DE BEERS

Main Site Components and Interactions

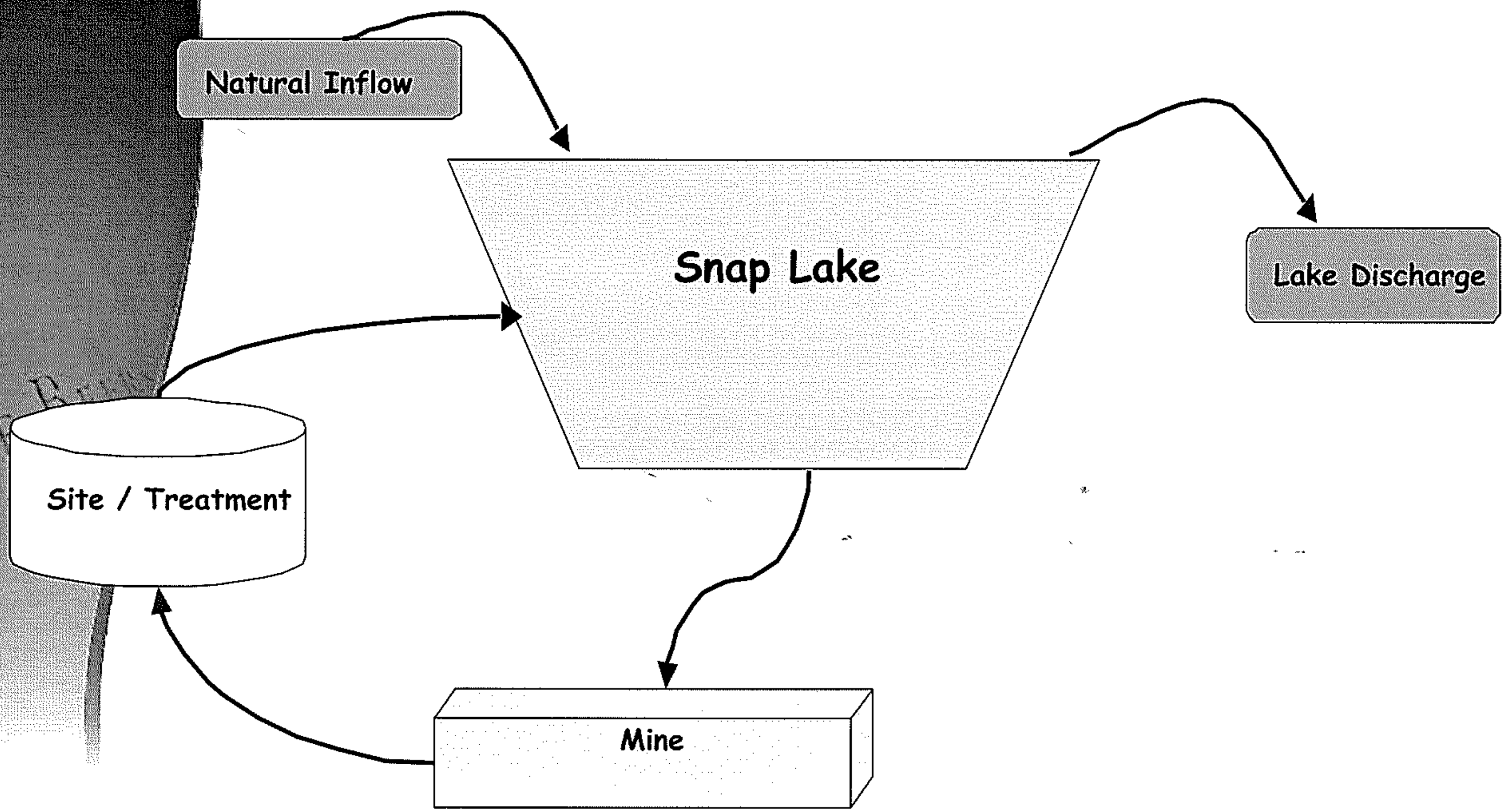
Purpose: to provide background on the main site areas and interactions that effect overall water quality and treatment requirements

Topic Has Been Addressed:

- Environmental Assessment Report
  - Section 3.6
  - Appendix IX.1

De Beers

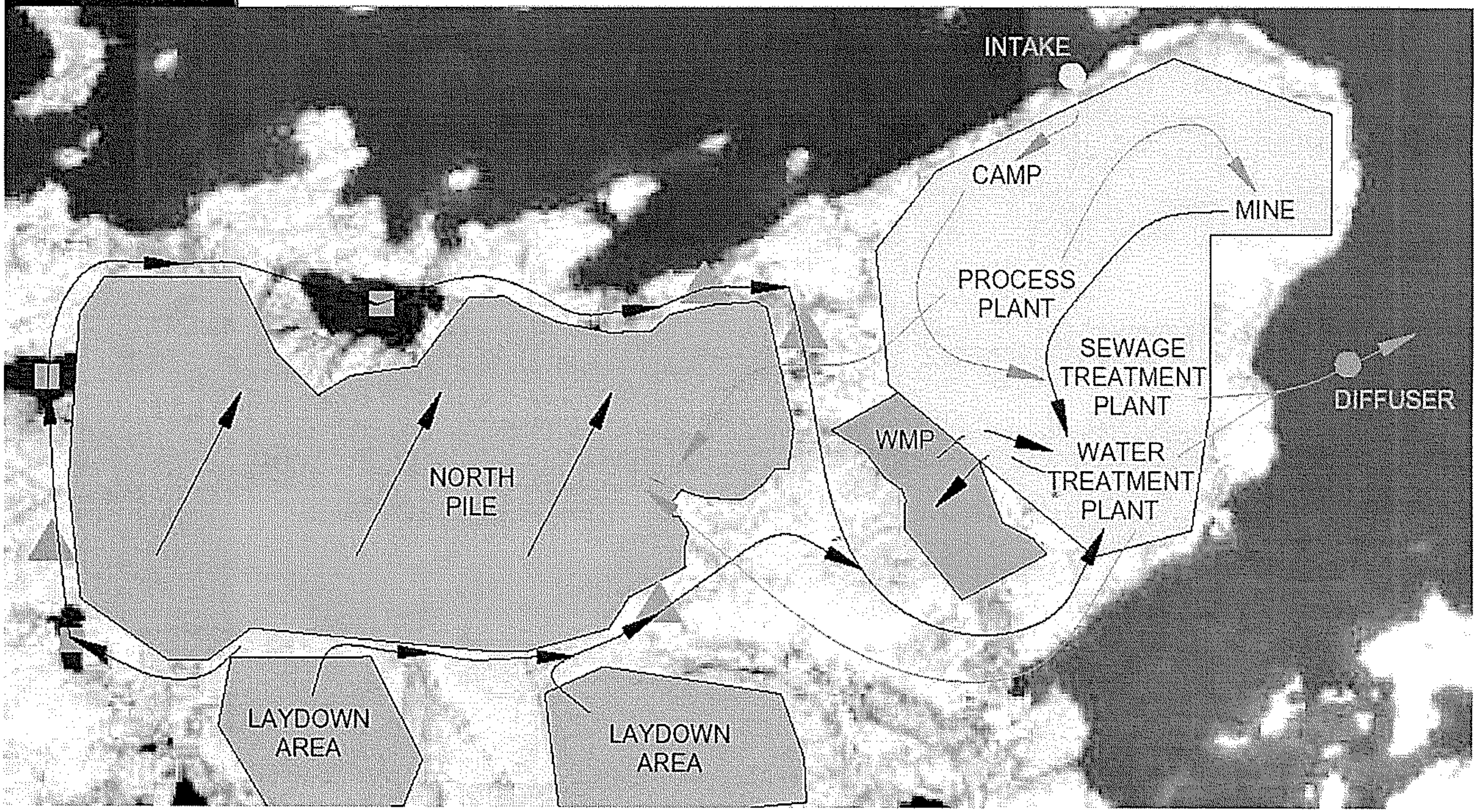
Simplified Schematic of Snap Lake Water Management System



www.debeerscanada.com

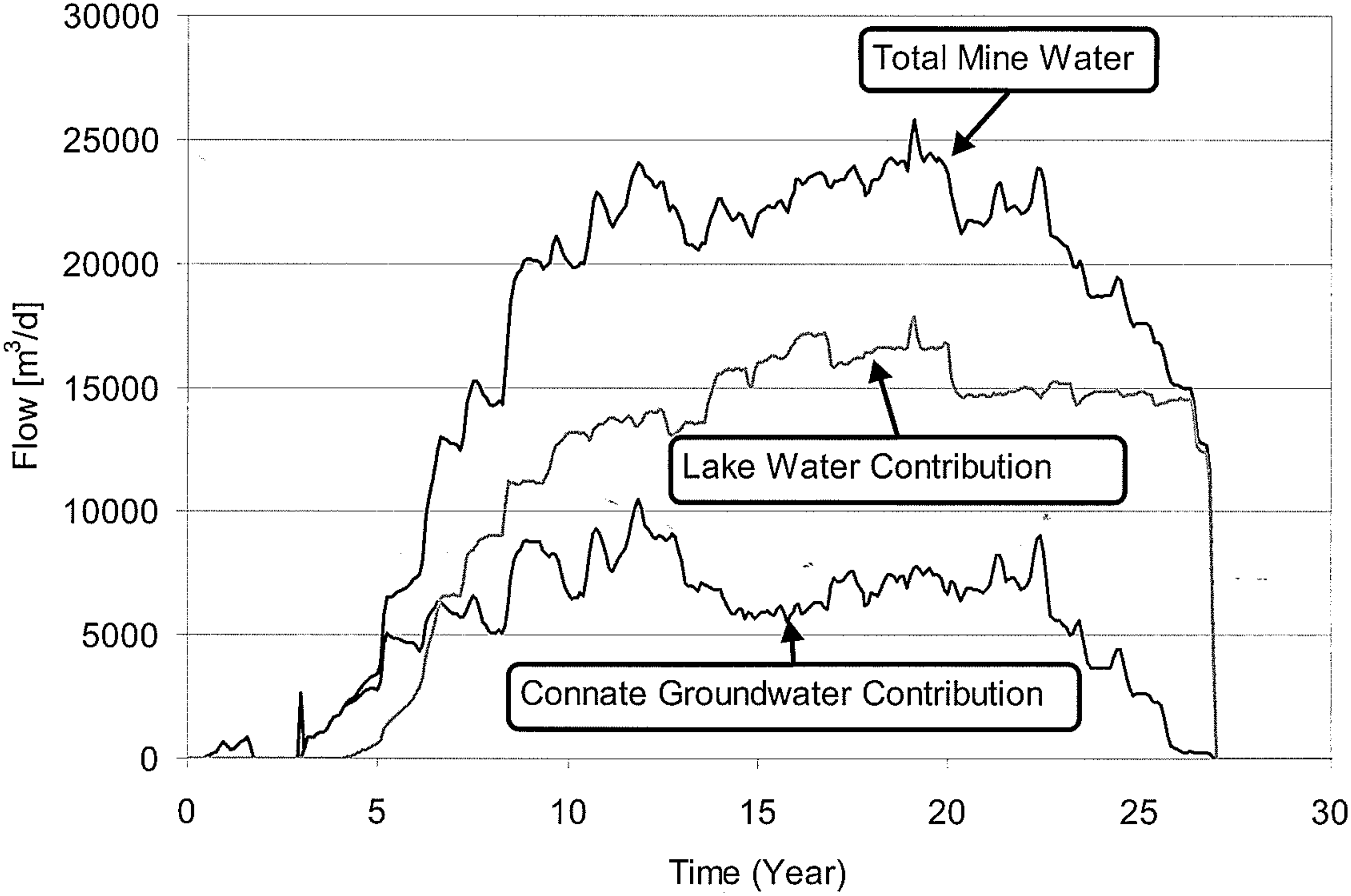
De Beers

Site Interactions and Flow Directions



De Beers

Mine Water



DE BEERS

Main Sources of Water to be Treated

Water Treatment

- Mine
- North Pile
- Site Runoff

Sewage Treatment

- Camp

DE BEERS

Key Areas

- Mine water represents over 90 % of treatment flows during operations
- Total suspended solids (TSS) and dissolved chloride are key constituents of mine and site water
- Phosphate is key constituent of camp-water (sewage)

DE BEERS

Conclusions

- Mine water values are conservative
  - Each chemical parameter in the solid phase (TSS) assigned the average concentration + 1 standard deviation
  - Dissolved chloride assessed at the average concentration + 1 standard deviation

