris	Windy
Doris Process Plant	880	-
Madrid Concentrator	110	-
Doris Camp Potable	-	120
Doris/Madrid General Use	1,470	-
Total Phase 2	**2,460**	**120**
Increase from Phase 1	1,340	57

Boston Water Use



Water Demand	Aimaokatalok Lake Withdrawal (m^3/day)
Boston Process Plant	550
Boston Camp Potable	90
Boston General Use	1,000
Total Phase 2	**1,600**

Marine Discharge

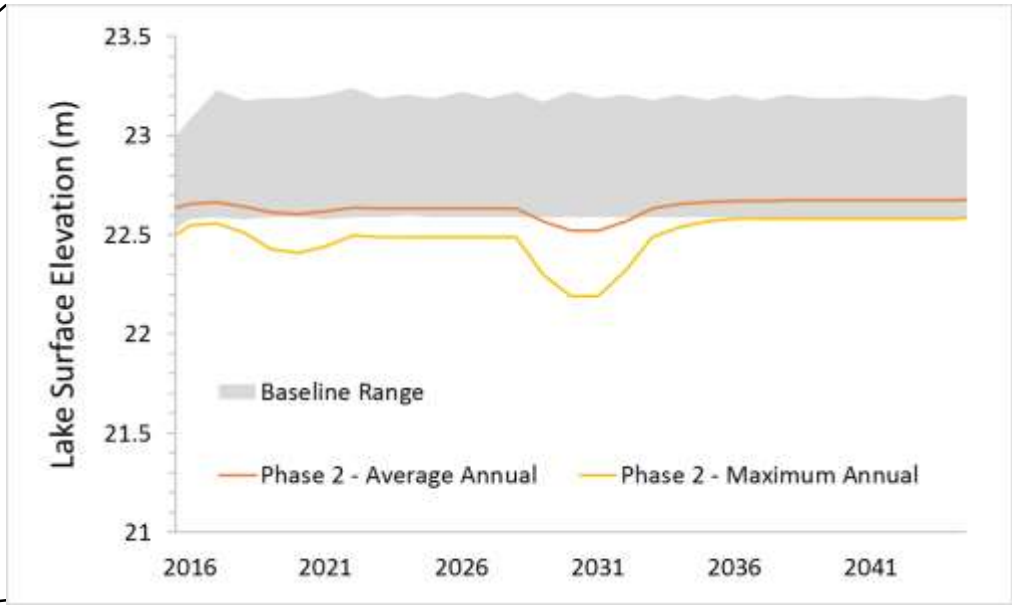


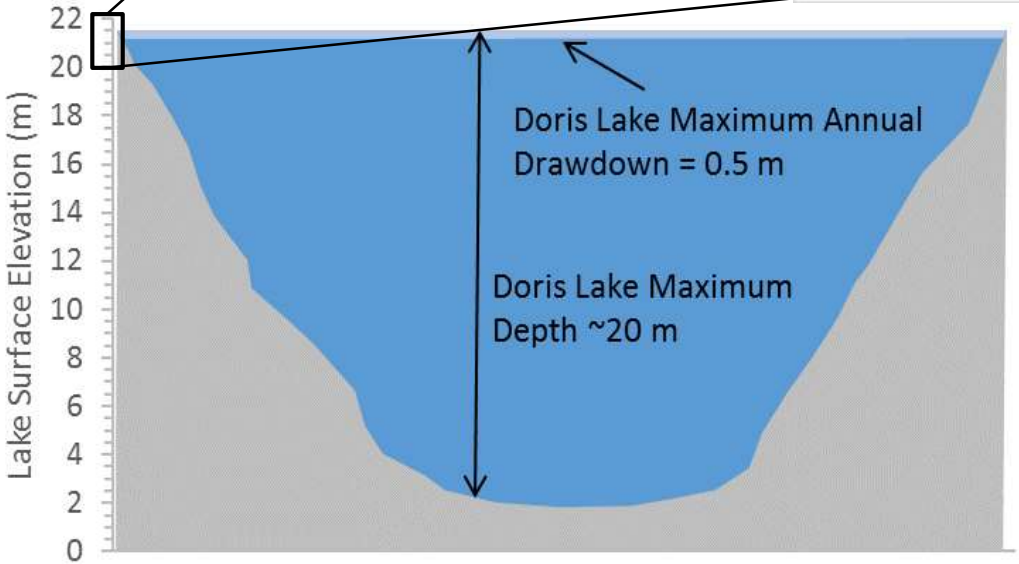
Maximum Discharge Rate to Roberts Bay (m^3/day)			
Phase	Summer	Winter	Closure
1	7,000	3,000	4,000
2	9,750	3,000	6,750

