Giant Mine Remediation Project

Canada

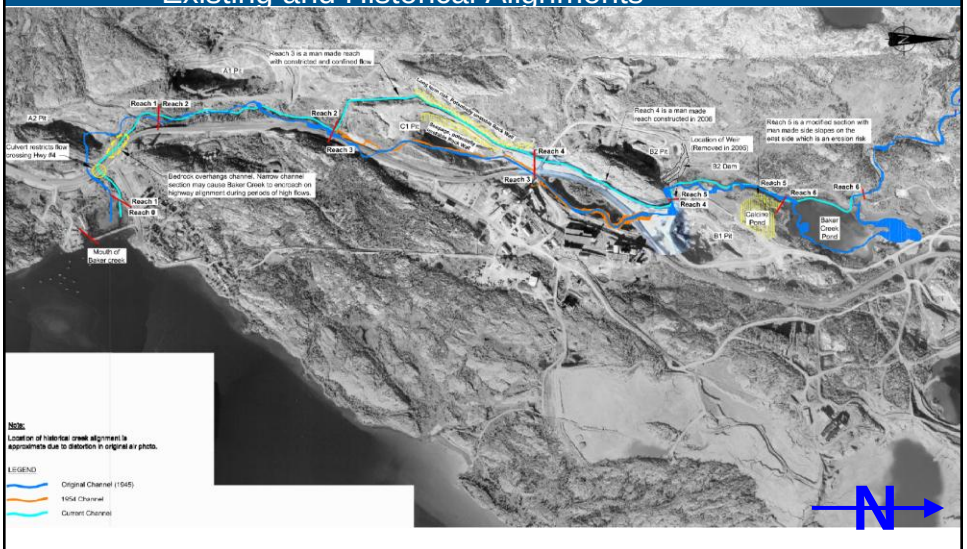
# Water – Baker Creek

Nathan Schmidt, P.Eng.

Giant Mine Remediation Project

Canada

## Existing and Historical Alignments

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## Giant Mine Remediation Project
### Closure Design Considerations

Key Concerns

- Flood Risk:
  - The existing creek may not convey extreme flood flows or lower flows under anchor ice, rockfall or bank failure conditions
  - Spillage to A2, B1 and C1 pits could occur if this is not addressed

- Environment:
  - Water and sediment quality in Baker Creek are affected by historical deposits and upstream inputs
  - Existing channel alignment includes alterations and diversions that limit fish habitat.

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## Giant Mine Remediation Project
### Closure Design Considerations

Objectives:

- Flood Risk: Provide flow conveyance through the site without spill to underground
  - Current design criteria consider the 500-year flood flow event, with 2 m anchor ice, plus 1 m freeboard
  - Minimize groundwater seepage to the underground workings
- Environment: Address habitat and contamination issues
  - Maintain a low flow channel for fish passage and habitat
  - Enhance/restore fish habitat in Baker Creek
  - Contaminated sediment management is still under review (a sediment study guided by the Federal Contaminated Sites Action Plan – FCSAP – is currently in progress).
- Restoring flow regime and habitat will be positive changes, as noted in the DAR

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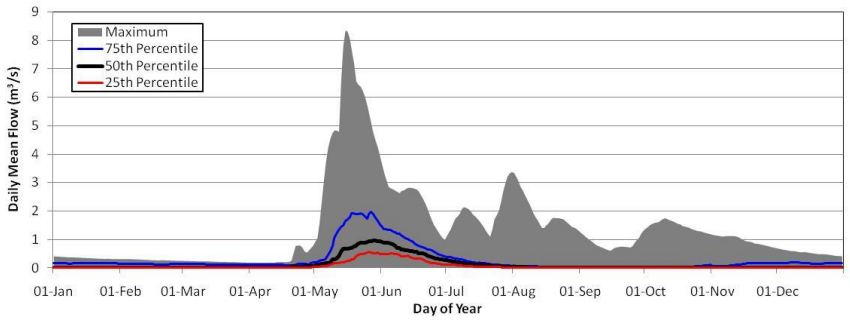
# Giant Mine Remediation Project

## Hydrology of the Creek




Baker Creek Flood Regime

| Return Period (years) | Estimated Flood Discharge ($m^3/s$) |
|---|---|
| 2 | 1.7 |
| 10 | 5.4 |
| 50 | 10.8 |
| 100 | 13.8 |
| 200 | 17.3 |
| 500 | 25.0 |
| Probable Maximum Flood | ~200 |

- The greatest recorded flow (since 1968) on the creek was in the spring of 1991, at 8.45 m3/s.
- The mean annual flow is approximately 6.8 million m3
- Aufeis formation observed in recent years, and particularly in the winter of 2010-11, was considered in the design.

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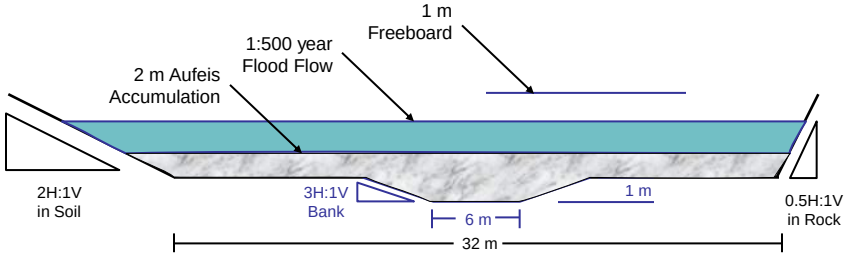
# Giant Mine Remediation Project

## Design Flows, Geometry and Materials

### Current Channel Design Criteria:




- Channel geometry and materials are based on local geomorphology investigation
- Active channel material will be graded with D50 = 120 mm
- Floodplain material will be graded with D50 = 120 to 250 mm
- Compacted till will be provided below the channel and floodplain, with a bituminous liner above shallow underground features

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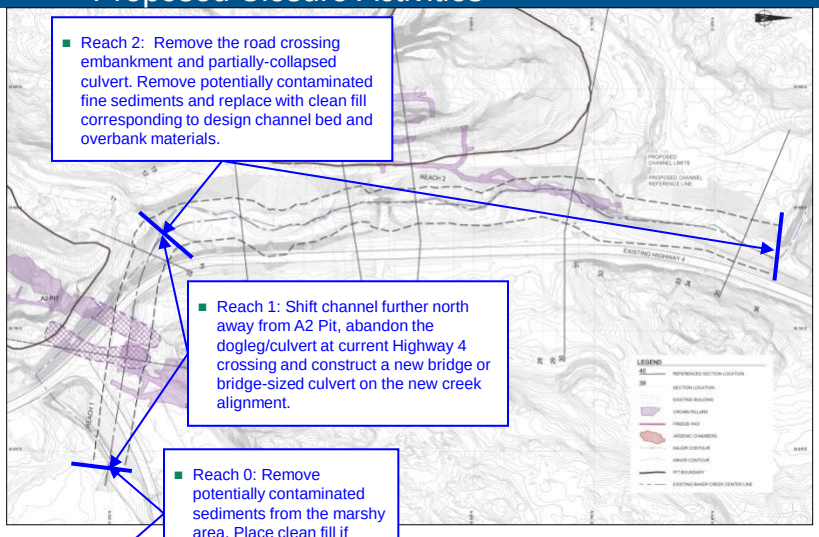
## Giant Mine Remediation Project
### Proposed Closure Activities



- Reach 2: Remove the road crossing embankment and partially-collapsed culvert. Remove potentially contaminated fine sediments and replace with clean fill corresponding to design channel bed and overbank materials.
- Reach 1: Shift channel further north away from A2 Pit, abandon the dogleg/culvert at current Highway 4 crossing and construct a new bridge or bridge-sized culvert on the new creek alignment.
- Reach 0: Remove potentially contaminated sediments from the marshy area. Place clean fill if required and re-vegetate.