DE BEERS

Snap Lake Diamond Project Technical Sessions

Water Quality and Quantity

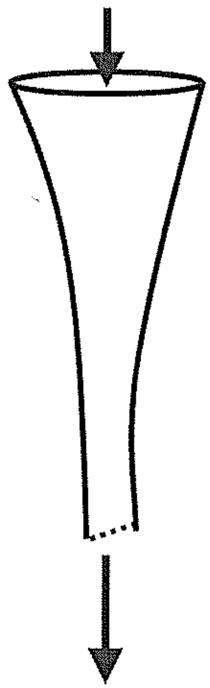
DE BEERS

Beginning of the Process

- Community Consultation (1999 - ongoing)
- Biophysical Baseline Data Collection (1999 - ongoing)
- Land Use Permit and Water Licence Applications Submitted to the MVLWB (Feb 2001)
- MVEIRB Referral - Impact Assessment (May 2001)

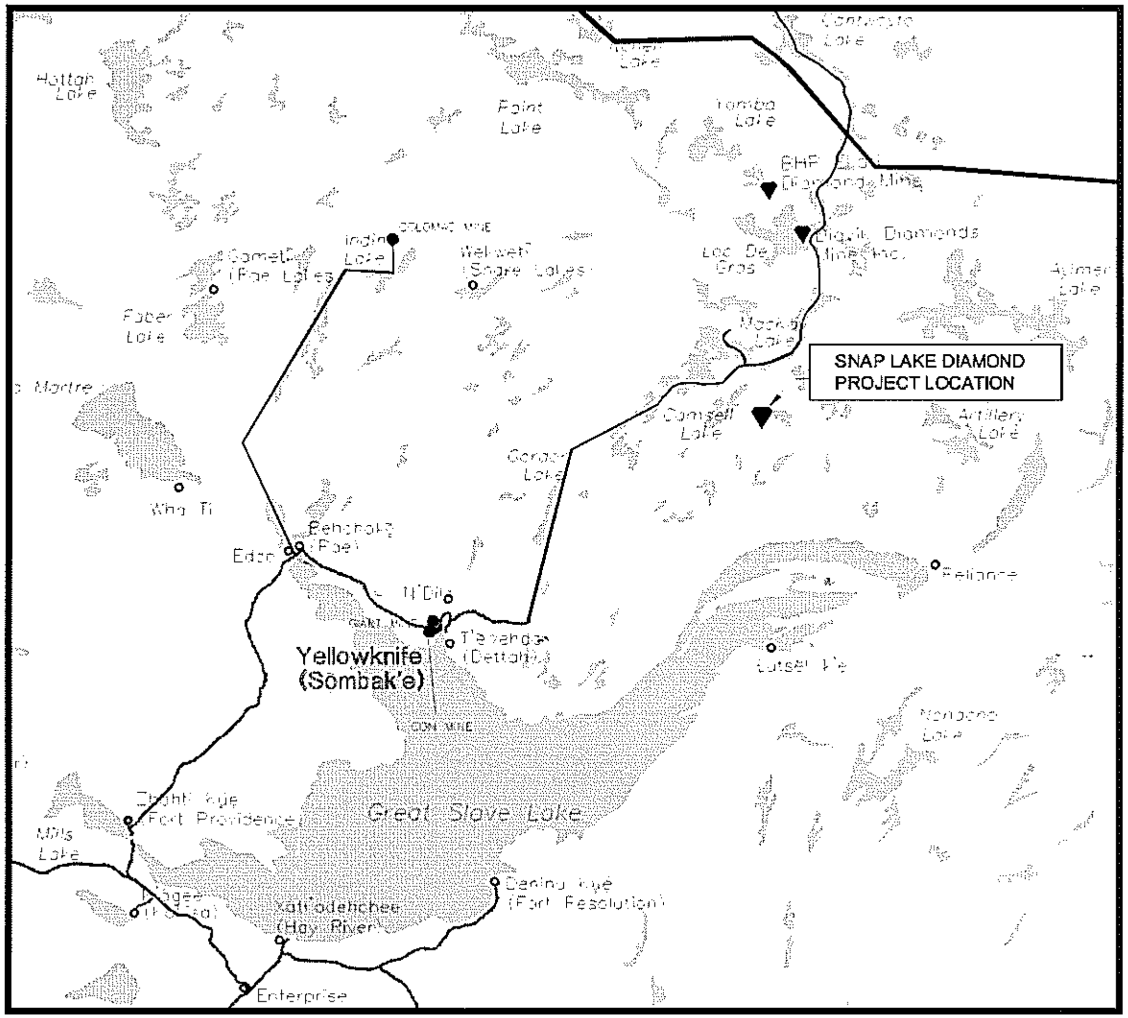
DE BEERS

Environmental Assessment Process



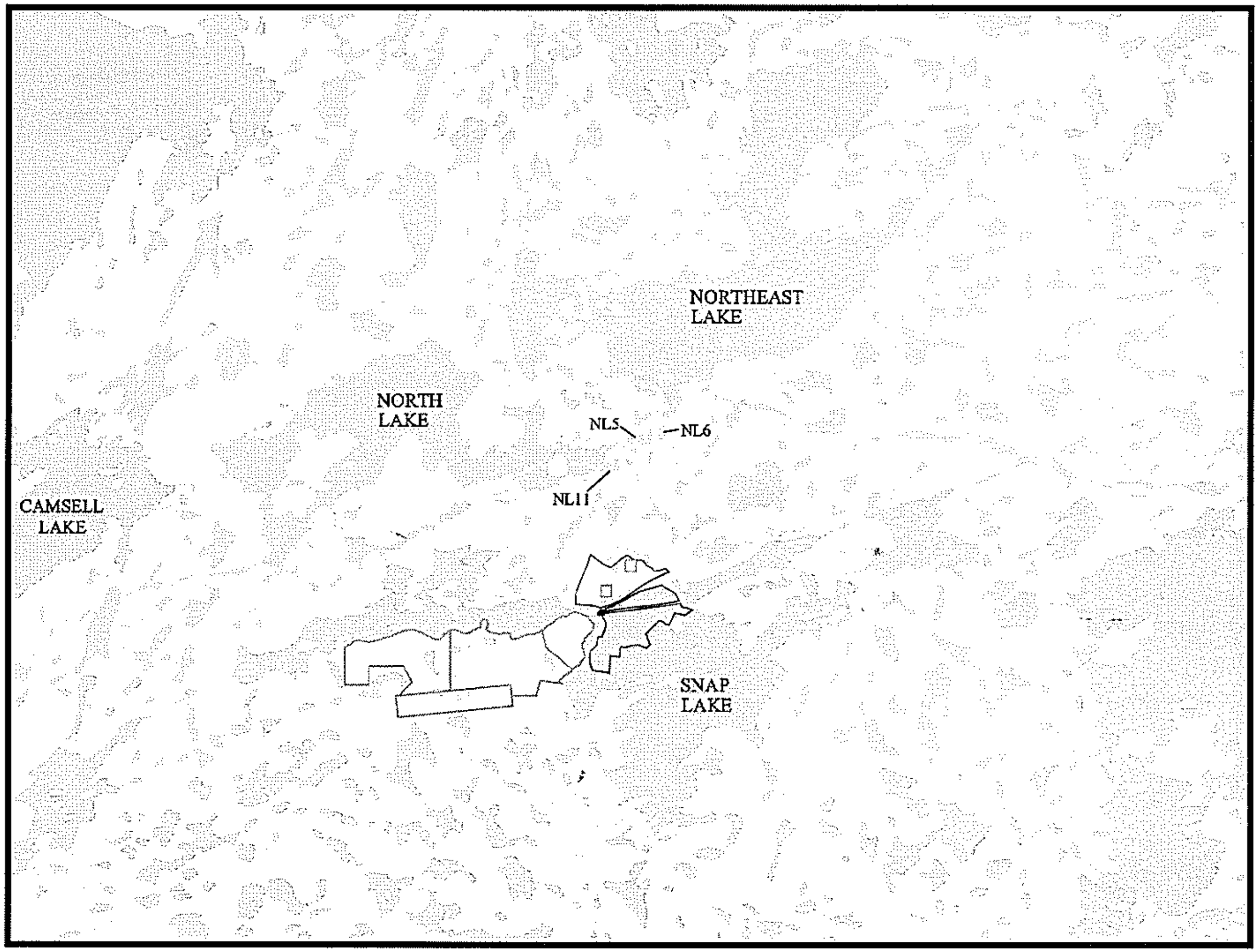
- Environmental Assessment Report (Feb 2002)
- De Beers Technical Sessions
  - **Three Water Quality Sessions**
  - **Comprehensive Technical Information Sessions**
  - **North Lakes Technical Session**
- Information Requests: Five Rounds (May - Nov 2002)
- Conformity Check Completion (Sep 2002)
- **MVEIRB Technical Sessions**
- Technical Report Submissions to the MVEIRB (Feb 2003)
- MVEIRB Public Hearings (March 24-28, 2003)
- MVEIRB Submission to Minister of INAC (June 2003)

Project Location



De Beers

Location of North Lake, Northeast Lake and Snap Lake



DE BEERS

Water Quality and Quantity Session

November 26, 2002:

Morning:

- Description of Water Flows
- Groundwater

Afternoon:

- Water Management System Overview
- Sewage and Water Treatment

DE BEERS

Water Quality and Quantity Session

November 27, 2002

- Snap Lake Water Quality Predictions
- Snap Lake Sediment Impacts
- North Lakes Groundwater and Surface Water Quality and Quantity

De Beers

Water Quantity and Quality

Groundwater

- Regional Groundwater Flow
- Groundwater Flow in Fractured Rock and Uncertainty Analysis
- Groundwater Inflow Chemistry
- Paste Backfill Geochemistry

Regional Groundwater Flow

- Purpose: to provide information on regional groundwater flow conditions during all phases of the project

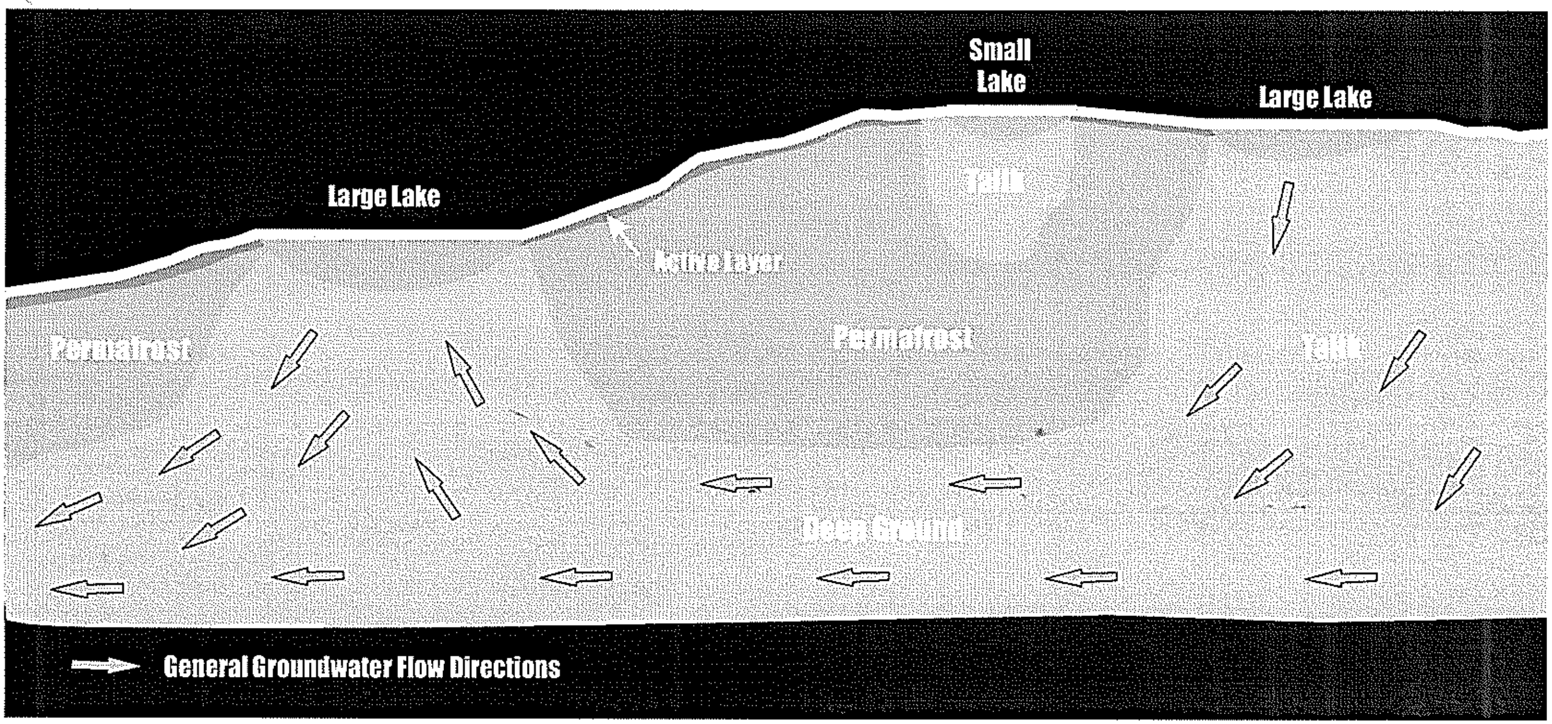
Topic Has Been Addressed:

- Environmental Assessment Report
  - Section 9.2.1
- Responses to Information Requests
  - IR 1.45
  - IR 1.38
  - IR 3.10.6

DE BEERS

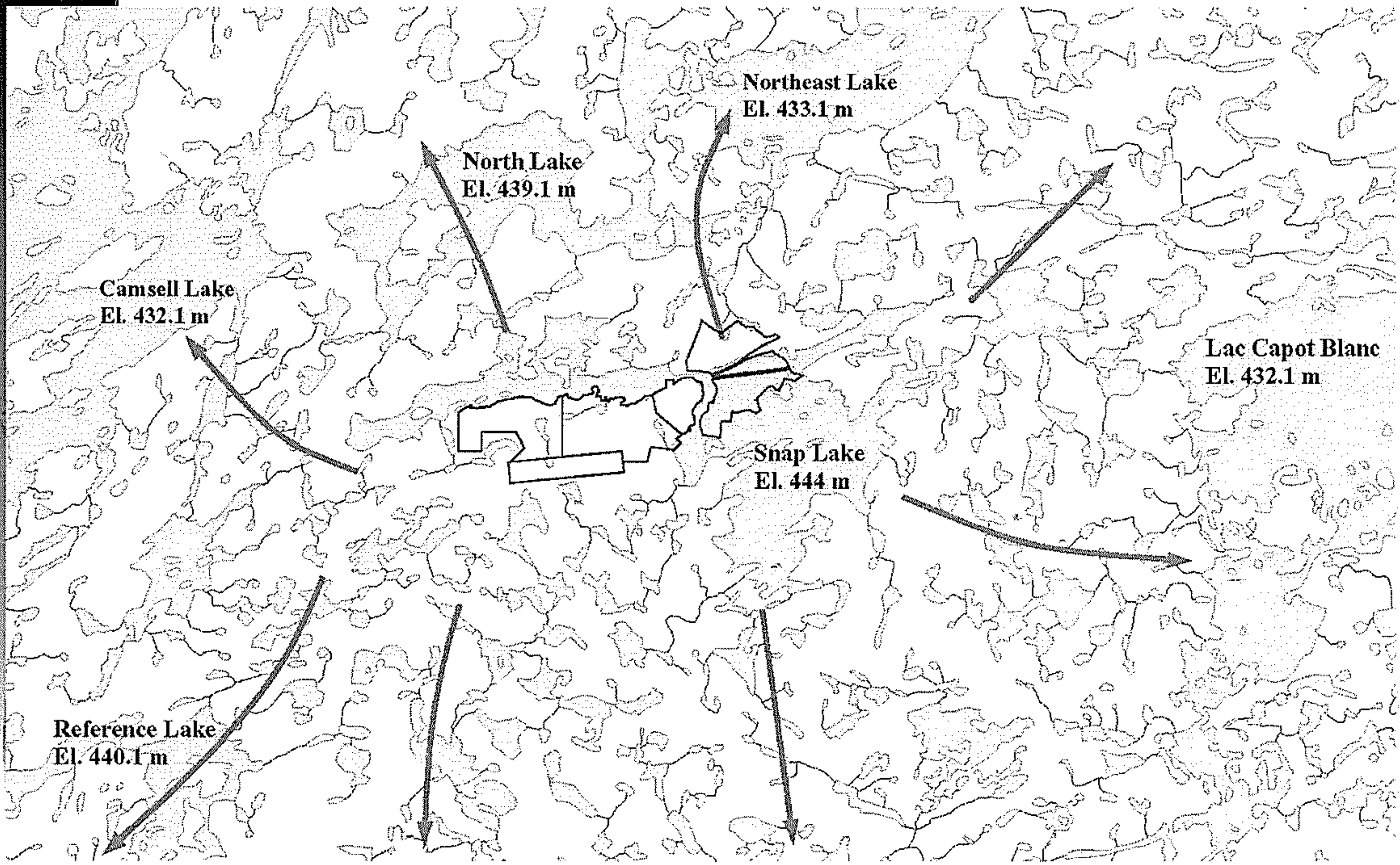
Groundwater Flow – Continuous Permafrost

Schematic diagram showing cross-section



DE BEERS

Conclusions

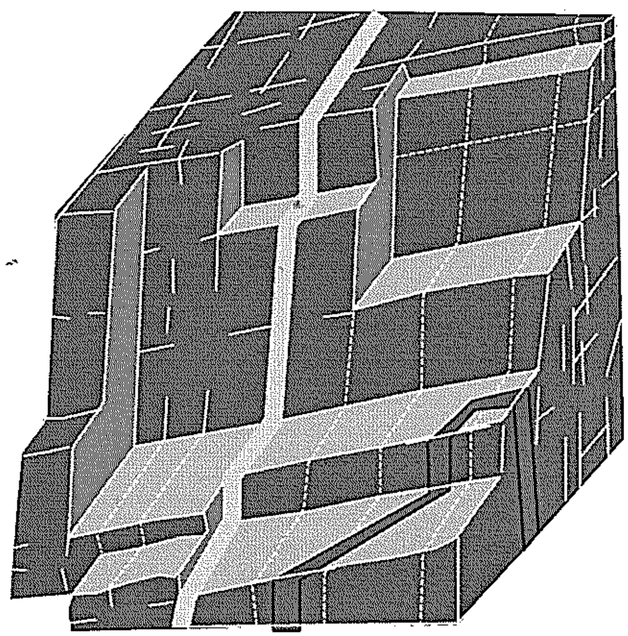


Groundwater Flow in Fractured Rock and Uncertainty Analysis

- Purpose: to clarify two specific questions related to the groundwater model

DE BEERS

Groundwater Characterisation and Flow in Fractured Rock



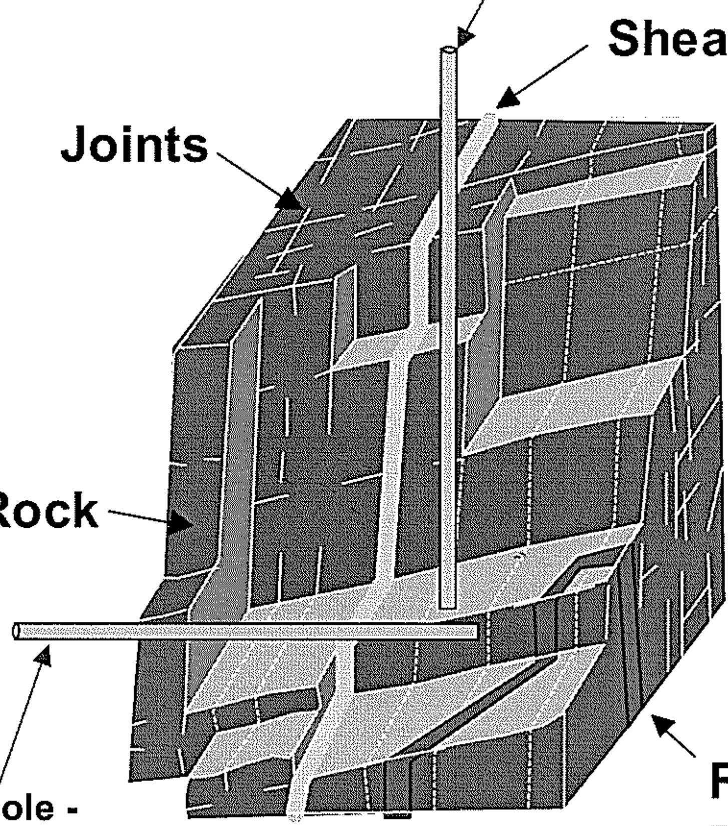
De Beers

Topic Has Been Addressed:

- Environmental Assessment Report
  - Section 9.2, especially 9.2.2.2.1
  - Appendix IX.2 (details of drilling program)
  - Appendix IX.3
- Responses to Information Requests
  - IR 2.3.8
  - IR 2.3.11 (a)
  - IR 3.10.7

DE BEERS

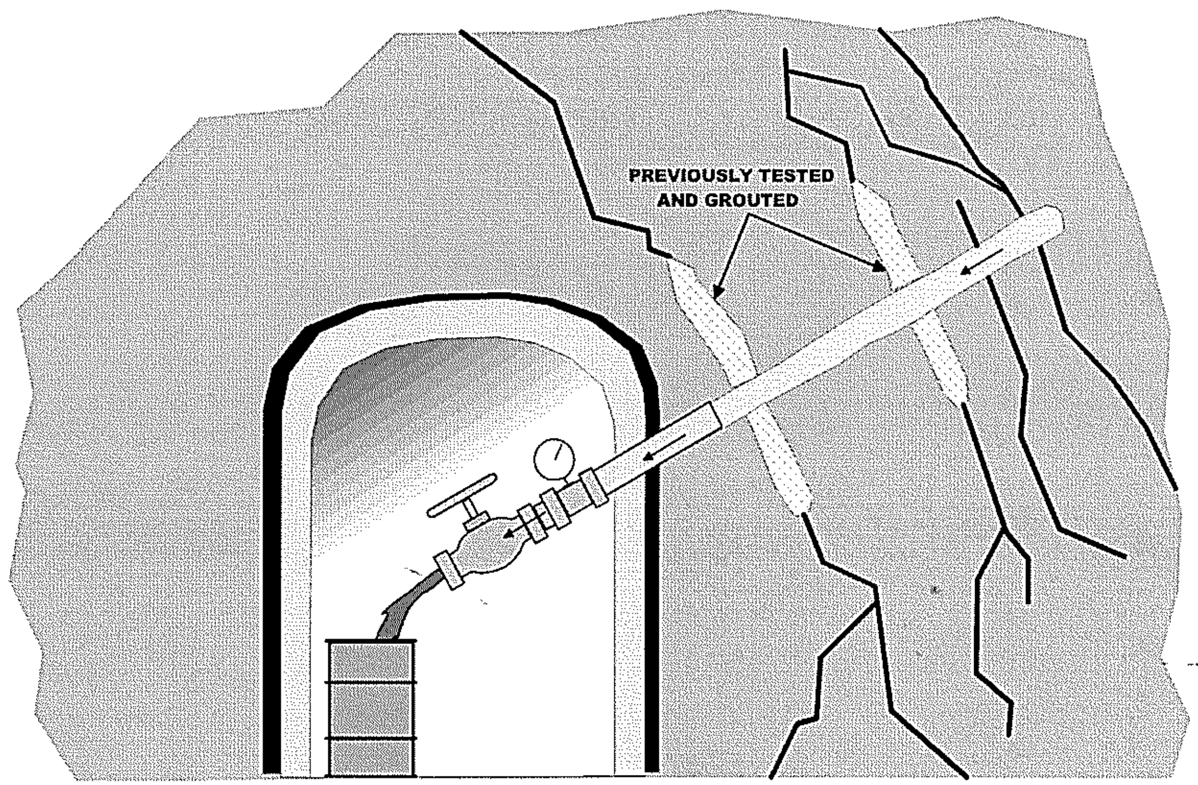
Flow in Fractured Rock



Hydraulic Conductivity (or Permeability) = Ability of a Material to Transmit Water