Model Results – Lake Results

Watershed	Lake	Drawdown (cm)		Annual Lake Outflow Reduction Relative to Baseline	
		Average	Maximum	Average	Maximum
Doris	Wolverine	1	5	26%	56%
	Imniagut	94	180	-	-
	Patch	2	7	11%	24%
	Doris	7	40	18%	32%
Madrid	Windy	<1	1	1%	1%
Boston	Stickleback	<1	1	8%	12%
	Aimaokatalok	<1	1	0%	0%

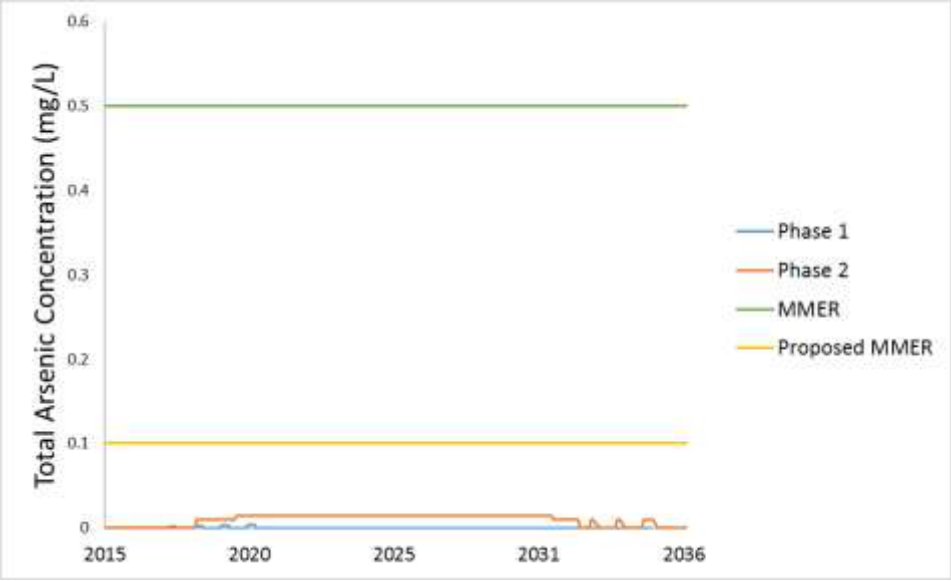
Model Results: Doris Lake Short Term Drawdown