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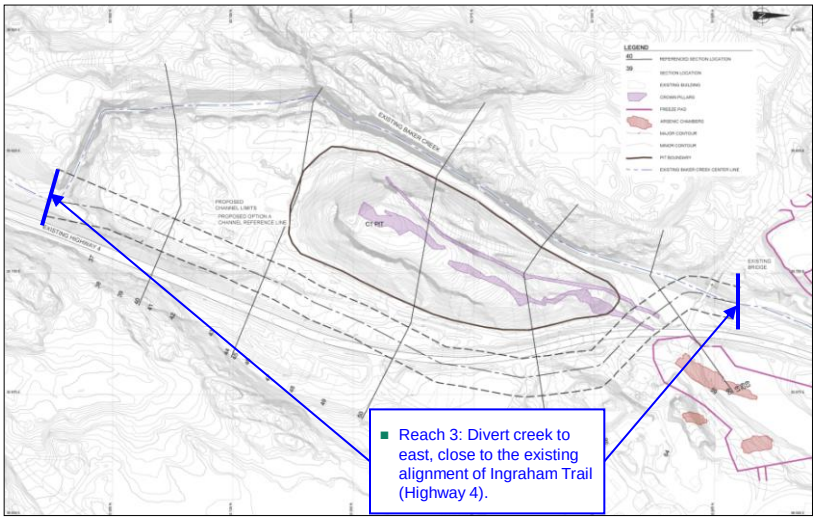
## Giant Mine Remediation Project
### Proposed Closure Activities



- Reach 3: Divert creek to east, close to the existing alignment of Ingraham Trail (Highway 4).

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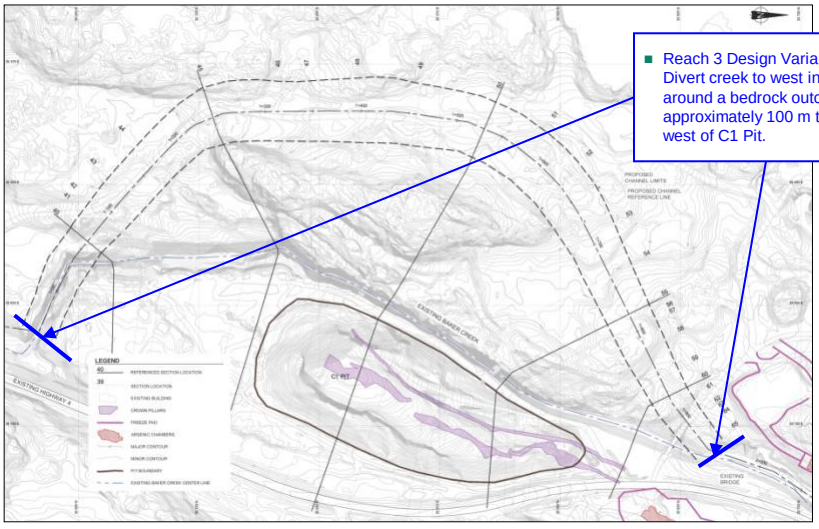
# Giant Mine Remediation Project
## Proposed Closure Activities




- Reach 3 Design Variant: Divert creek to west in deep cut around a bedrock outcrop, approximately 100 m to 250 m west of C1 Pit.

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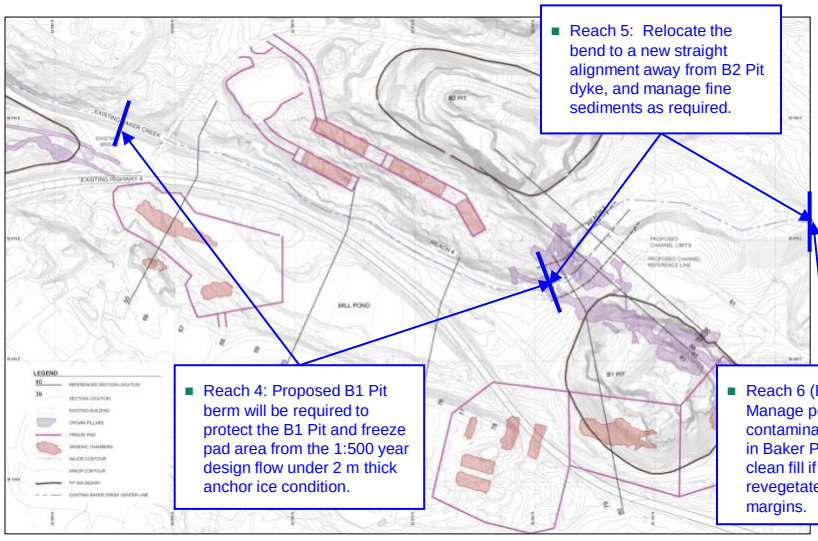
# Giant Mine Remediation Project
## Proposed Closure Activities




- Reach 5: Relocate the bend to a new straight alignment away from B2 Pit dyke, and manage fine sediments as required.
- Reach 4: Proposed B1 Pit berm will be required to protect the B1 Pit and freeze pad area from the 1:500 year design flow under 2 m thick anchor ice condition.
- Reach 6 (Baker Pond): Manage potentially contaminated sediments in Baker Pond. Place clean fill if required and revegetate along pond margins.

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## Giant Mine Remediation Project
### North Diversion Contingency

The feasibility of an off-site diversion of Baker Creek has now been evaluated as a contingency to provide a basis for an additional risk-based evaluation of diversion alternatives:

- Looking at diverting Baker Creek around the Site to the north;
- Based on Digital Elevation Data from City of Yellowknife;
- Flood-only diversion was previously assessed by SRK;
- Fish-friendly diversion limited to 2% valley slope;
- Multiple alternatives examined to minimize excavation volumes.

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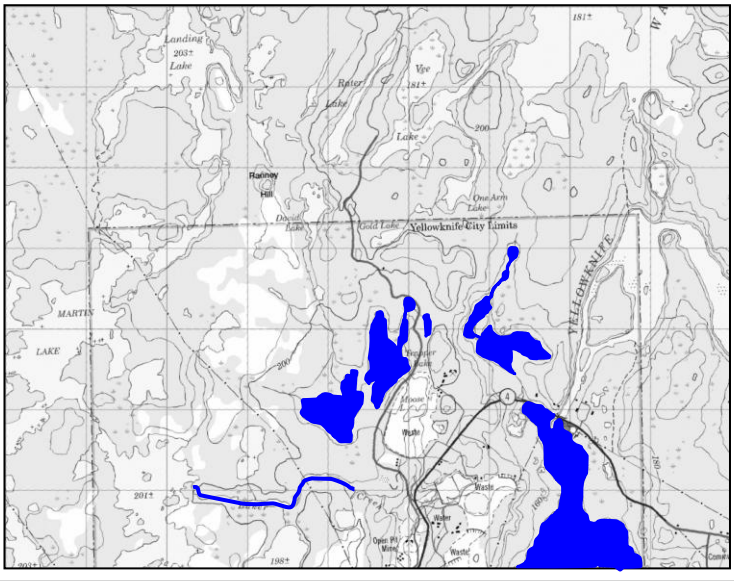
## Giant Mine Remediation Project
### North Diversion Contingency