DE BEERS

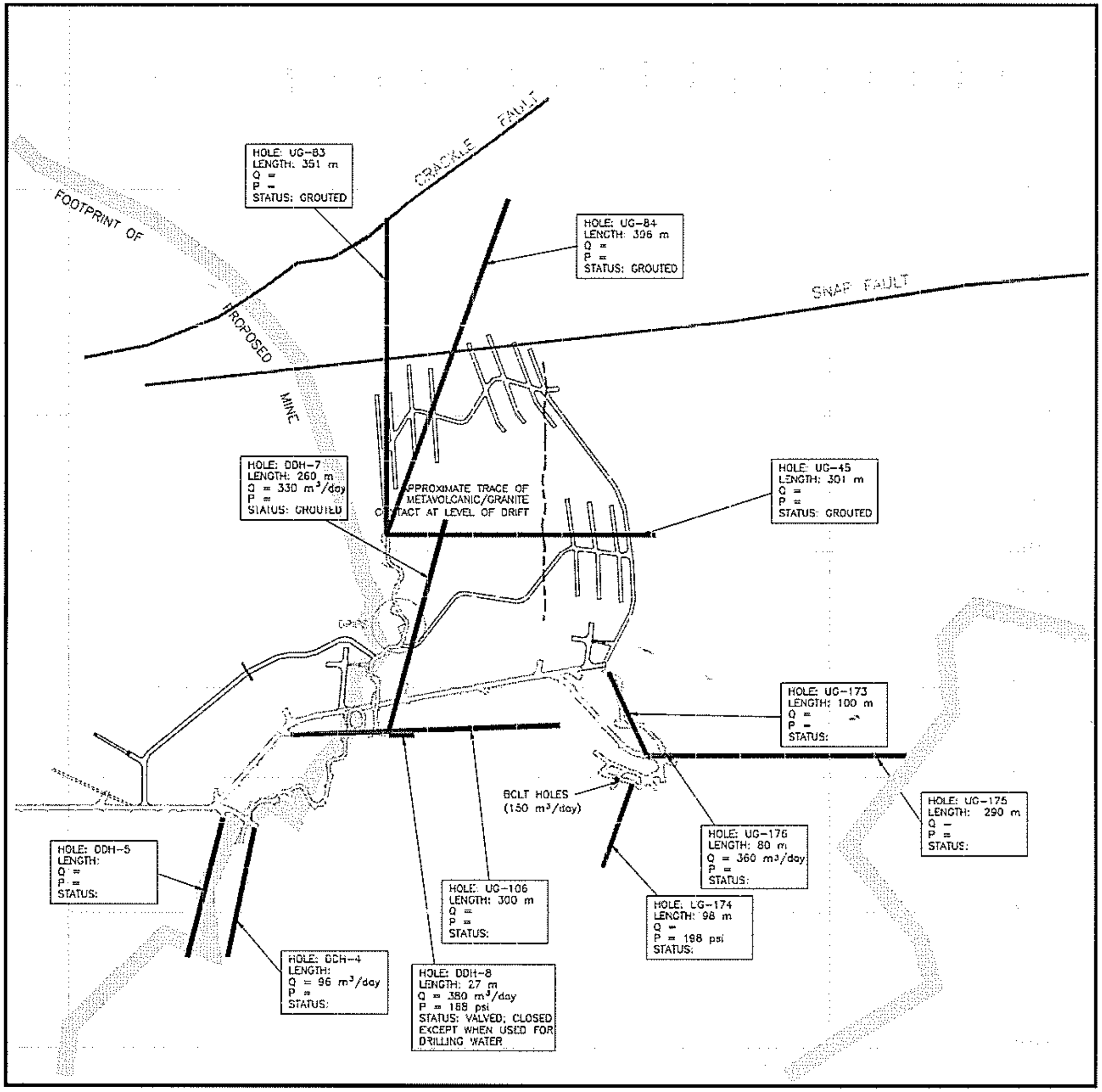
Specific Procedures for Drilling, Testing, and Grouting



$$K_{effective} = K_{fracture} + K_{rockmass} = \frac{\sum_{i=1}^{n} \frac{g(a_i)^2}{12\upsilon}(a_i) + \sum_{j=1}^{m} K_j b_j}{\sum_{j=1}^{m} b_j}$$

DE BEERS

Hydrogeologic Investigations of Snap Lake Area



EXPLANATION

BOREHOLE (SURFACE TRACE)

- COMPLETED DURING INITIAL EXPLORATION
- COMPLETED DURING 2001 AEP

DRIFT

- INITIAL EXPLORATION DRIFT
- 2001 AEP
- PRE-DEVELOPMENT, PHASE I

N

0 100 m
SCALE

2001 AEP TESTHOLES

BOREHOLE	AZIMUTH	DIP (DEGREES)	LENGTH (m)
UG-45	090	-5	301
UG-83	360	-2	351
UG-84	020	-2	396
UG-106	090	-4	300
UG-173	340	+4	100
UG-174	200	+6	98
UG-175	090	0	290
UG-176	090	+70	80
		TOTAL LENGTH (m)	1,916

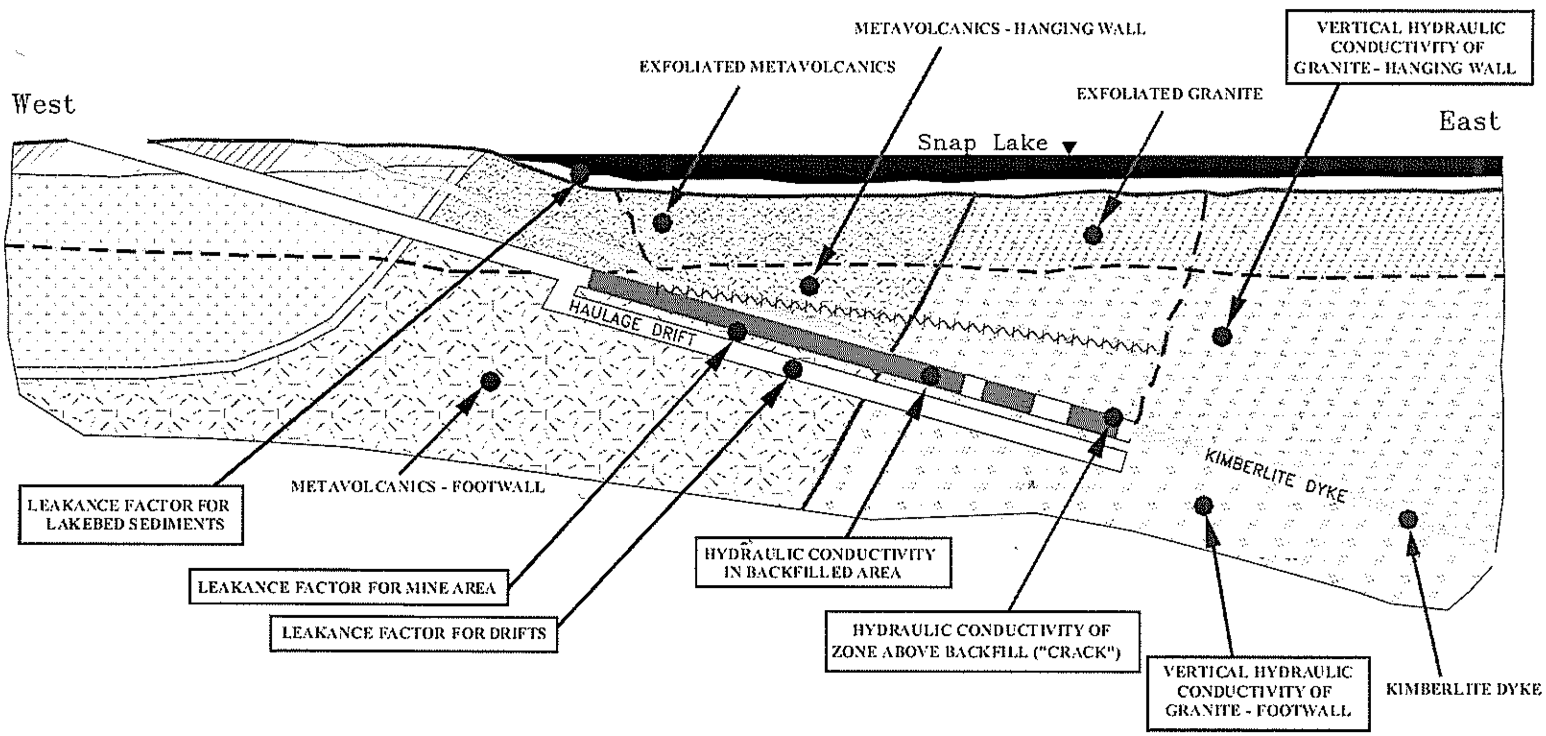
Uncertainty Analysis

Topic Has Been Addressed:

- Environmental Assessment Report
  - Section 9.2, especially 9.2.2.2.1
  - Appendix IX.3
- Responses to Information Requests
  - IR 2.3.11 (a)
  - IR 2.4.13
  - IR 3.10.7

De Beers

Hydraulic Parameters Utilised in Uncertainty Analysis



Example of Multi-Variant Analysis

C = A x B

A = 10 B = 10 so C = 100

Incorporating Uncertainty

		← Range →		
			Mean	
Inputs	A	1	10	100
	B	1	10	100
Results		≠1	= 100 Expected	≠ 10,000

Assumed
95% of values within this range

Uncertainty Analysis
Highly improbable that all factors would be at one of their extremes

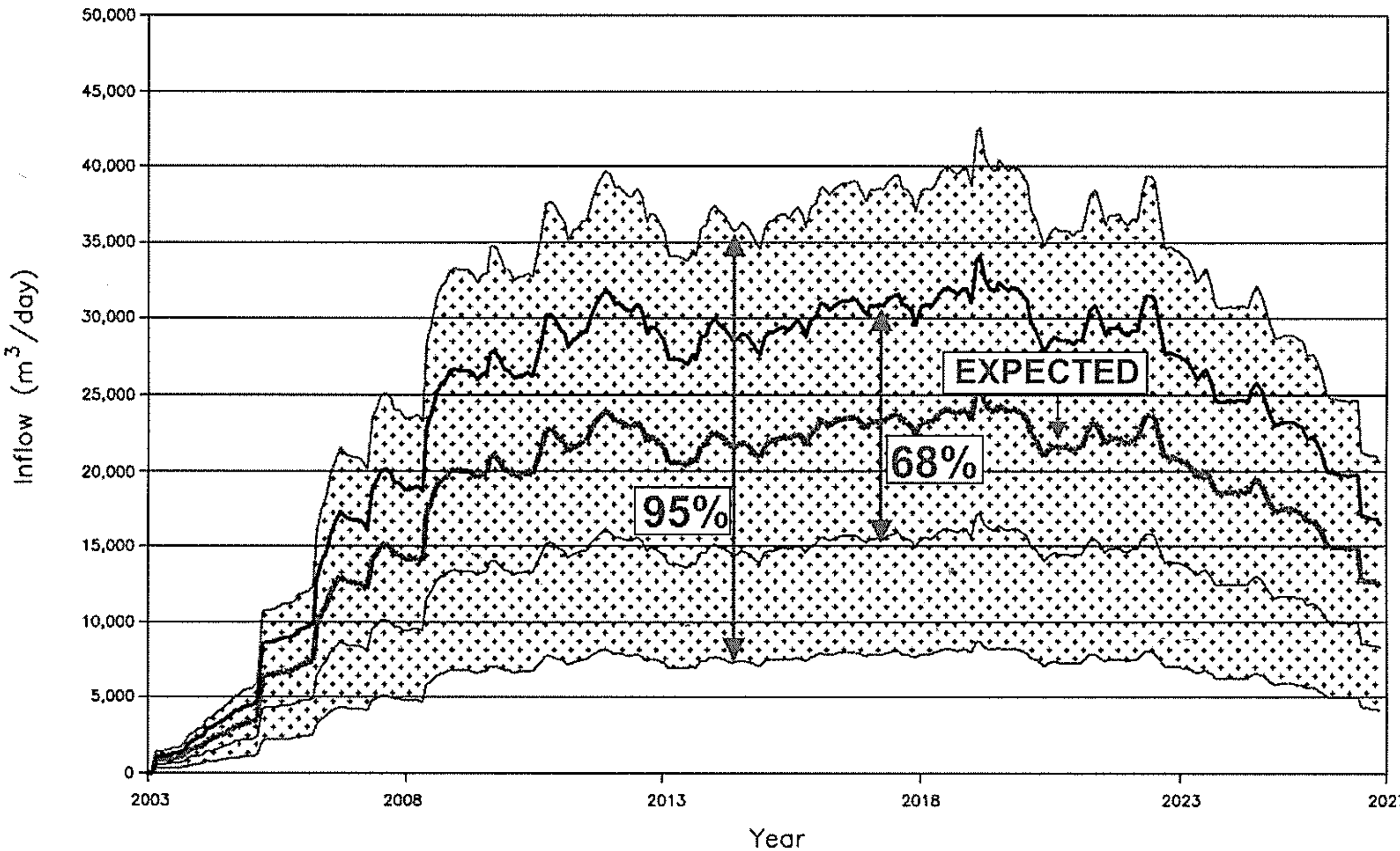
←→

This range is expressed in terms of uncertainty

68%, 95%

DE BEERS

Uncertainty Analysis

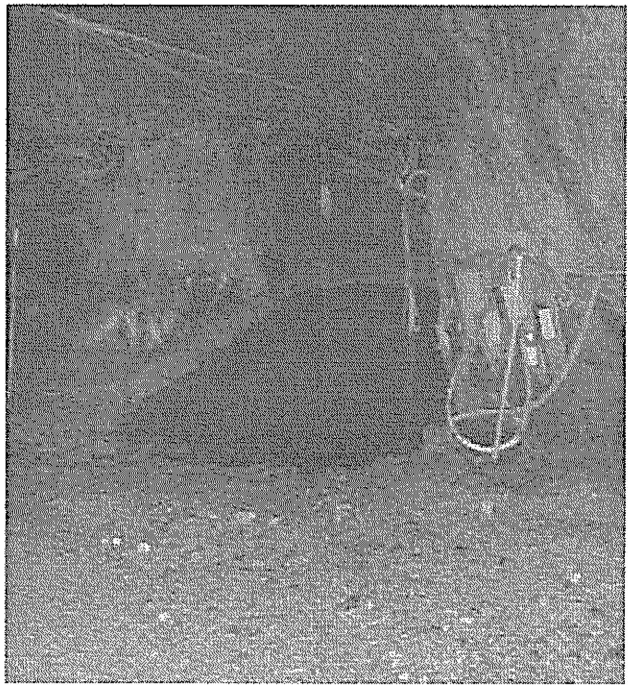


Conclusions

- Fractures have been incorporated into the calculation of the hydraulic conductivity both in terms of its magnitude and direction
- An appropriate uncertainty analysis has been conducted