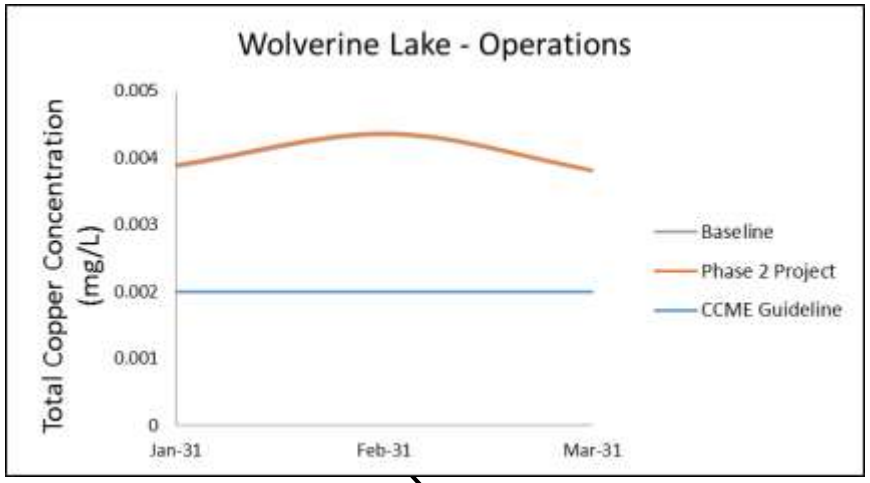


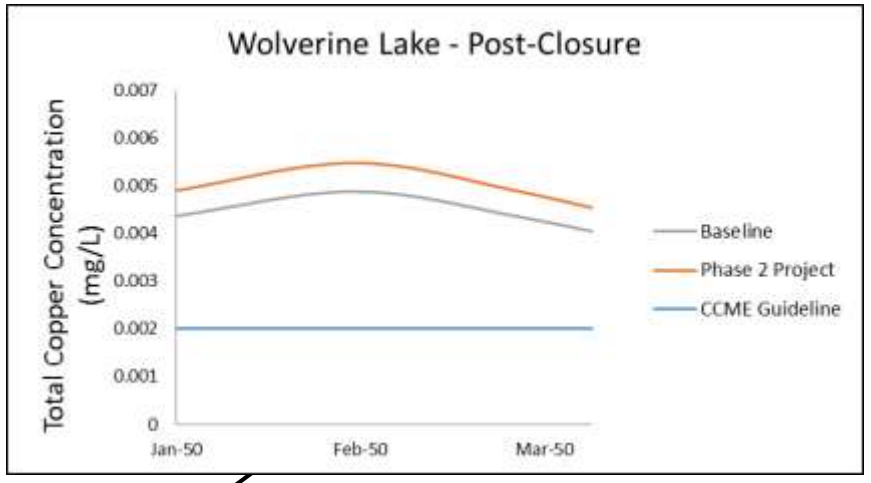
Effluent Quality

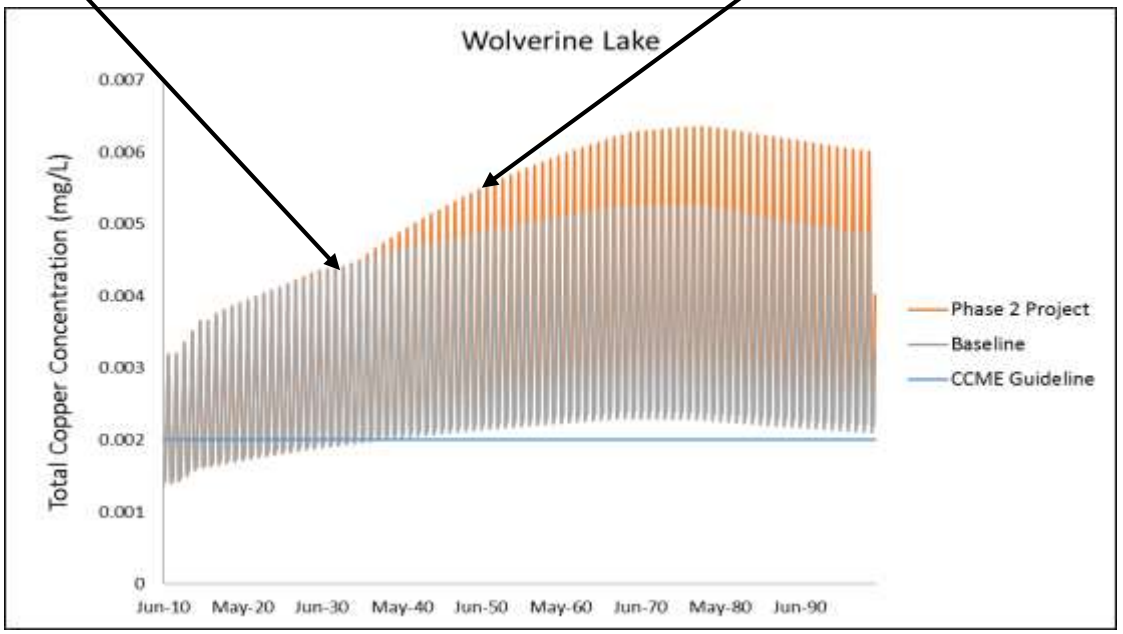
Parameter	MMER	Marine Mixing Box				Boston	
		Operations		Closure		Operations	
		Average	Peak	Average	Peak	Average	Peak
TSS	15	15	15	12	15	8.5	14
Arsenic	0.5	0.014	0.015	0.0081	0.01	0.0041	0.013
Copper	0.3	0.0093	0.031	0.0052	0.0085	0.00061	0.0019
Cyanide	1	0.024	0.23	0.0011	0.0092	0.069	0.25
Lead	0.2	0.00042	0.00092	0.00027	0.00064	0.00054	0.0018
Nickel	0.5	0.077	0.2	0.0056	0.013	0.0026	0.0085
Zinc	0.5	0.051	0.16	0.0093	0.022	0.0058	0.019



Wolverine Lake – Minimal Incremental Change







Freshwater Environment

Freshwater Environment

- **Valued Ecosystem Components**:
  - Surface Hydrology
  - Surface Water Quality
  - Sediment Quality
  - Fish
    - Fish Community
      - Arctic Char
      - Arctic Grayling
      - Lake Trout
      - Arctic Cisco
      - Broad Whitefish
    - Fish Habitat