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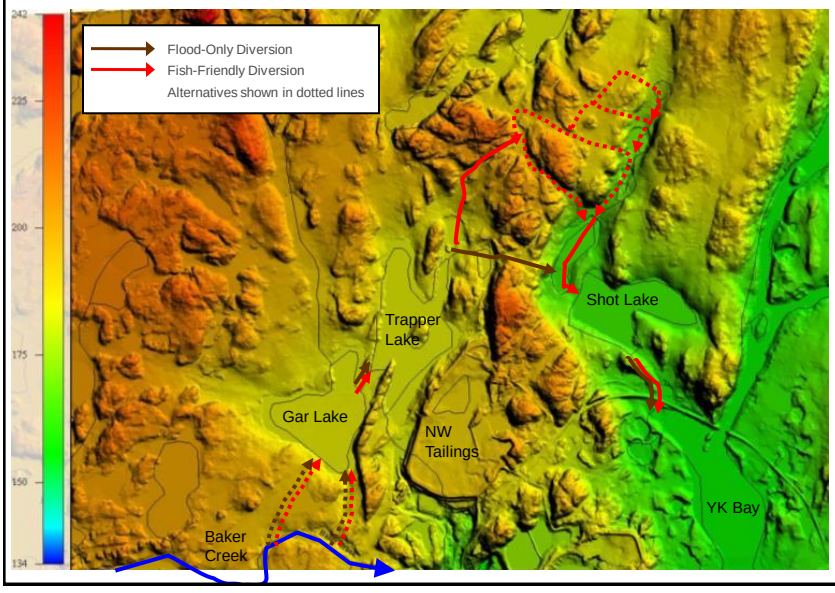
## Giant Mine Remediation Project

### North Diversion Contingency

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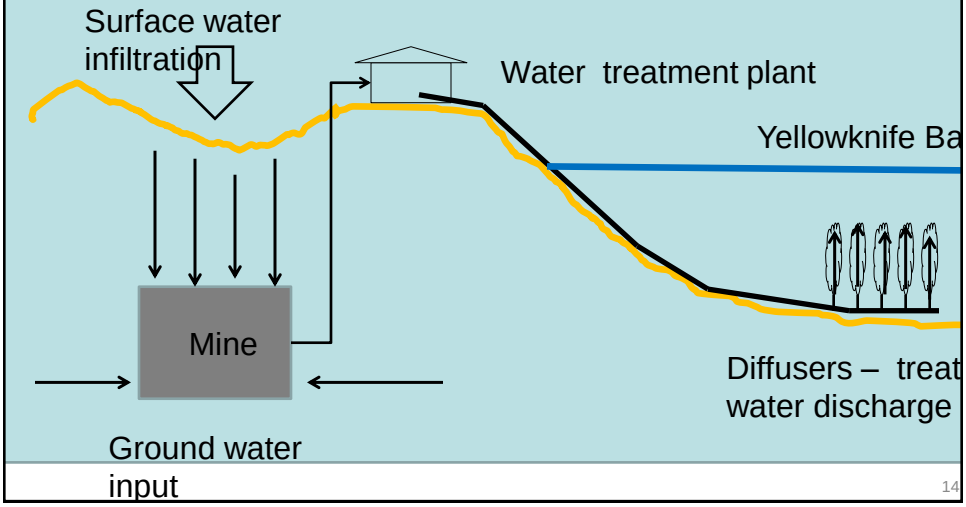
## Giant Mine Remediation Project

### Mine Water – Collection – Treatment – Discharge

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# Underground Water &Treatment

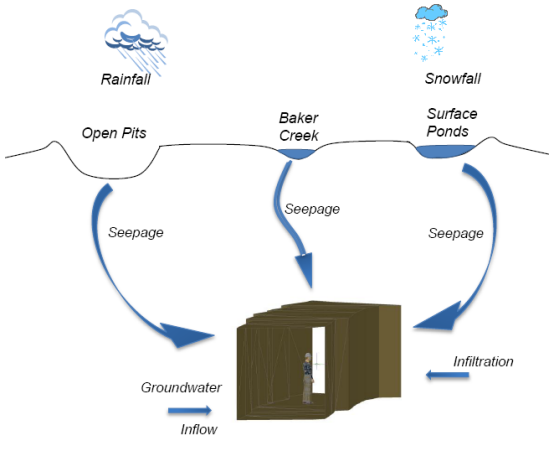
- Objective
  - Treat all underground water to meet CCME 2007 or Guidelines for Canadian Drinking Water Quality, whichever is more stringent, at the edge of the mixing zone
  - The background level will be used if it is higher than the guidelines





# Groundwater Management

Robert Boon, P. Eng



# Introduction

- Groundwater monitoring
- Water levels in the mine
- Storage of water in the mine
- Contingency
- Design variants



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# Existing Groundwater Monitoring

- Over 120 monitoring points are in place and continue to be monitored
- Results clearly indicate the presence of a hydraulic trap
- No significant difference in piezometric levels during flooding from 600 m to current 230 m below surface.
- No specific water quality standards set for groundwater as all groundwater reports to a Water Treatment Plant

# Yearly Volumes To Be Handled ($m^3$)

| | Average Year | Wet Year |
|---|---|---|
| Pre-Freezing | 630,000 | 822,200 |
| DAR | 540,000 | |
| Post Freezing | 404,300 | 517,500 |
| DAR | 345,000 | |

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# Underground Water Characterization Update

- Underground water has been studied and sampled for many years
- Additional sampling points are being added
- Additional flow monitoring is planned at various sources in the mine

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# High Test

- Majority of high arsenic content water (High Test) is currently captured & piped to the 750 level Akaitcho Sump.
- Ongoing work to identify and map high test sources
- Sampling is occurring & will be expanded to better characterize these high test flows
- Water metering is being added to quantify flows from various sources
  - Metering will help identify changes to flows during & after freezing



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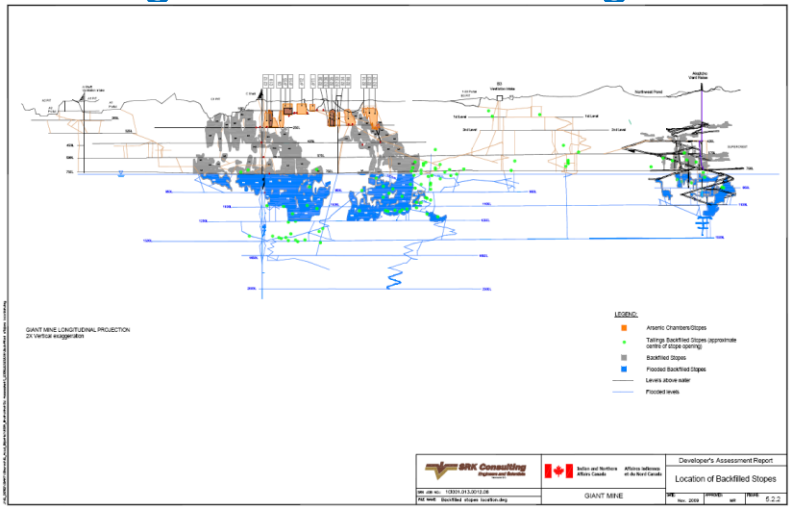
# Storage Volume Underground



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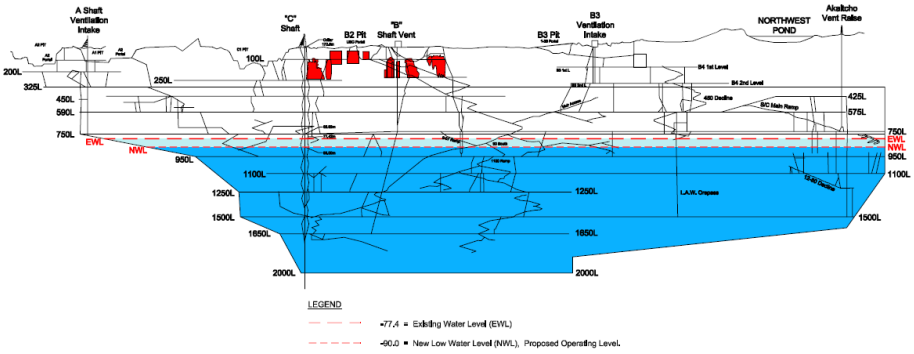
# Current Short-term Plan
# Maintain the Water Below 750

