

## North Pile Development

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Purpose:

– to describe:

- ◆ Pile stability
- ◆ Operation scenarios
- ◆ Processed kimberlite (PK) material properties

## Topic Has Been Addressed:

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- ◆ Environmental Assessment Report
  - Section 10.2
  - Appendix III.1
  
- ◆ Response to Information Requests
  - IRs 2.2.3, 2.4.20, 2.4.22, 2.4.24, 2.4.27, 2.4.28, 2.4.30, 2.4.35, 2.4.36
  - IRs 3.4.15, 3.4.16, 3.4.18, 3.4.19, 3.4.20, 3.4.21, 3.8.2, 3.9.2, 3.10.1, 3.10.2, 3.10.3, 3.10.4, 3.10.5, 4.1.3, 4.1.6

DE BEERS

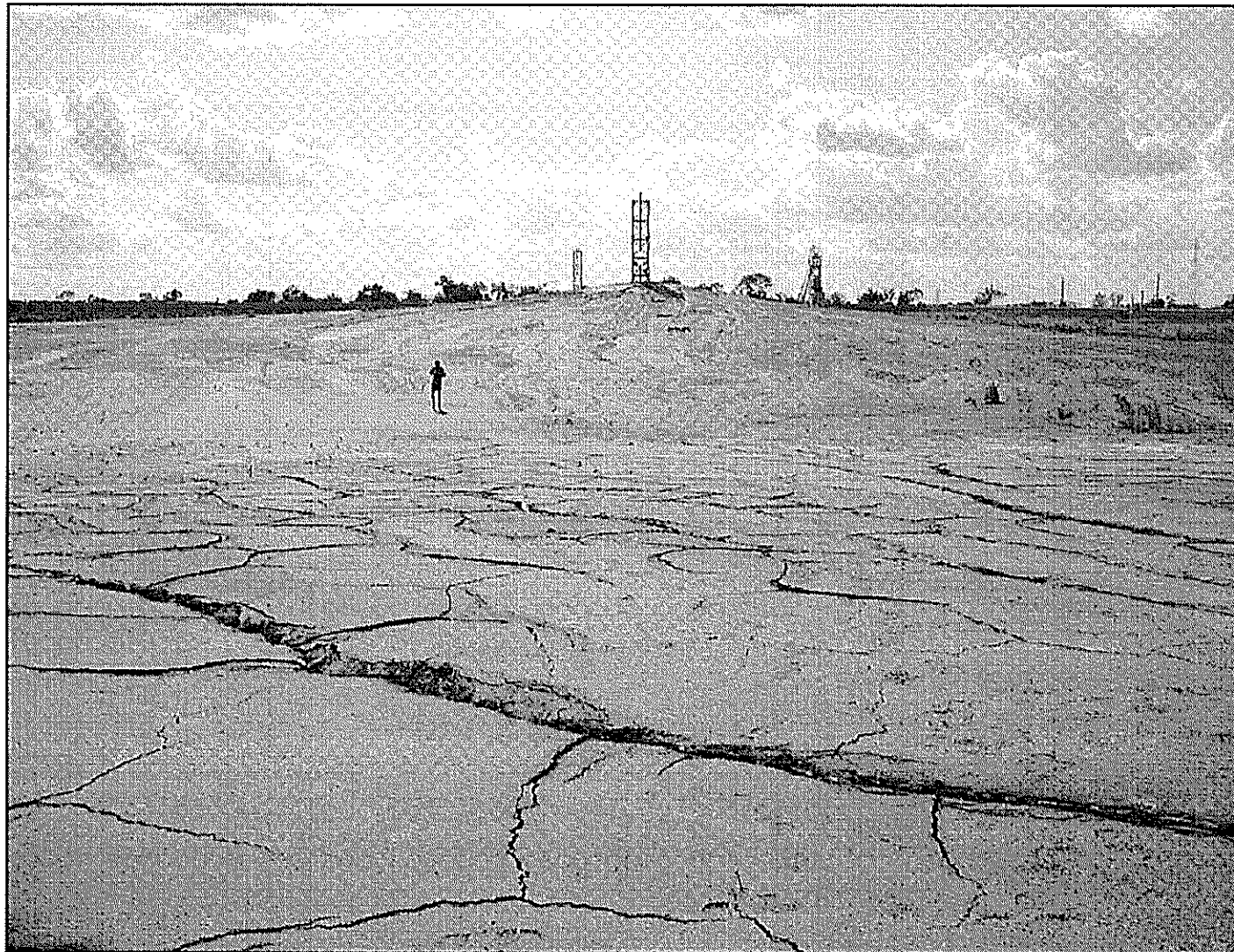
# Conventional Tailings Impoundment with Large Water Pond