DE BEERS

Groundwater Inflow Chemistry



Purpose: to provide background and rationale for the chemistry values used in the environmental assessment for groundwater inflow chemistry

DE BEERS

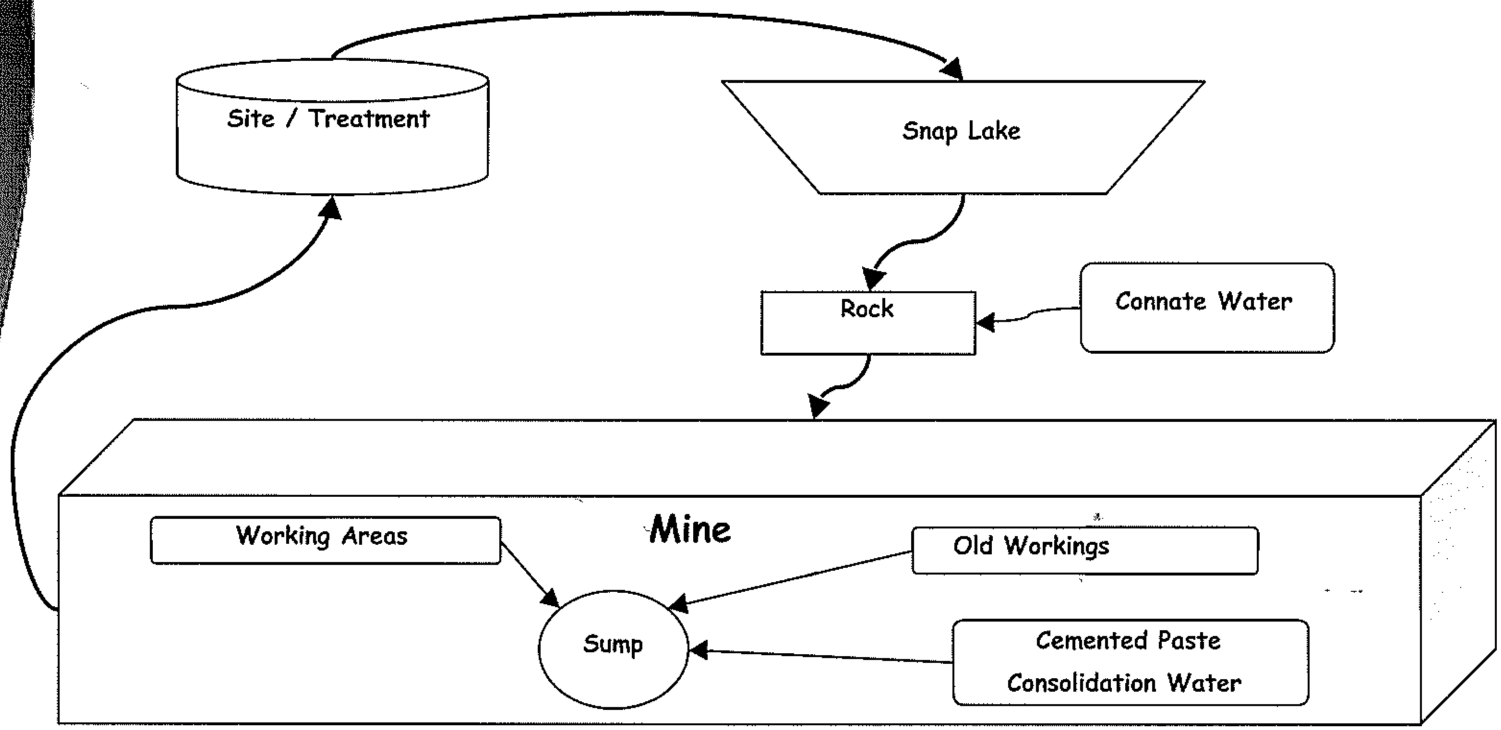
Topic Has Been Addressed

- Environmental Assessment Report
  - Sections 9.2.1; 9.2.2
  - Appendix IX.1
    - Section 5.3.1
  - Responses to Information Requests
    - IR 1.57; IR 2.4.15; IR 2.4.14(g); IR 3.10.9

- Relevant References Cited
  - Diavik (1999)
  - Fritz and Frape (1987)
  - Gascoyne (1997)

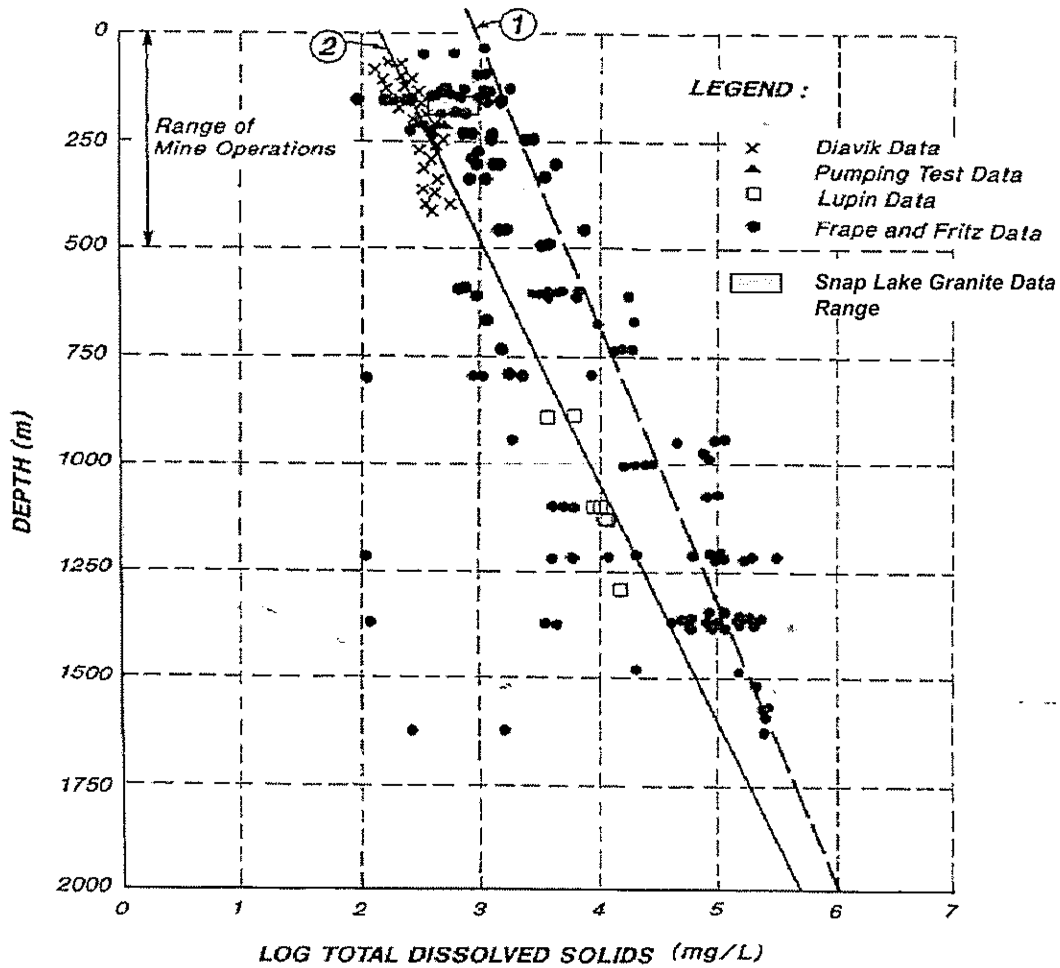
DE BEERS

Setting



DE BEERS

Log TDS vs. Depth (after Diavik 1999)

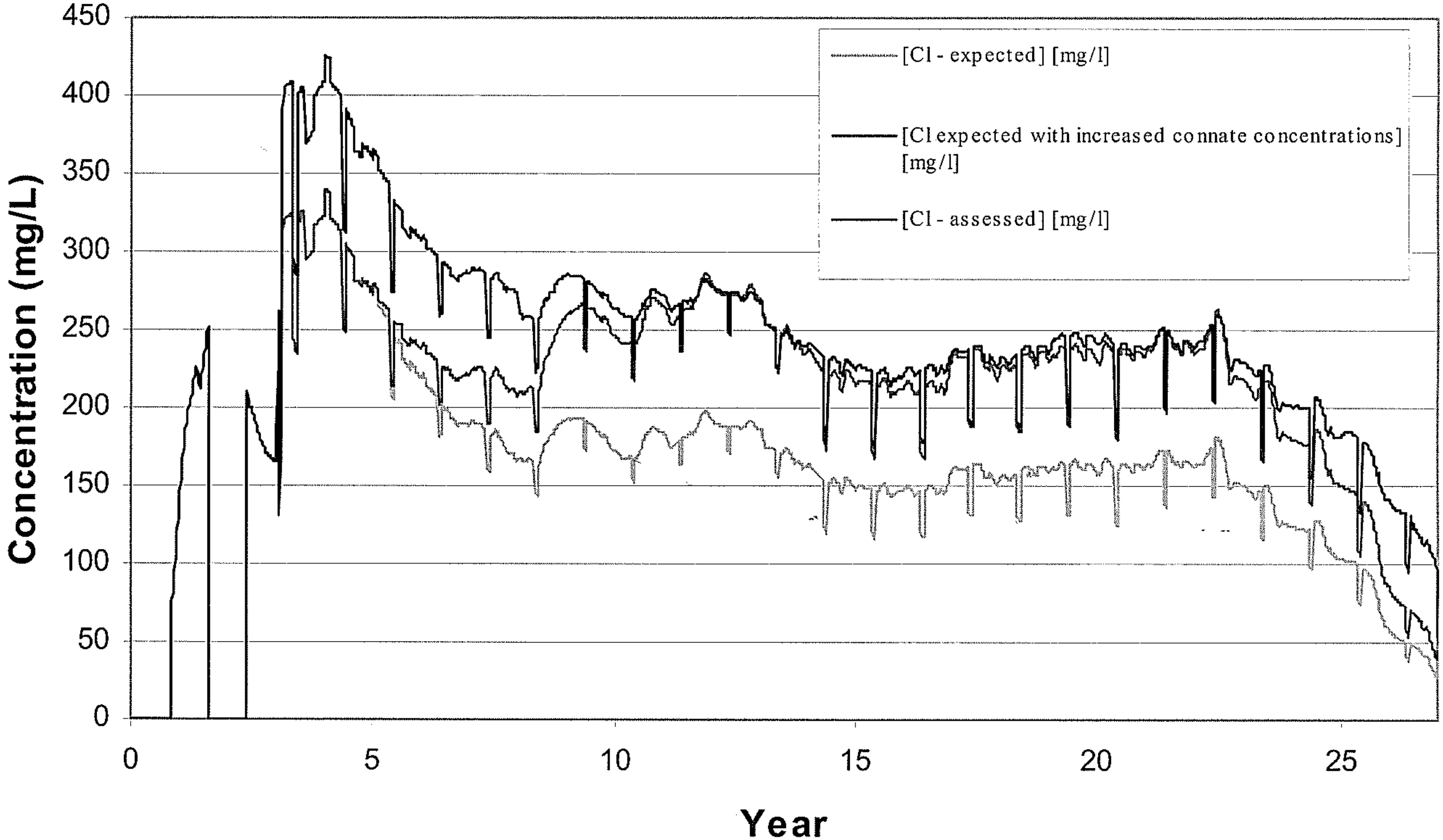


(1) Frape & Fritz Interpretation : Log (TDS) = $3.0 + 1.5 \times 10^{-3}$ (depth)
(Blowes & Logsdon Memo Sept.'97)