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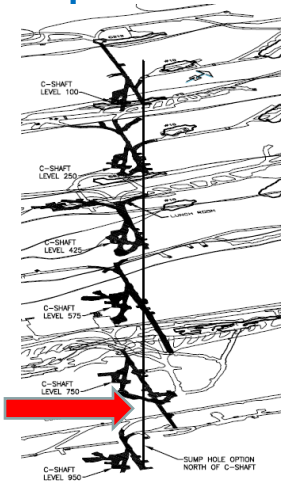
# Initial Raw Water Pump Placement

- 25 m below 750 level near C Shaft
  - Current water level 10 m below 750 at C Shaft

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# Short-Term Contingency

- Retain Akaitcho pumping system, existing water plant and NW pond until:
  - Existing ponds are dewatered (by existing plant)
  - New plant is on line & functioning
  - Operational experience is gained with new system
  - Mine water is better understood

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# Future Water Level

- Final minewater level is under discussion
- Timing of additional flooding is also under discussion
- Only raise level based on detail design & operational experience

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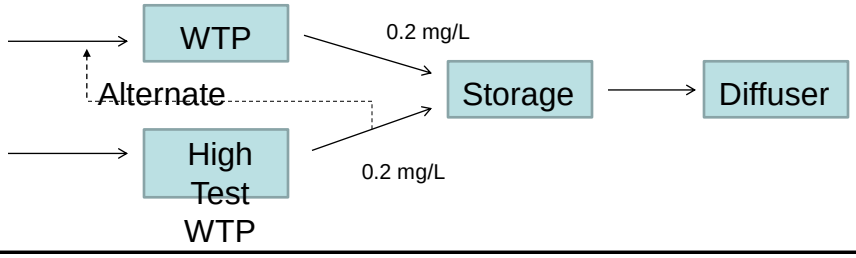
# Potential High Test WTP Component

- Detail design of WTP is to consider the benefits of:
  - Retaining the high test piping system & possibly expanding it
  - A separate treatment segment specifically designed to treat high test water until freeze is completed

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# Future Monitoring

- Minewater will be monitored at the entry to the water plant
- Seven Multipoint wells to be installed surrounding the frozen arsenic areas as per DAR 14.2
- Groundwater will be monitored in both shallow & deep monitoring wells, per DAR 14.2
- All sampling will follow industry standards.
- Monitoring results to be included in Annual Reports and Status of Environment Reports (3 years during remediation, 5 years thereafter).

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# Design Variants

- Continued review of a potential separate treatment segment specifically designed to treat high test water.
- Mine access for personnel required if high test piping is retained
- Minewater Level to be 20 m below 750 level for some time
- Future minewater level is under discussion

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# Summary

- Groundwater & minewater are being monitored, this will be continued & expanded.
- The mine water level is to be held at current levels during remediation
- Future water levels are being discussed
- Hydraulic trap will be maintained for some time

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# Water Treatment

Till Freihammer, P.Eng.
Hydrometrik





## Outline

- Design Criteria
- Minewater Quality
- Performance Criteria
- Technology Review
- Process Design
- Performance Validation
- Residuals Handling
- Sampling & Monitoring
- Contingency Plans
- Design Variants
- Summary

# Design Criteria

| Flows & Storage | | |
|---|---|---|
| Short-Term | | |
| Average Treatment Flow Rate | 26 | L/s |
| Peak Wet Year Flow Rate | 34 | L/s |
| Maximum Equalization Storage Volume Required | 177,000 | $m^3$ |
| Long-Term | | |
| Average Treatment Flow Rate | 17 | L/s |
| Peak Wet Year Flow Rate | 21 | L/s |
| Maximum Equalization Storage Volume Required | Minimal | |

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# Minewater Quality

- Major parameters of concern
  - Arsenic
  - Suspended Solids
  - pH
- Salinity from deep ground water does not affect the treatment process nor water quality at the edge of the mixing zone
- Preliminary sampling & monitoring program
  - Blended water to surface (est. up to 280 mg total As/L)
  - High test (up to 7300 mg dissolved As/L)

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# Raw Water Data

| Parameter | General Northwest Pond (2009-2010 data) | Akaitcho Dewatering System (2009-2010 data) | Unit |
|---|---|---|---|
| **Ammonia** | 0.063 – 0.488 | 0.017 – 5.3 | mg/L |
| **Arsenic (total)** | 17.0 – 40.6 | 1.99 - 123 | mg/L |
| **Total Suspended Solids** | <1.0 – 39.2 | <1.0 – 20.2 | mg/L |
| **Nickel** | 0.064 – 0.106 | 0.00058 – 0.198 | mg/L |
| **Cyanide** | N/A | <0.005 – 0.028 | mg/L |
| **Copper** | 0.006 – 0.04 | 0.0053 – 0.103 | mg/L |
| **Lead** | 0.0042 - 0.0169 | <0.0001 – 0.15 | mg/L |
| **pH** | 6.55 - 8.35 | 6.54 – 8.17 | units |
| **Radium 226** | N/A | N/A | Bq/L |
| **Zinc** | 0.034 – 0.205 | 0.046 – 0.559 | mg/L |
| **Oil & Grease** | N/A | <1.0 – 10 | mg/L |

*N/A: Not available*

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# Performance Criteria

| Parameter | Existing Treatment Plant Effluent (2009-2010 data) | New Treatment Plant Effluent (Predicted) | Existing Maximum Criteria[(a)(b)] | Unit |
|---|---|---|---|---|
| **Ammonia** | 0.005 – 0.067 | 0.017 – 5.3 (1.5 average) [(c)] | 12 | mg/L |
| **Arsenic (total)** | 0.205 – 0.418 | 0.20 (target) | 0.50 | mg/L |
| **Total Suspended Solids** | <1.0 - 14 | <5 (target) | 15 | mg/L |
| **Nickel** | 0.0234 – 0.0687 | No change | 0.50 | mg/L |
| **Cyanide** | <0.002 – 0.0145 | No change | 0.80 | mg/L |
| **Copper** | 0.0054 – 0.0162 | No change | 0.30 | mg/L |
| **Lead** | <0.0001 - <0.00025 | No change | 0.20 | mg/L |
| **pH** | 6.24 – 8.96 | 7.5 – 8.0 (target) | 6.5-9.5 | units |
| **Radium 226** | <0.005 - <1.0 | No change | 0.37 | Bq/L |
| **Zinc** | 0.0028 – 0.0713 | No change | 0.20 | mg/L |
| **Oil & Grease** | 0.005 - <2.0 | No change | 5 | mg/L |

*(a) Based on former water licence (N1L2-0043) for the existing treatment plant*
*(b) Plant effluent criteria to be set in conjunction with the diffuser design to meet the objectives at the edge of the mixing zone*
*(c) Based on 2009 – 2010 existing ammonia levels in minewater*

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# Technology Review

- Reviewed various technologies
- Validated previous studies that concluded that conventional treatment as the most appropriate technology for this application