Assessment Approach

Early Stages of Assessment

1. Start with Traditional Knowledge
2. Identify Study Areas based on potential Project interactions
3. Collect baseline data from within designated Study Areas

Impact Assessment Approach

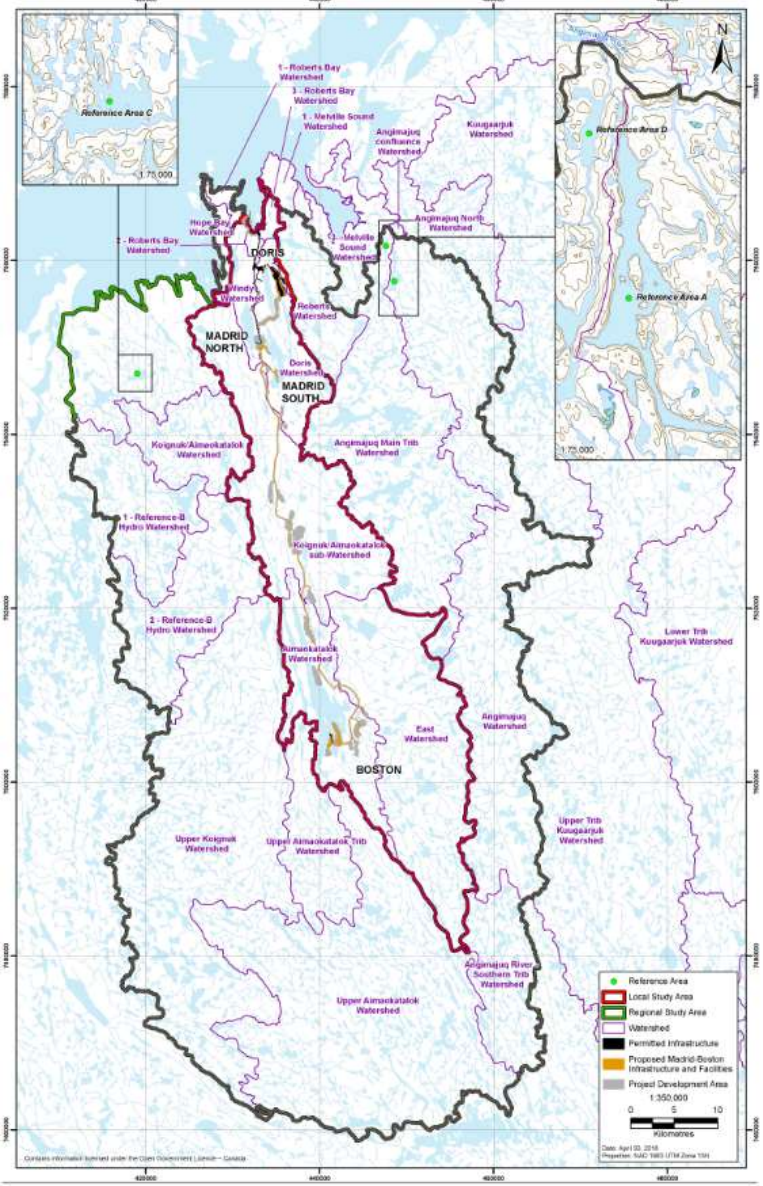
4. Identify Project Interactions with Freshwater Environment
5. Identify Mitigations to reduce Project Impacts
6. Model Project Interactions on water quantity and quality
7. Assess potential Residual Effects of Project on Freshwater Environment
8. Develop monitoring approach based on outcome of EIS review

Inuit Engagement

Historical and Current Inuit Comments and Concerns:

- shallower lakes and lower water flows
  - frozen to streambed in winter
- mine exploration and development
- contaminant exposure through fish consumption
- potential habitat loss and approach to fisheries offsetting
- no identified drinking water sources in Project area, but water use exists

Freshwater Environment – Study Area



Local Study Area – Extending one watershed or sub watershed boundary from Project infrastructure