(2) Diavik/Lupin Data : Equation : Log (TDS) = $2.1 + 1.8 \times 10^{-3}$ (depth)

DE BEERS

Expected vs. Assessed Chloride Values



Conclusion

- Data used falls within range of observed data for Canadian Shield
- Data was adjusted for potential increase as a function of depth
- Data used in model is appropriate

Paste Backfill Geochemistry

- Purpose: to provide background and rationale for the chemistry values used in the environmental assessment for paste backfill geochemistry

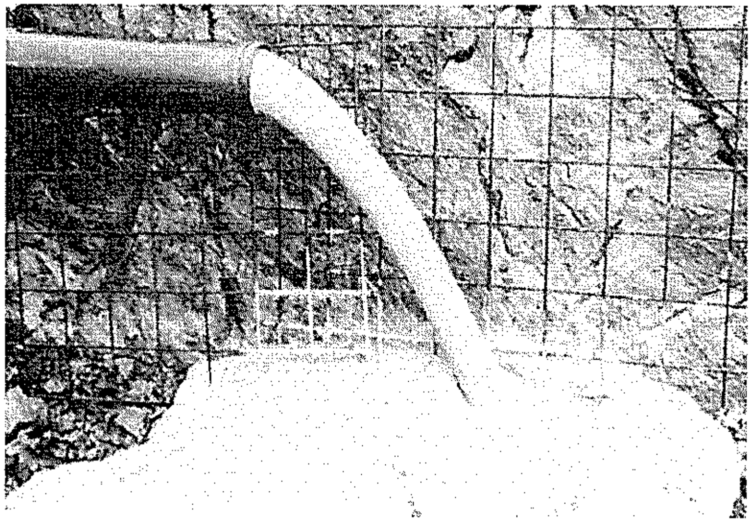
DE BEERS

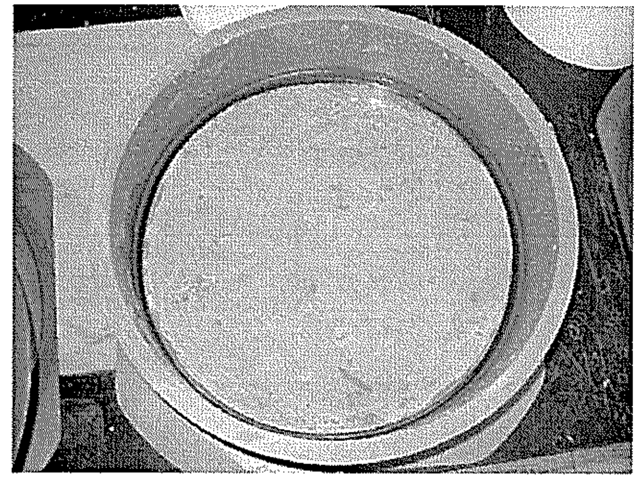
Topic Has Been Addressed

- Environmental Assessment Report
  - Appendix IX.1
    - Section 5.3.5, Section 5.4.
  - Appendix III.2
    - Section 7.1.1
- North Lakes Report
- Responses to Information Requests
    - IR 1.47
    - IR 2.4.16
    - IR 2.6.18
    - IR 3.5.12

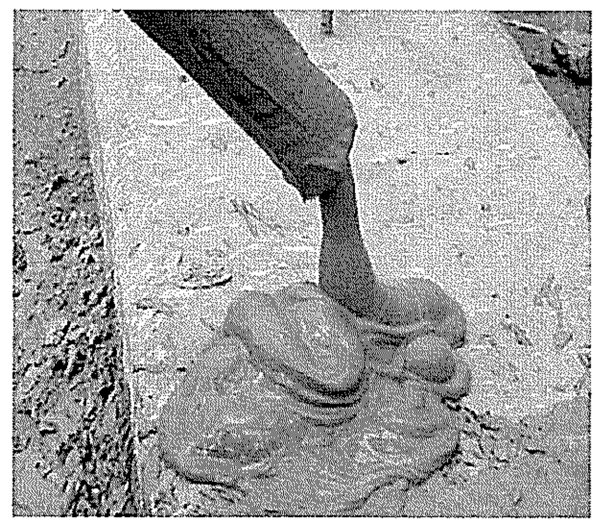
DE BEERS

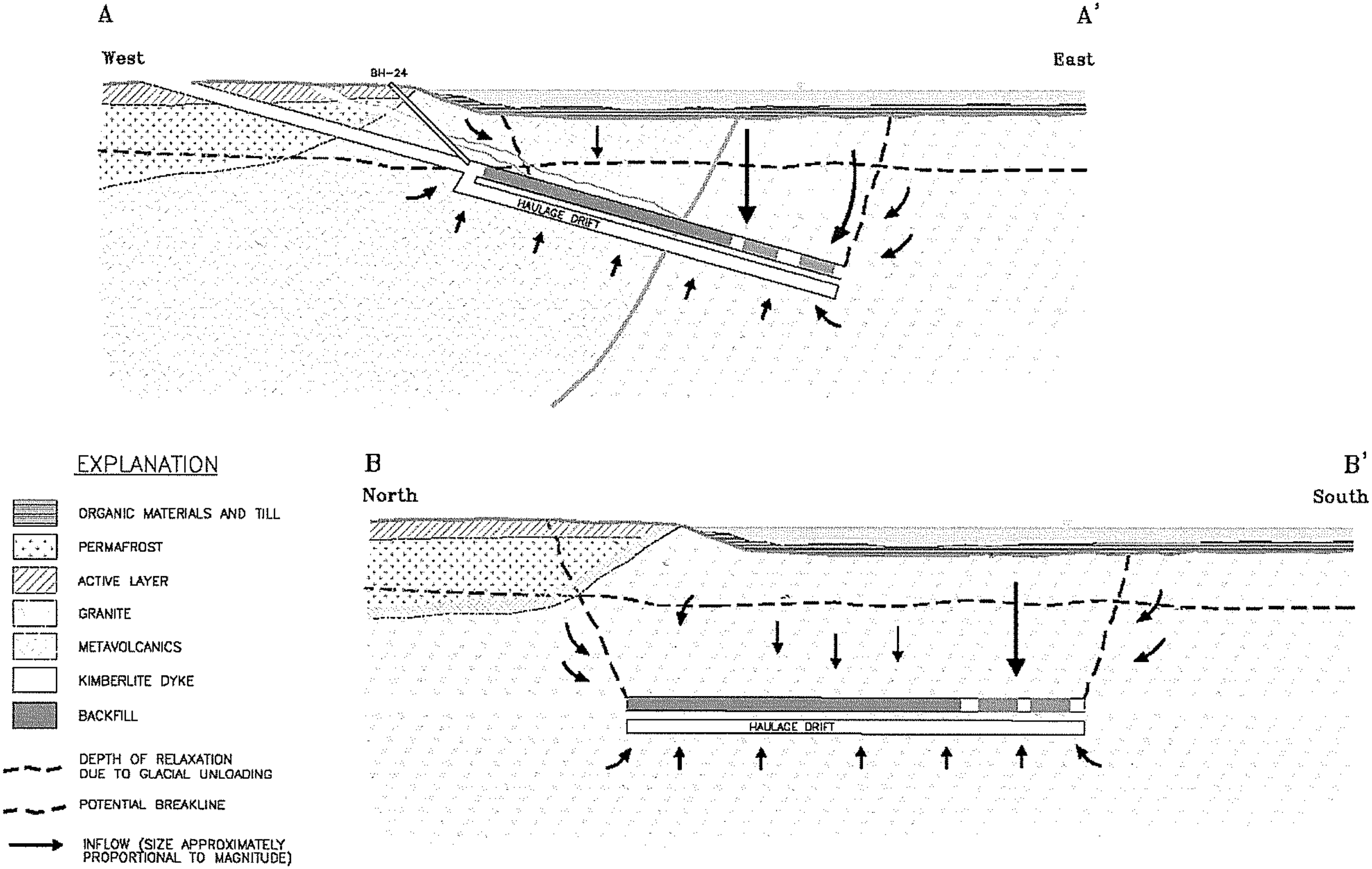
Paste Backfill Geochemistry





Application of Paste Backfill at Sudbury, Ontario

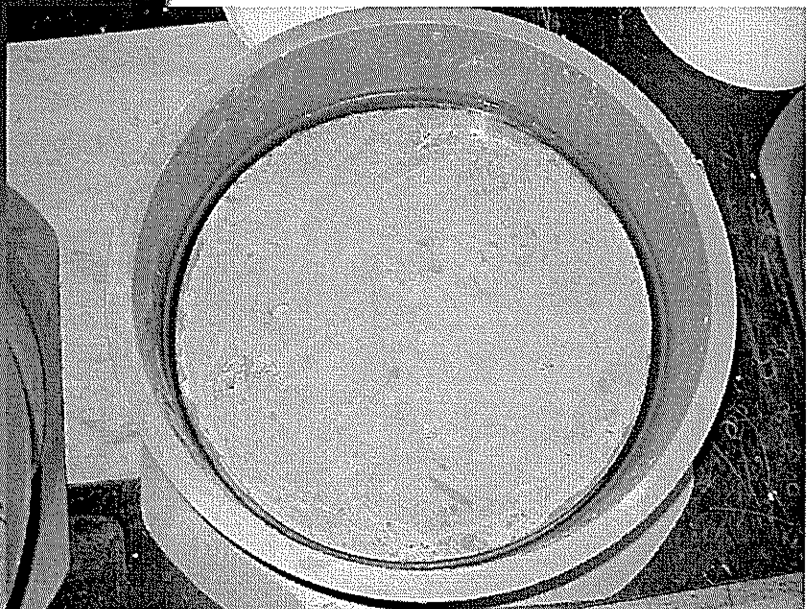


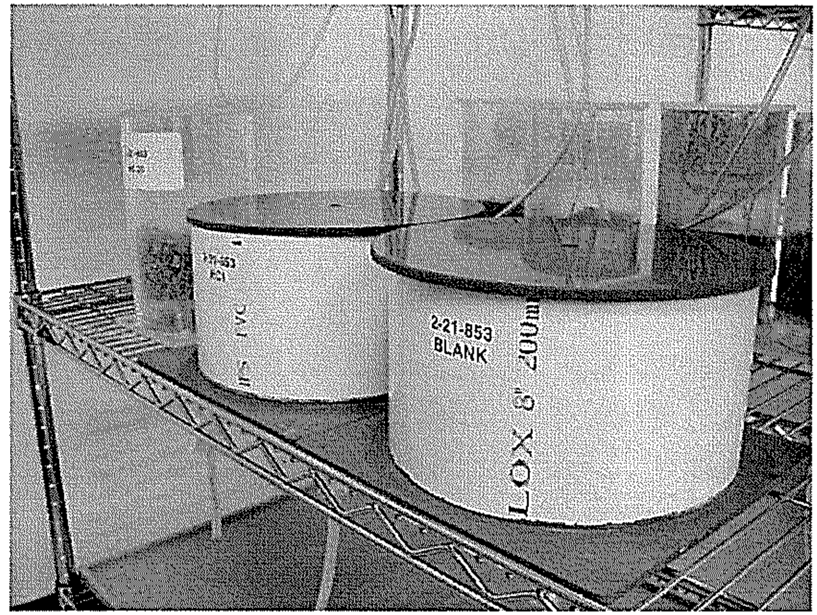


CROSS SECTIONS NOT TO SCALE

DE BEERS

Laboratory Testing of Cemented PK Paste





DE BEERS

Results of Laboratory Testing

	Cemented PK Backfill (EAR)	Cemented PK Backfill (Latest Kinetic Data)
pH	11.8	10.3
Al (mg/L)	0.47	0.48
Cr (ug/L)	313	38
Cu (ug/L)	6.1	2
Mo (ug/L)	81	40
NH_4 (mg/L)	6.6	2.2

Conclusion

- Data used in assessment is conservative
- All available results from kinetic testing confirm lower concentrations than those used in the Environmental Assessment Report