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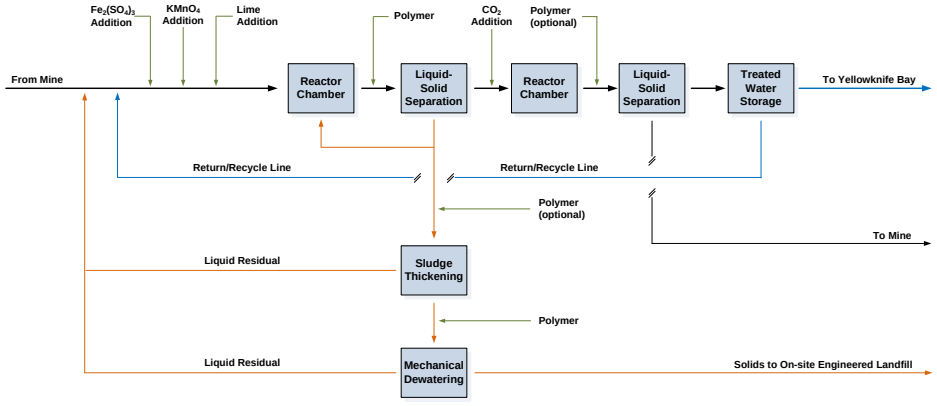
# Process Design

- Three main steps for arsenic removal
  - Oxidation of arsenite to arsenate
    - $3H_3AsO_3 + 2MnO_4^- \longrightarrow 3H_2AsO_4^- + 2MnO_2 + H_2O + H^+$
  - Precipitation of arsenate
    - $Fe^{3+} + AsO_4^{3-} \rightarrow FeAsO_4$
  - Removal of precipitate
    - Liquid-solid separation process

# Simplified Process Flow Diagram



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# Performance Validation

- Bench scale testing
  - Confirm choice of process chemicals
  - Provide chemical consumption estimates
- Pilot plant
  - Confirm proposed process will meet effluent requirements
  - Confirm arsenic treatment threshold value

# Residuals Handling

- Sludge volumes
  - 150 $m^3$/day (average)
  - 210 $m^3$/day (peak)
- Sludge disposal
  - Return to mine
  - Storage in empty arsenic stope
  - Storage in an onsite engineered landfill

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# Dewatered Residuals Handling

- On-site engineered landfill
- Estimated dewatered sludge volumes
  - 15 $m^3$/day (average)
  - 50 $m^3$/day (peak)
- Bench Scale and Pilot Testing
  - Confirm sludge characteristics
  - Confirm suitability of dewatering equipment
  - Optimize polymer dosage

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# Sampling & Monitoring

- Ongoing water sampling and monitoring program
- Sampling and monitoring locations
  - Plant inlet
    - Arsenic, suspended solids, general chemistry parameters, total metals, flow rate, pH, temperature and conductivity
  - Process stages
    - TSS, pH and/or flow rate
  - Entering treated water storage cells
    - pH, TSS and total arsenic
  - Exiting treated water storage cells
    - Flow rate, total metals, pH, suspended solids, general chemistry parameters and acute lethality

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# Contingency Plans

- Provide extra capacity at new plant
- Provide room for expansion at new plant
- Provide redundancy
- Standby generators
- Store and retreat non-compliant effluent prior to discharge

- Other contingencies as previously presented

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# Design Variants

- Conforms to the overall objectives
- Variants
  - Choice of oxidant
  - Additional liquid-solid separation steps
  - Polymer addition
  - Treatment volumes
  - Arsenic concentrations
    - Current Design: 76.8 mg/L (average); 280 mg/L (peak)



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# Summary

- Plant will treat up to 34 L/s of minewater
- Sampling & monitoring programs will be in place pre- and post-water treatment plant
- Dewatered residuals are to stored in an on-site engineered landfill
- Bench scale and pilot tests will be performed
- Non-compliant effluent will not be discharged
- Several contingency plans will be in place
- Conforms to the overall project objectives


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Water – Diffuser
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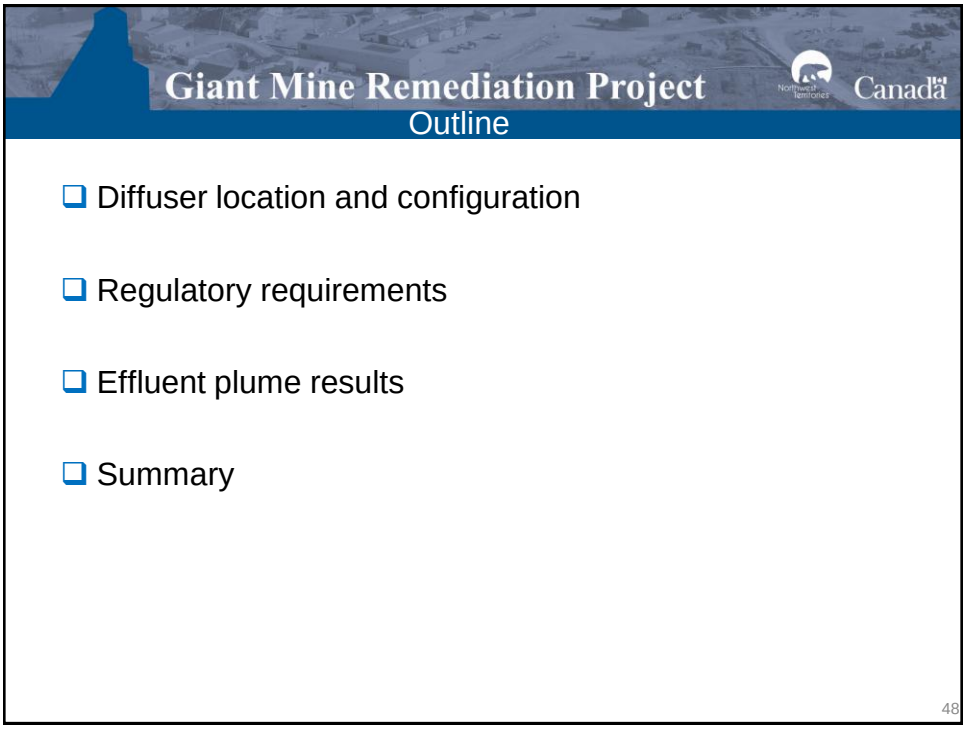
Giant Mine Remediation Project
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Outline
Diffuser location and configuration
Regulatory requirements
Effluent plume results
Summary
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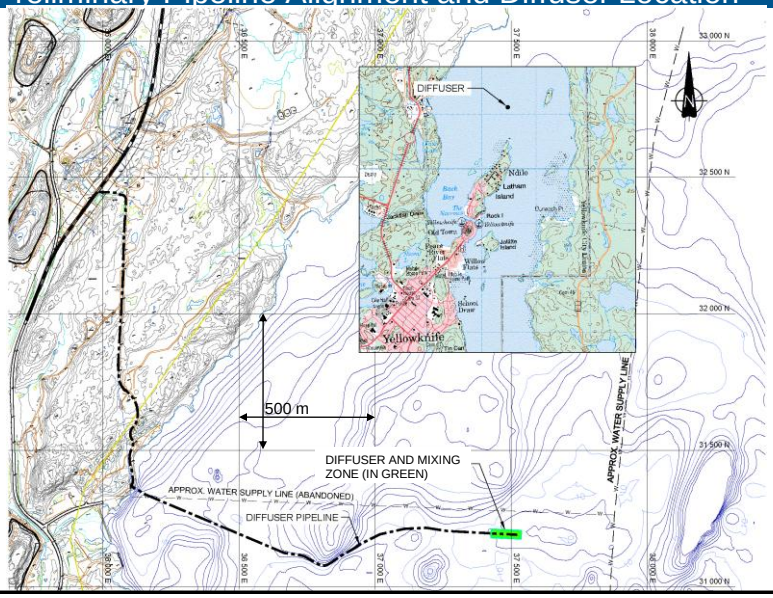
# Giant Mine Remediation Project