Regional Study Area – Extending one watershed or sub watershed boundary from LSA

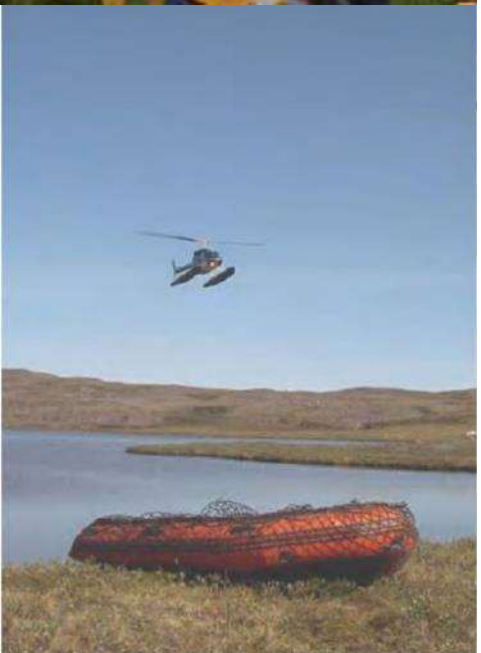
Existing Environment

- **Freshwater data has been collected in Hope Bay Belt since 1993**
  - Project lakes and streams
  - Reference lakes and streams
- **Freshwater lake and stream data includes:**
  - Hydrology (streams) and lake levels
  - Water quality (winter and summer)
  - Sediment quality (summer)
  - Primary producers
  - Secondary producers
  - Fish and fish habitat, including tissue metals

Hydrology Assessment

- **Potential impacts assessed:**
  - **Changes to surface hydrology**
    - Water withdrawal from lakes
    - Construction and use of underground mines
    - Modification of natural drainages

Water and Sediment Quality Assessment



- **Potential impacts assessed:**
  - **Changes to freshwater water or sediment quality**
    - Site preparation, construction and decommissioning
    - Site and mine contact water
    - Explosives
    - Treated discharge
    - Dust Deposition

Fish Assessment

- **Potential impacts assessed:**
  - **Fish habitat loss or alteration**
  - **Fish mortality or changes to population abundance**
    - Project infrastructure and development
    - Water withdrawal and use
    - Changes in water and sediment quality

Freshwater – Mitigation and Management

- **Mitigation by Project Design**
  - Use existing infrastructure
  - Only 1 Metal Mining Effluent Regulations discharge to freshwater throughout entire Belt
- **Regulatory Requirements**
  - Type A Water License
  - *Fisheries Act* - Metal Mining Effluent Regulations, Offsetting
- **Management Practices**
  - DFO guidance (work windows, explosives use, harm avoidance)
  - Reuse and recycle water
- **Adaptive Management**
  - Monitoring

Freshwater – Monitoring and Management

- **Aquatic Effects Monitoring Plan**
  - Belt-wide plan including Doris, Madrid, and Boston
- **Environmental Effects Monitoring Program**
  - Aimaokatalok Lake
- **Surveillance Network Program**
  - Type A Water Licence
- **Fisheries Offsetting Monitoring Program**
- **Management Plans**

Technical Comments – Freshwater Receiving Environment

- **KIA: 7 comments**
- **ECCC: 4 comments**
- **DFO: 4 comments**
- **INAC: 4 comments**

Technical Comments and Responses - Water

- **Aquatic Effects Monitoring Program**
  - Belt-wide AEMP
  - Total and free cyanide will be analyzed
  - Lake levels in Doris, Patch, Windy, Ogama, PO, and Imniagut lakes will be monitored to inform Fisheries Authorizations
  - MMER/EEM studies have been harmonized within AEMP
  - Aquatic Response Framework has been developed
- **Environmental Effects Monitoring Program**
  - Statistical approach has been clarified
  - Sampling stations have been moved closer to outfall
- **Site Specific Water Quality Objectives**
  - TMAC will monitor lake water quality and SSWQOs will be considered under the Aquatic Response Framework of the AEMP if necessary.

Technical Comments and Responses – Freshwater Fish

- **Fisheries Offsetting**
  - Lake level/stream flow monitoring to refine fish habitat losses (m^2) predicted during FEIS
  - TMAC will work with DFO, the KIA, and Inuit Environmental Advisory Committee to identify candidate offsetting options with a preference for developing a community-based offsetting program near Cambridge Bay
  - TMAC will develop an Offsetting Plan commensurate with anticipated losses

- **Construction of in-water infrastructure**
  - Provide final designs to DFO
  - Work with DFO, the KIA, and the Inuit Environmental Advisory Committee to develop a construction plan that includes mitigation, monitoring, and reporting requirements.

Conclusions of Freshwater Assessments

- **No significant Project or Cumulative impacts**

Thank You, Questions