De Beers

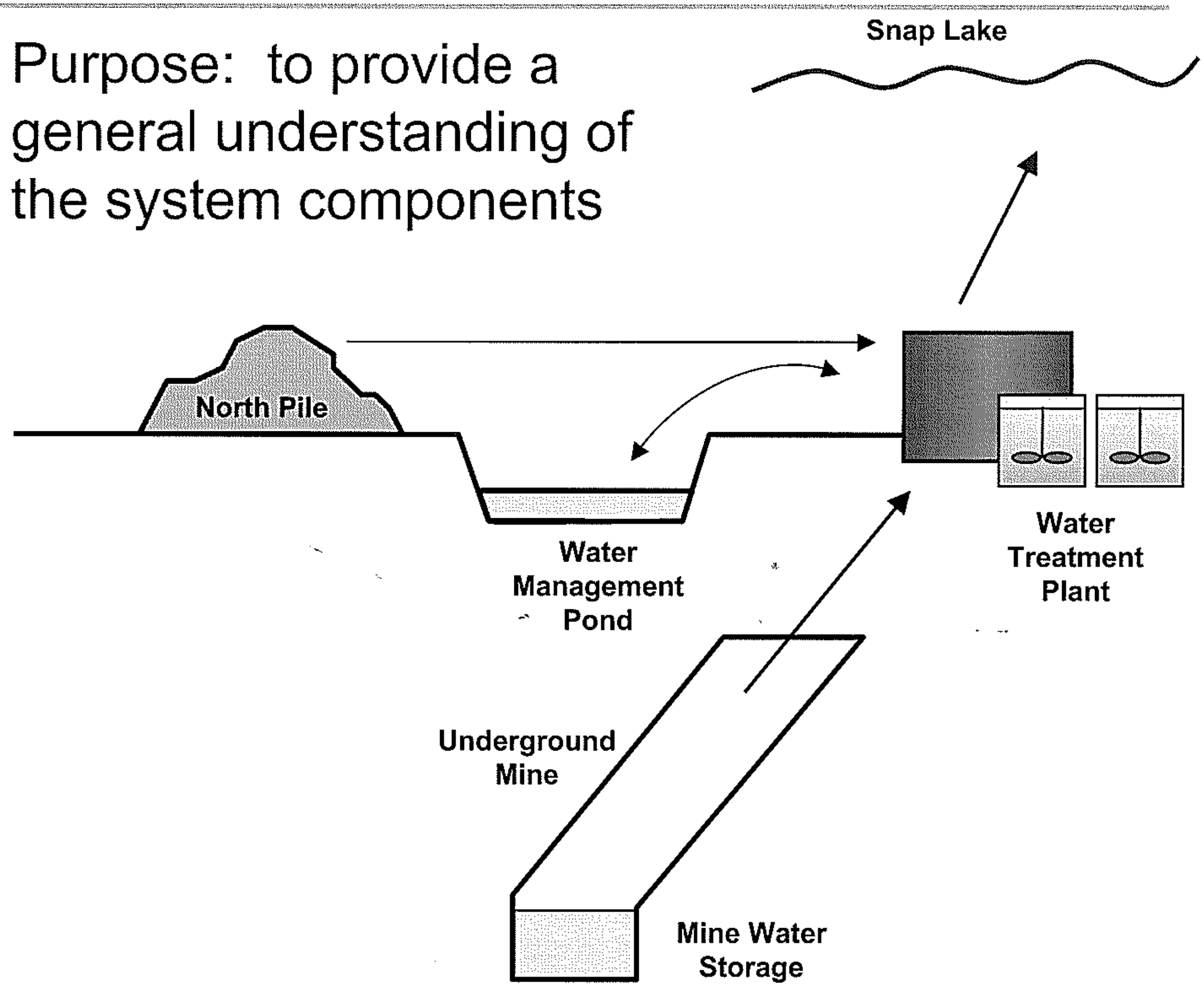
Water Management System

- Overview
- Water Management Scenarios

DE BEERS

Water Management System Overview

- Purpose: to provide a general understanding of the system components



DE BEERS

Topic Has Been Addressed:

- Environmental Assessment Report
  - Section 3.6
  - Appendix III.4
- Responses to Information Requests
  - IR 2.4.38

Water Management Basics

- Mine water is the predominant component
- Provide practical redundancy and overcapacity in pumping and treatment systems
- Provide short-term storage capacity as backup
- Monitor actual vs predicted flows, and recalculate predictions
- Mitigating mine management practices

Snap Lake Situation

- Geology
  - Impermeable, competent, country rock; water flow through steeply dipping fractures
- Operating Practices
  - Cover drill before development
  - Grouting equipment, materials and trained personnel on site
  - Emergency water storage areas and extra portable pumps
  - Monitoring structural integrity of hanging walls and pillars

DE BEERS

Snap Lake Situation (cont'd)

- Water Inflow Forecast
  - Gradual flow increase as mined area expands
  - Monitoring to improve forecast accuracy
  - Experience of other Canadian Shield mines operating below lakes
- Water Management Pond
  - 250,000 m^3
  - 10 days storage at predicted flows

Snap Lake Situation (cont'd)

- Water Treatment Facilities
  - Installed extra capacity
  - Increase capacity ahead of forecast requirements
  - Emergency power supply for water management system

DE BEERS

Different Water Management Scenarios

- Purpose: to explain how the water management system responds in different situations

Water Management Scenario #1

- Unexpected large mine inflow
  - Grout to reduce flow
  - Handle additional flow in treatment plant and pumping system overcapacity
  - Temporary water storage underground or in water management pond
  - Pump out temporary underground storage when flow returns to normal

Water Management Scenario #2

- Water treatment plant equipment breakdown
  - Isolate equipment for repair
  - Use remaining plant
  - Water management pond available for temporary storage
  - Underground temporary water storage available
  - Re-start repaired equipment, and draw down temporary storage units

DE BEERS

Water Management Scenario #3

- Extremely large, uncontrollable mine water inflow
  - Considered to be highly unlikely
  - Controlled flooding of the mine to contain all water
  - Considering bulkhead designs (e.g., water-tight doors) to isolate mine sections
  - Review, repair and re-open if possible

DE BEERS

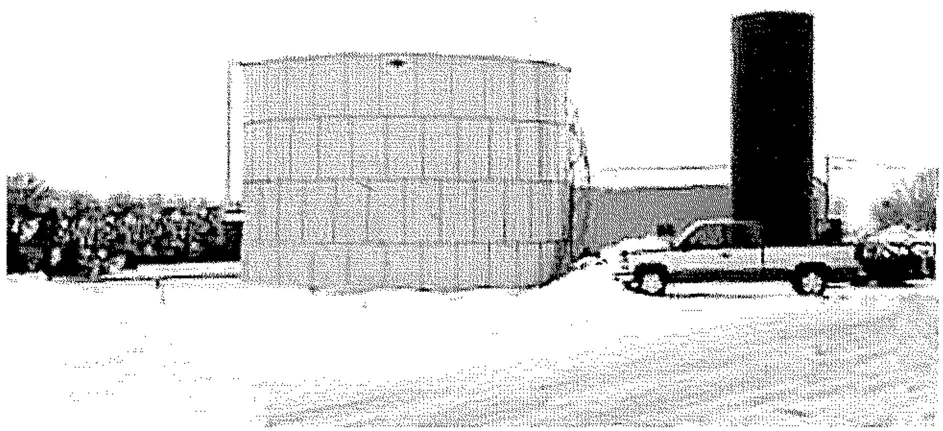
Sewage and Water Treatment

- Sewage Treatment Plant
  - Description of system
  - Phosphorus removal
- Water Treatment System
  - Description of system
  - Plant capacity
  - TSS removal

DE BEERS

Sewage Treatment Plant (STP)

- Purpose: to describe the sewage treatment plant and its ability to reduce effluent phosphorus to 0.2 mg/L



Single Tank SBR High Rate Plant

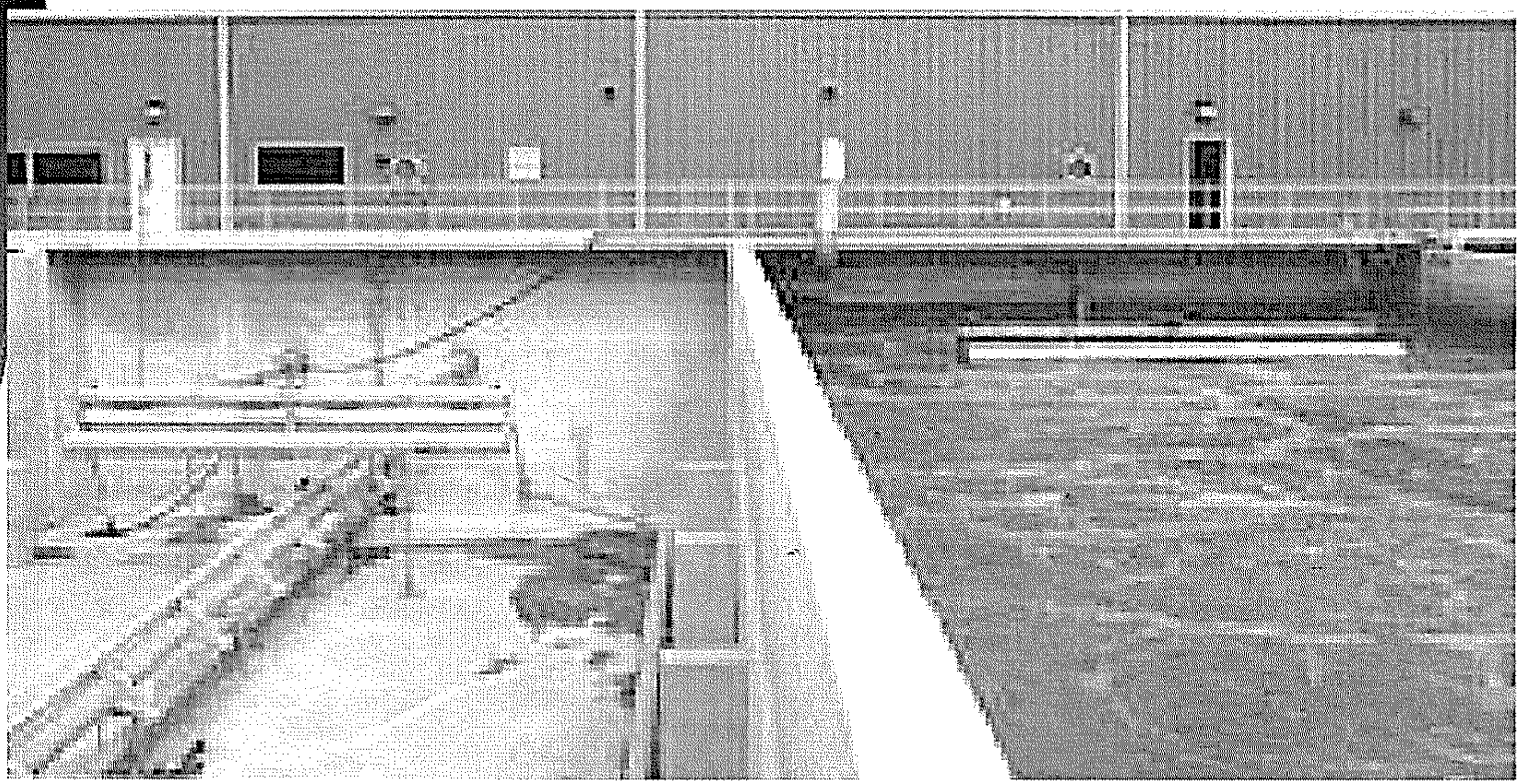
Ref www.aquatecinc.com

Topic Has Been Addressed:

- Environmental Assessment Report
  - Section 3.6.9
  - Appendix III.4
- Responses to Information Requests
  - IR 1.60
  - IR 2.1.4
  - IR 2.2.1
  - IR 3.3.6

DE BEERS

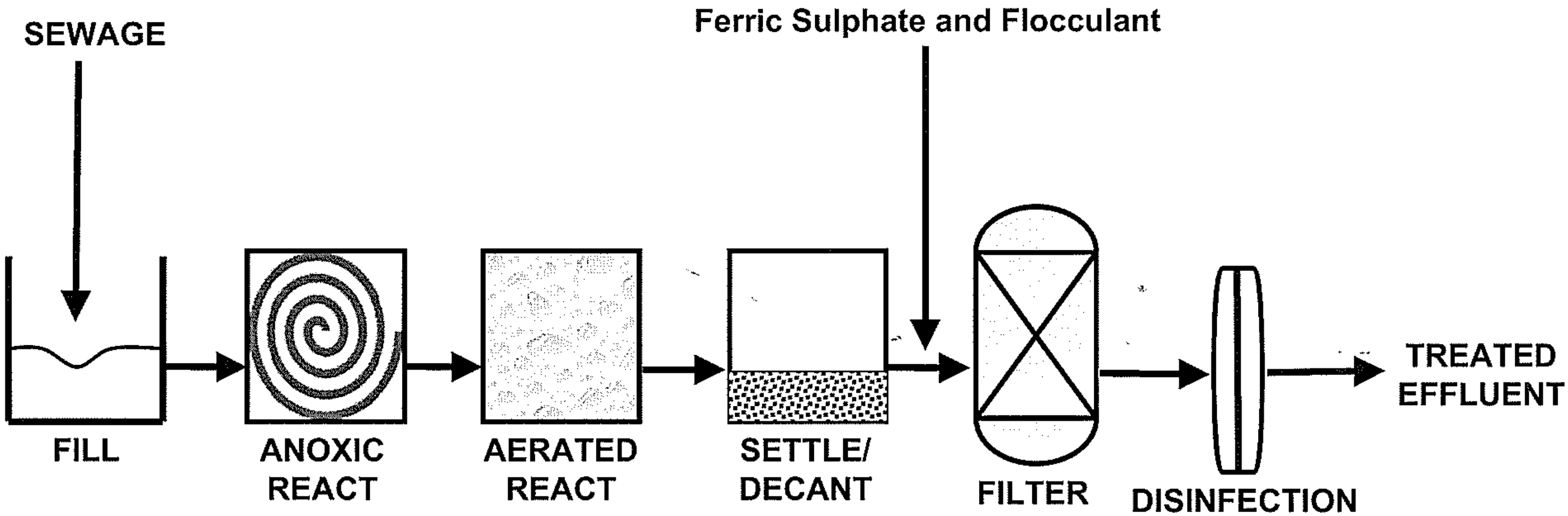
Sequencing Batch Reactor (SBR)



Ref www.sequencertech.com

De Beers

SBR Process



Batch Treatment

Phosphorus in STP Effluent

- Can the sewage treatment plant meet the phosphorus target of 0.2 mg/L?