## Preliminary Pipeline Alignment and Diffuser Location

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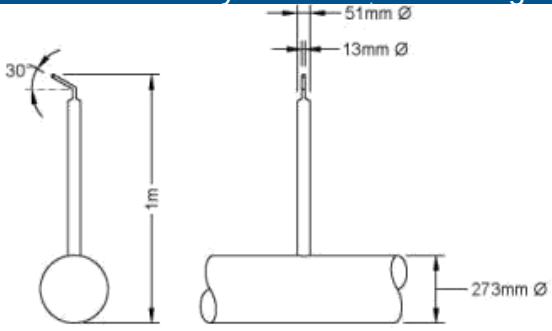
# Giant Mine Remediation Project

## Proposed Preliminary Diffuser Port Configuration




| Parameter | Value |
|---|---|
| Length of diffuser (m) | 81 |
| Number of ports | 28 (short term) and 18 (long term) |
| Discharge pattern | Alternate opposing direction |
| Distance between pairs of ports (m) | 3 |
| Port diameter (m) | 0.013 (or 0.5 inch) |
| Pipeline diameter (m) | 0.273 (or 11 inches) |
| Angle of ports from the reservoir bottom (˚) | 30 |
| Height of ports from the reservoir bottom (m) | 1 (or 3.28 feet) |
| Minimum discharge flow (l/s) | 20 (short term) and 15 (long term) |

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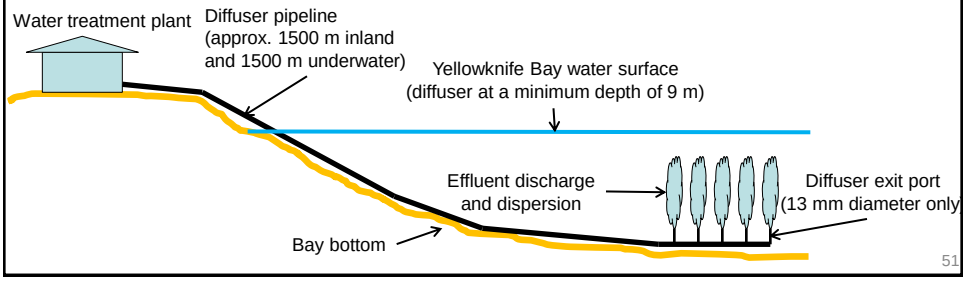
## Giant Mine Remediation Project
### Schematic of a diffuser

1. Diffuser ports diameter for Giant diffuser would be very small (13 mm only)
2. Pipeline protected against ice at the shoreline by burial
3. Diffuser exit ports at height above bay bottom to minimize sediment disturbance

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## Giant Mine Remediation Project
### Regulatory Requirements

- Water plant effluent quality criteria were set in conjunction with the diffuser design
- Water quality standards (in the aquatic environment beyond a mixing zone of the discharged effluent) based on regulatory guidelines and ambient concentrations.
- Diffuser designed to meet the water quality standard beyond the mixing zone, while minimizing the extent of the mixing zone (i.e., 15 m radius from each of the diffuser ports).

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## Giant Mine Remediation Project

### Water Quality Standards for each Parameter

| Parameter | Unit | Standard | Source |
|---|---|---|---|
| Total Suspended Solids | mg/L | 2.4 | Background concentration |
| Total Dissolved Solids | mg/L | 500 | Drinking water guideline |
| Chloride | mg/L | 250 | Drinking water guideline |
| Sodium | mg/L | 200 | Drinking water guideline |
| Sulphate | mg/L | 500 | Drinking water guideline |
| Ammonia | mg/L | 1.51 | CCME guideline |
| Total Cyanide | mg/L | 0.005 | CCME guideline |
| Aluminium | mg/L | 0.1 | CCME guideline |
| Arsenic | mg/L | 0.005 | CCME guideline |
| Cadmium | mg/L | 0.009 | CCME guideline |
| Copper | mg/L | 0.31 | Background concentration |
| Iron | mg/L | 0.3 | CCME guideline |
| Lead | mg/L | 0.2 | Background concentration |
| Manganese | mg/L | 0.05 | Drinking water guideline |
| Mercury (Inorganic) | mg/L | 0.02 | Background concentration |
| Molybdenum | mg/L | 0.073 | CCME guideline |
| Nickel | mg/L | 0.25 | Background concentration |
| Selenium | mg/L | 0.001 | CCME guideline |
| Uranium | mg/L | 0.5 | Background concentration |
| Zinc | mg/L | 0.28 | Background concentration |
| Radium-226 | Bq/L | 0.5 | Drinking water guideline |

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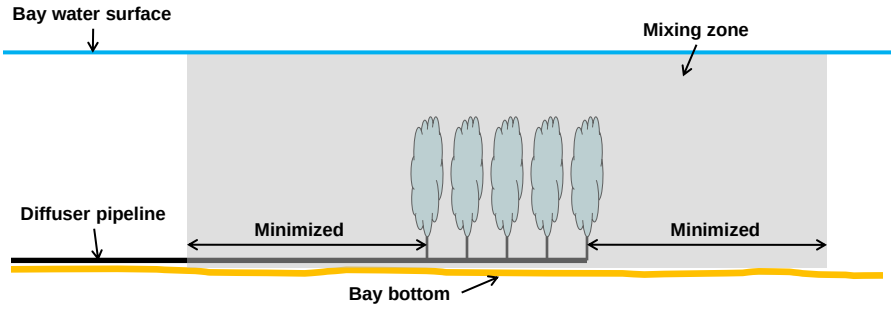
## Giant Mine Remediation Project

### Diffuser mixing zone

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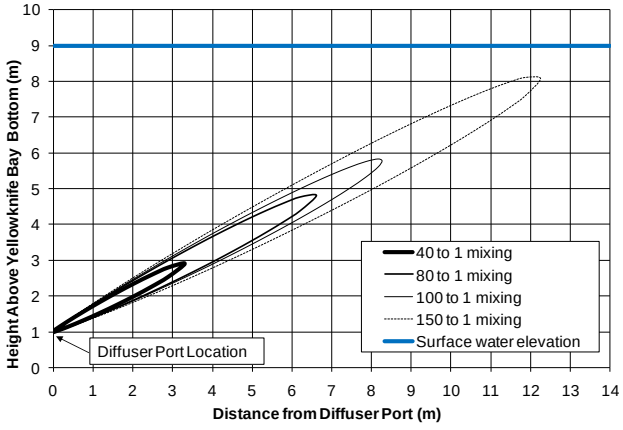
Effluent Dilution from a Single Port for an Un-Stratified Ambient Water Column

## Open Water Period




Worst ambient conditions, with near stagnant current.
Effluent plume shown above is the same for each port

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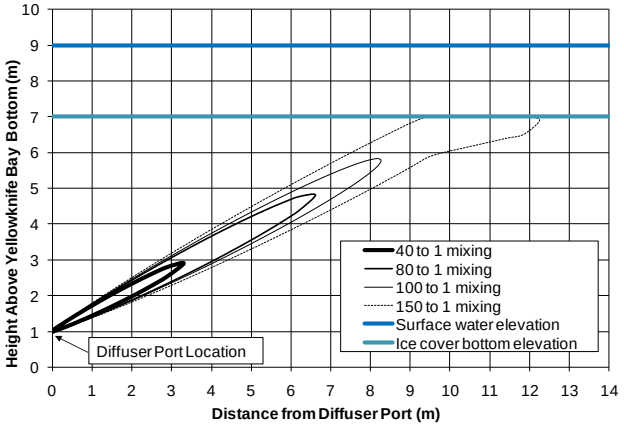
Effluent Dilution from a Single Port for an Un-Stratified Ambient Water Column