Phosphorus in STP Effluent

- SBR is a proven advanced treatment system
- Phosphorus loading limited by use of non-phosphate detergents
- Phosphorus removal occurs in two steps:
  - **biological** in the SBR system
  - **chemical precipitation** as part of filtration.
- Conservative filtration design

DE BEERS

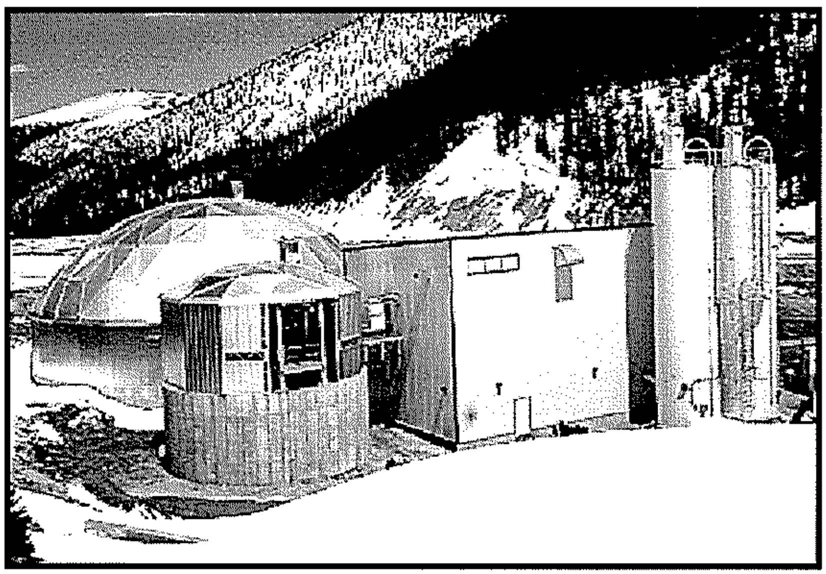
Conclusion

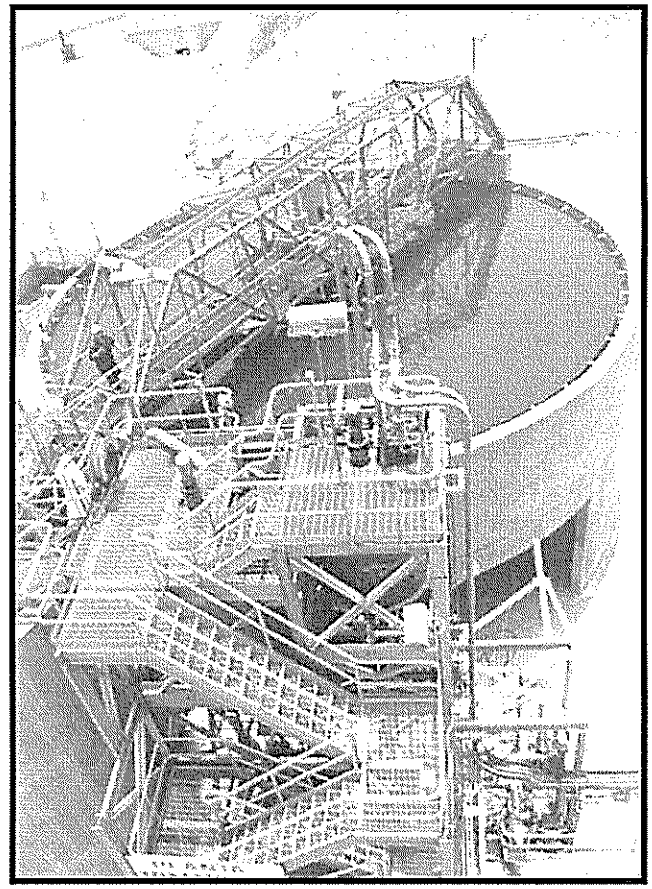
- Proposed treatment system is capable of meeting phosphorus target

DE BEERS

Water Treatment Plant (WTP) Capacity

Purpose: to discuss questions regarding WTP capacity





De Beers

Water Treatment Plant Capacity

1. Capacity for high inflows?
2. Capacity during mine shut-down?
3. Capacity needed for mechanical or process failures?

Topic Has Been Addressed:

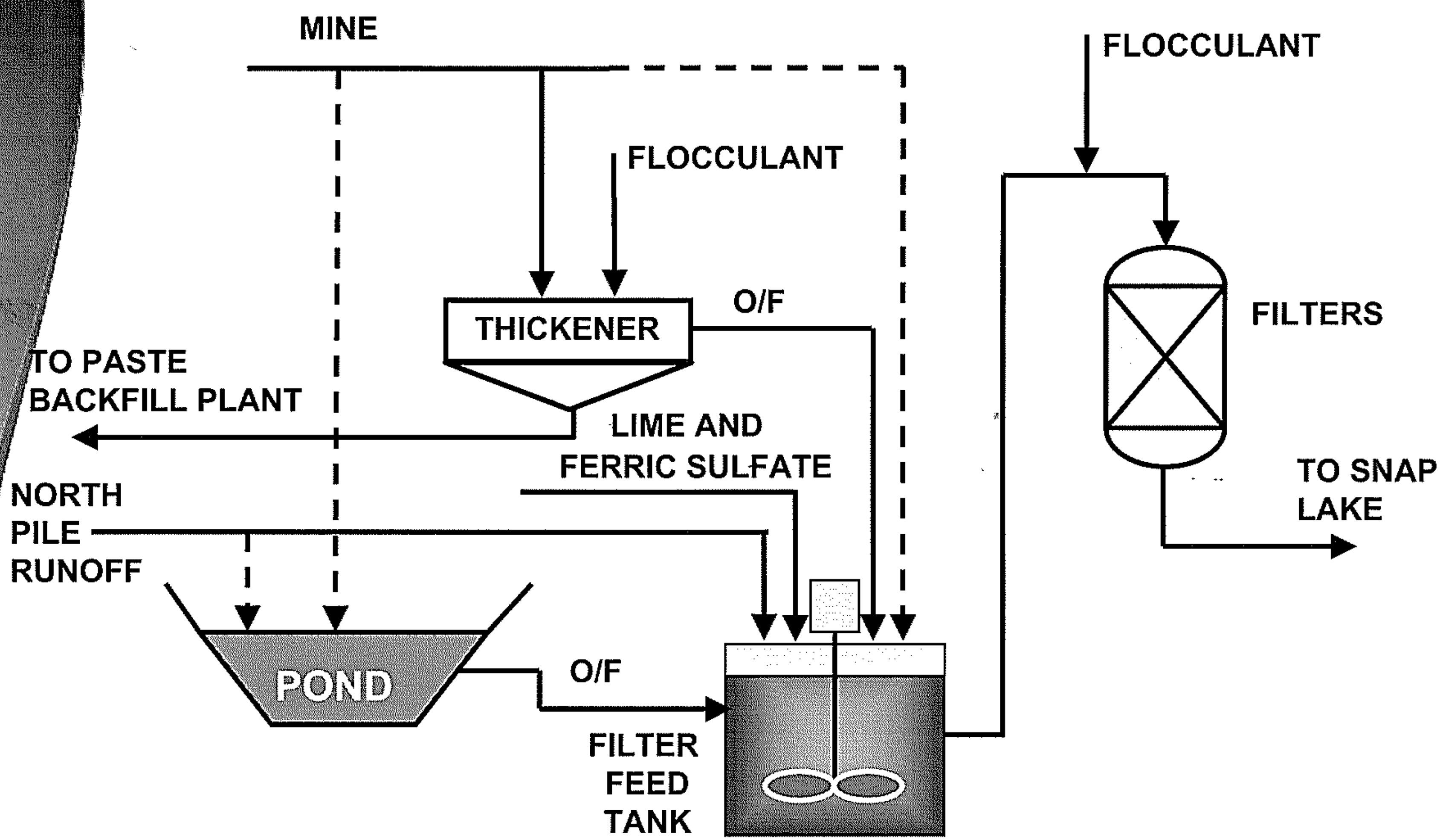
- Environmental Assessment Report
  - Section 3.6
- Responses to Information Requests
  - IR 4.8.9
  - IR 2.4.38

DE BEERS

Factors Related to Capacity

- Design accommodates high inflows because capacity installed in advance of requirement
- No additional capacity required for mine shutdowns
- Water management pond provides storage to allow plant shut-down for repair or maintenance

Water Treatment Process



Factors Related to Capacity

- Capacity of 20,000 m^3/d installed in Year 1
- Year 1 projected flow - 7000 m^3/d
- Mine provides 90% of water to WTP
- Flow increases with mine development
- Future flowrates estimated
- Estimates re-checked during Year 1 to evaluate future years

Factors Related to Capacity

- Reagents maximize performance
- Mechanical facility – not complicated process
- Key mechanical equipment twinned
- Monitoring and process control systems
- Storage in WMP provides flexibility

De Beers

Conclusion

- Current water balance indicates Year 1 WTP sufficient for 6 years
- Monitoring in early years will provide time to design and add capacity
- WMP storage allows for water treatment plant shut-down

DE BEERS

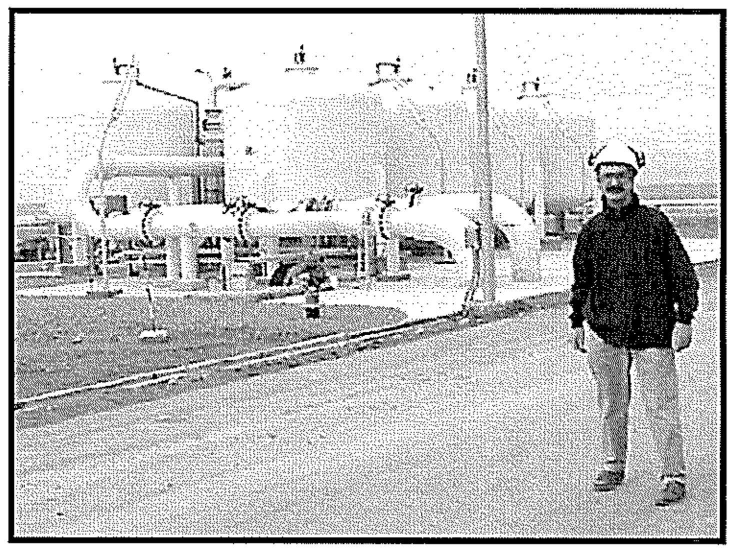
Total Suspended Solids (TSS) in Water Treatment Plant Effluent

Can the WTP meet the 5 mg/L TSS target?

Purpose: to describe the performance of the WTP

Factors Related to TSS Reduction

- Two removal steps
  - thickener
  - filters
- Filtration design conservatively sized using rates for drinking water treatment plants
- Reagents assist performance for TSS removal



Factors Related to TSS Reduction

- Final effluent monitored continuously for turbidity - ensures that TSS targets met
- Controls divert treated water back to water management pond if targets exceeded
- Flexible design and storage allows process issues to be solved prior to discharge

Conclusion

- Technology and controls are designed for compliance with 5 mg/L TSS target