## Ice Cover Period




Worst ambient conditions, with near stagnant current.
Effluent plume shown above is the same for each port

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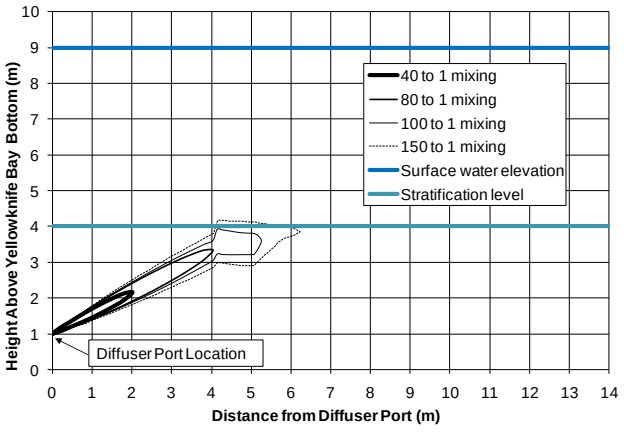
## Giant Mine Remediation Project

Effluent Dilution from a Single Port for a Stratified Ambient Water Column

### Profile view




Worst ambient conditions, with near stagnant current.
Effluent plume shown above is the same for each port

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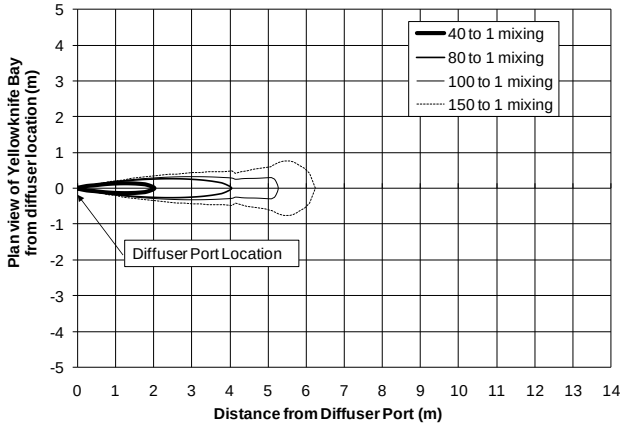
## Giant Mine Remediation Project

Effluent Dilution from a Single Port for a Stratified Ambient Water Column

### Plan view




Worst ambient conditions, with near stagnant current.
Effluent plume shown above is the same for each port

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## Giant Mine Remediation Project

### Ice Cover and Bottom Sediment

- Ice cover:
  - Discharge temperature between 2°C and 8°C
  - Local thinning of the ice cover may occur, and the potential for this will be further investigated during the diffuser detailed design phase.
  - Thinning, if any, would be local and may be further minimized by adjusting the port angle
- Bottom sediment:
  - Diffuser ports located 1 m above the bay bottom to minimize sediment entrainment from the port jets.
  - Ports angled toward the water surface to avoid direct contact of port jets with bay bottom

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## Giant Mine Remediation Project

### Summary

- Design water quality criteria for the bay were established based on regulatory guidelines and background concentrations.
- The diffuser was configured to achieve an effluent mixing that meets the water quality guideline for all constituents (including arsenic) within a mixing zone of 15 m around each diffuser port.
- The diffuser is configured to minimize entrainment of bottom sediment.
- Ice cover thinning, if any, is anticipated to be local, and can be further minimized by adjusting port angle during detail design phase.

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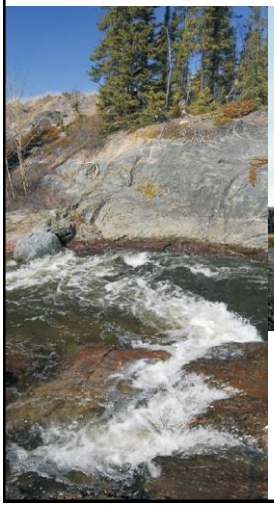
Giant Mine Remediation Project

# SURFACE WATER ENVIRONMENT OVERVIEW



Giant Mine Remediation Project Environmental Assessment
Technical Sessions – October 17-21, 2011

Bruce Halbert, SENES Consultants Limited

Giant Mine Remediation Project

## Positive Effects:

### Reduction in Arsenic Loads to Surface Water Environment

- The frozen block method will effectively isolate arsenic trioxide in underground vaults and thus minimize significant adverse environmental effects that would otherwise occur.
- Shifting the discharge point for treated minewater to a new outfall in Yellowknife Bay will reduce arsenic loading to Baker Creek from 800 kg/year to 480 kg/year.
- Relative to current conditions, management of surface contamination is predicted to result in a drop of arsenic loadings to Yellowknife Bay from 910 kg/year to 690 kg/year.
- Over time, these reductions are expected to result in a measureable improvement to the water quality of Baker Creek and Yellowknife Bay.

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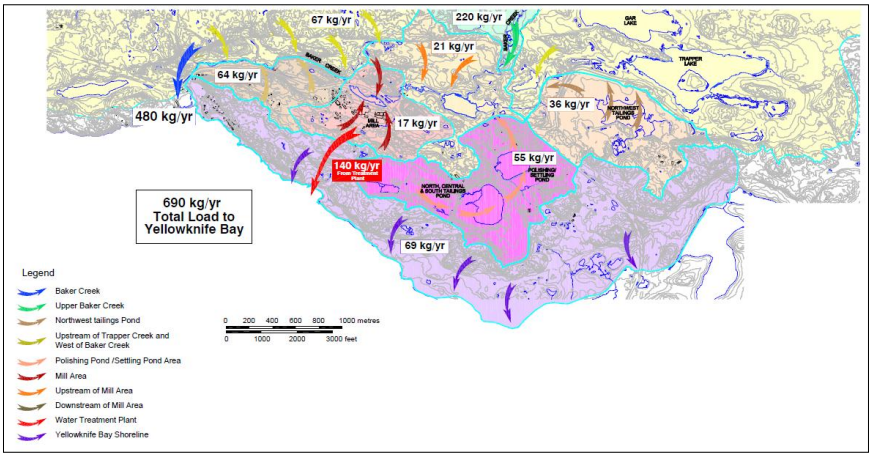
Giant Mine Remediation Project

Canada

## Post Remediation Arsenic Loads

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Giant Mine Remediation Project

Canada

## Positive Effects:

### Reduced Arsenic Loads to Surface Water Environment

| Sources | Estimated Arsenic Releases to Water (kg/year) | | |
|---|---|---|---|
| | Current | Post-Remediation | No-Remediation |
| **Inputs to Baker Creek** | | | |
| Baker Creek Upstream of Giant Mine | 220 | 220 | 220 |
| Tributaries from West of Giant Mine | 67 | 67 | 67 |
| Current Water Treatment Plant | 290 | n/a | n/a |
| Runoff from Surface Facilities to Baker Creek | 220 | 190 | 220 |
| Underground Mine to Baker Creek[a] | 0 | 0 | 7,100 |
| Total Inputs to Baker Creek | 800 | 480 | 7,607 |
| **Inputs to Yellowknife Bay** | | | |
| From Baker Creek | 800 | 480 | 7,607 |
| Direct Runoff to Yellowknife Bay | 110 | 69 | 110 |
| New Water Treatment Plant[b] | n/a | 140 | n/a |
| Total Inputs to Yellowknife Bay | 910 | 690 | 7,717 |

Notes: Numbers may not add up due to rounding; n/a: not applicable
a: Estimates of arsenic release after complete flooding of the mine with uncontrolled discharge of the resulting contaminated minewater range from 2,000 – 12,000 kg/year.
b: The calculated arsenic loading of the New Water Treatment Plant is based on an annual average discharge concentration of approximately 400 µg/L. Actual performance of the New Water Treatment Plant may be better than this, as demonstrated by 2009 discharges to Baker Creek being on average 300 µg/L.

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Giant Mine Remediation Project

## Environmental Quality

Environmental quality for the Giant Mine Remediation Project was evaluated by:

1) Comparison of predicted arsenic levels to environmental guidelines/criteria

2) Assessment of human health and ecological risks from exposure to arsenic based on:
   - Current conditions; and
   - Post-remediation conditions

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Giant Mine Remediation Project

## Environmental Quality

### Predicted Conditions – Water Quality

| | Canadian Water Quality Guideline for Protection of Freshwater Aquatic Life (5 µg/L) | | | | Canadian Guideline for Drinking Water (10 µg/L) | | | |
|---|---|---|---|---|---|---|---|---|
| | Baker Creek | Back Bay | North YK Bay | South YK Bay | Baker Creek | Back Bay | North YK Bay | South YK Bay |
| Mean Arsenic Concentration (µg/L) | 118 | 3 | 1.4 | 0.59 | 118 | 3 | 1.4 | 0.59 |
| Meets CCME Guideline? | x | √ | √ | √ | x | √ | √ | √ |

**Notes:** Both the mean and 95th percentile arsenic concentrations exceed the guideline
√ - All predicted arsenic concentrations are below the guideline

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## Environmental Quality

### Predicted Conditions – Aquatic Species

| Aquatic Receptor | Remediation Case | | | |
|---|---|---|---|---|
| | Baker Creek | Back Bay | North Yellowknife Bay | South Yellowknife Bay |
| Aquatic Plant | ✔ | ✔ | ✔ | ✔ |
| Benthic Invertebrates | ✔ | ✔ | ✔ | ✔ |
| Predatory Fish | x[2] | ✔ | ✔ | ✔ |
| Forage Fish | x[1] | ✔ | ✔ | ✔ |

Notes: x[1] - The predicted upper bound (95th percentile) concentration exceeds the EC25 toxicity reference value, and the lower bound (5th), expected (mean) and upper bound (95th percentile) concentrations exceed the EC10 toxicity reference value.
x[2] - The predicted lower bound (5th) and expected (mean) concentrations exceeds the EC10 toxicity reference value, but is below the EC25 toxicity reference value
✔ - Indicates that all predicted arsenic concentrations are below the EC25 and EC10 toxicity reference value.

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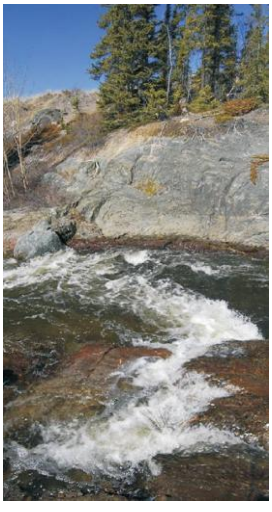
Giant Mine Remediation Project

## Monitoring

### Surface Water Quality

- Continued operation of the existing surface water Surveillance Network Program (SNP):
  - Trapper Creek (2 locations)
  - Baker Creek (6 locations)
- New sampling stations to be established in Great Slave Lake:
  - Back Bay (3 locations)
  - Yellowknife Bay (4 locations)
- Ongoing sampling of surface water “seeps”.



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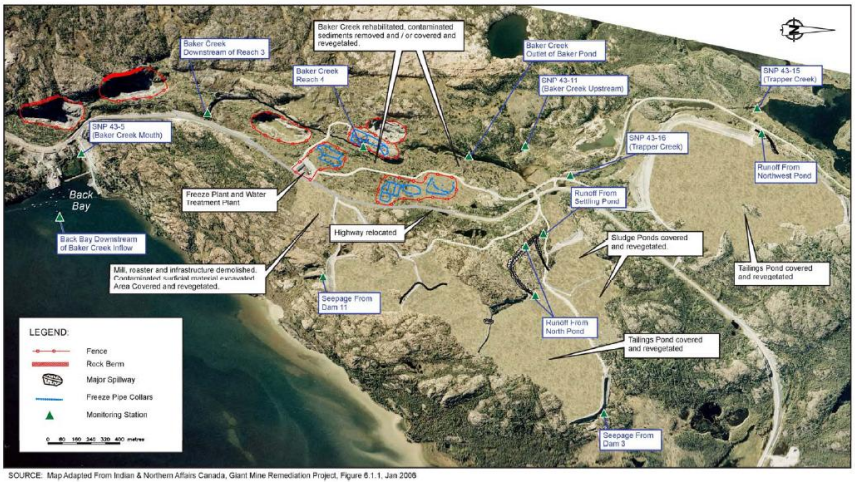
# Monitoring - Baker Creek (Proposed)




SOURCE: Map Adapted From Indian & Northern Affairs Canada, Giant Mine Remediation Project, Figure 6.1.1, Jan 2006

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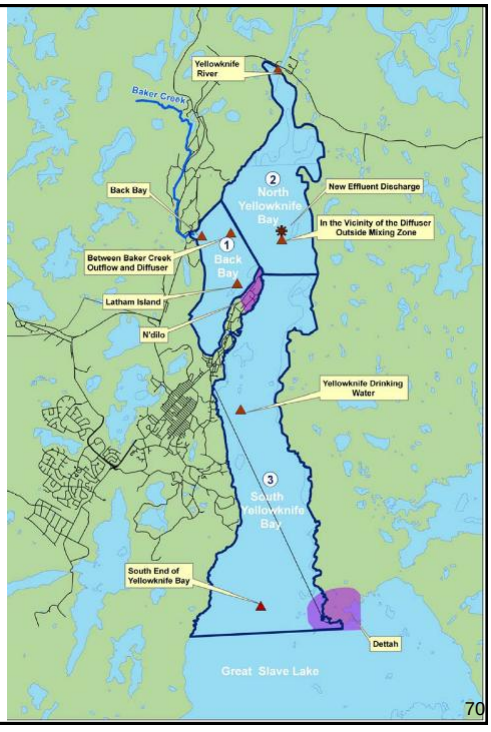
# Monitoring
## Yellowknife Bay (Proposed)

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## Monitoring

### Aquatic Environment

- Fish monitoring in Baker Creek and Yellowknife Bay (every 3 years):
  - to assess fish health and fish tissue chemistry.
- Aquatic effects monitoring (every 3 years):
  - to evaluate effects of the treated minewater discharge to Yellowknife Bay.
- Benthic invertebrate, aquatic vegetation and sediment monitoring in Baker Creek (every 3 years):
  - to determine how recovery is progressing.

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Giant Mine Remediation Project

## Overall Conclusions of the DAR

- Baker Creek environmental quality is expected to improve as a result of the Remediation Project; however, it will not return to pre-mining conditions.
- Back Bay and Yellowknife Bay water quality has improved dramatically in the past several decades and is expected to continue to improve. Arsenic levels in water today are below criteria that are protective of all forms of aquatic life. Arsenic levels in Yellowknife Bay are also well below Health Canada's drinking water guideline of 10 µg/L.
- The proposed outfall to Yellowknife Bay will not adversely impact the arsenic level in the bay beyond the initial mixing zone. As indicated in the preceding presentation, the treated minewater discharge will be fully mixed with lake water within approximately 15 metres of the outfall diffuser.

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## Overall Conclusions of the DAR

- Consistent with its overall objective, the Remediation Project will result in an overall improvement in the quality of the Surface Water Environment.
- To confirm these conclusions and identify any adaptations that may be required, a comprehensive environmental monitoring program will be put in place.

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