**Example from  
Elliot Lake,  
Ontario**

DE BEERS

# Paste Tailings Pile



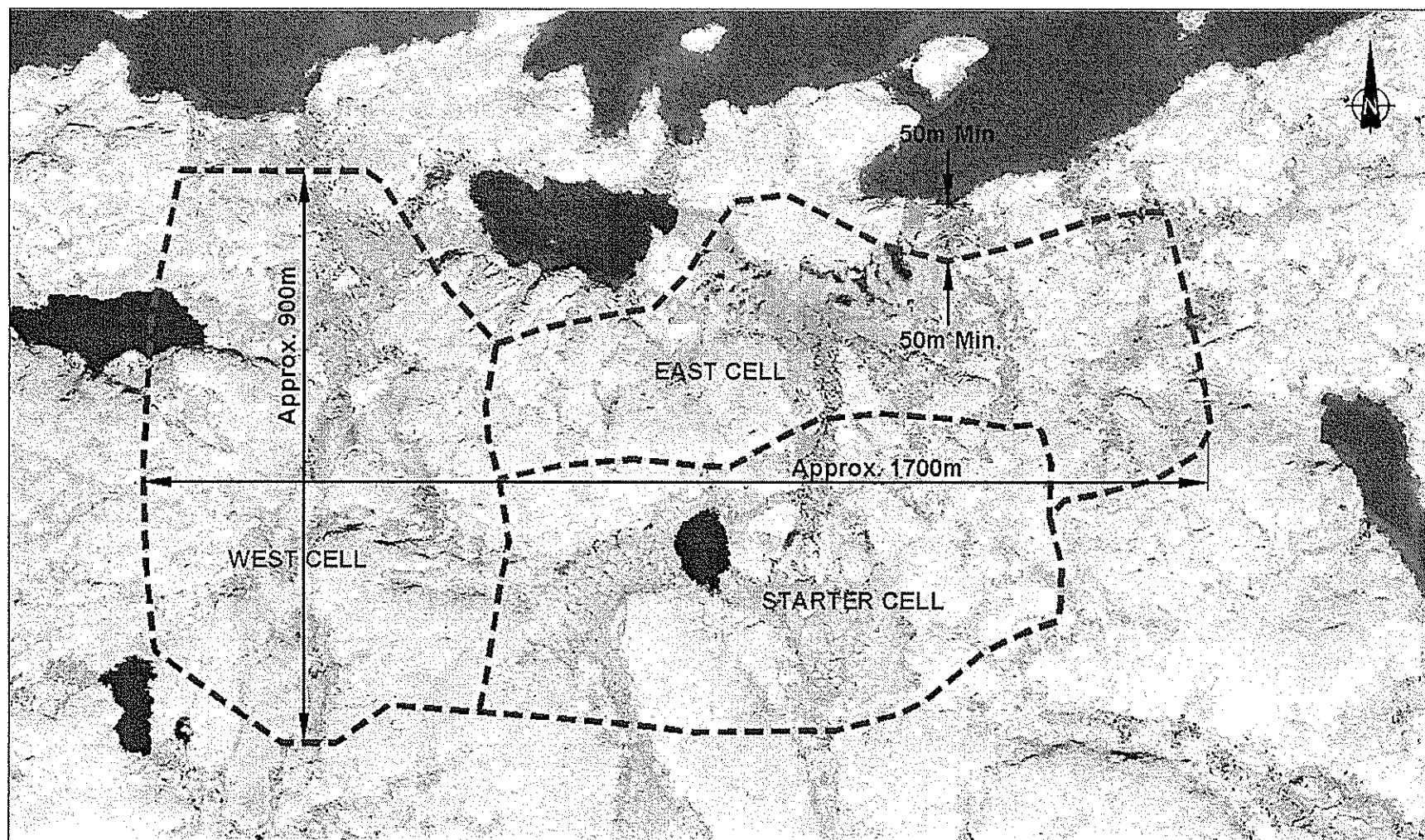


DE BEERS

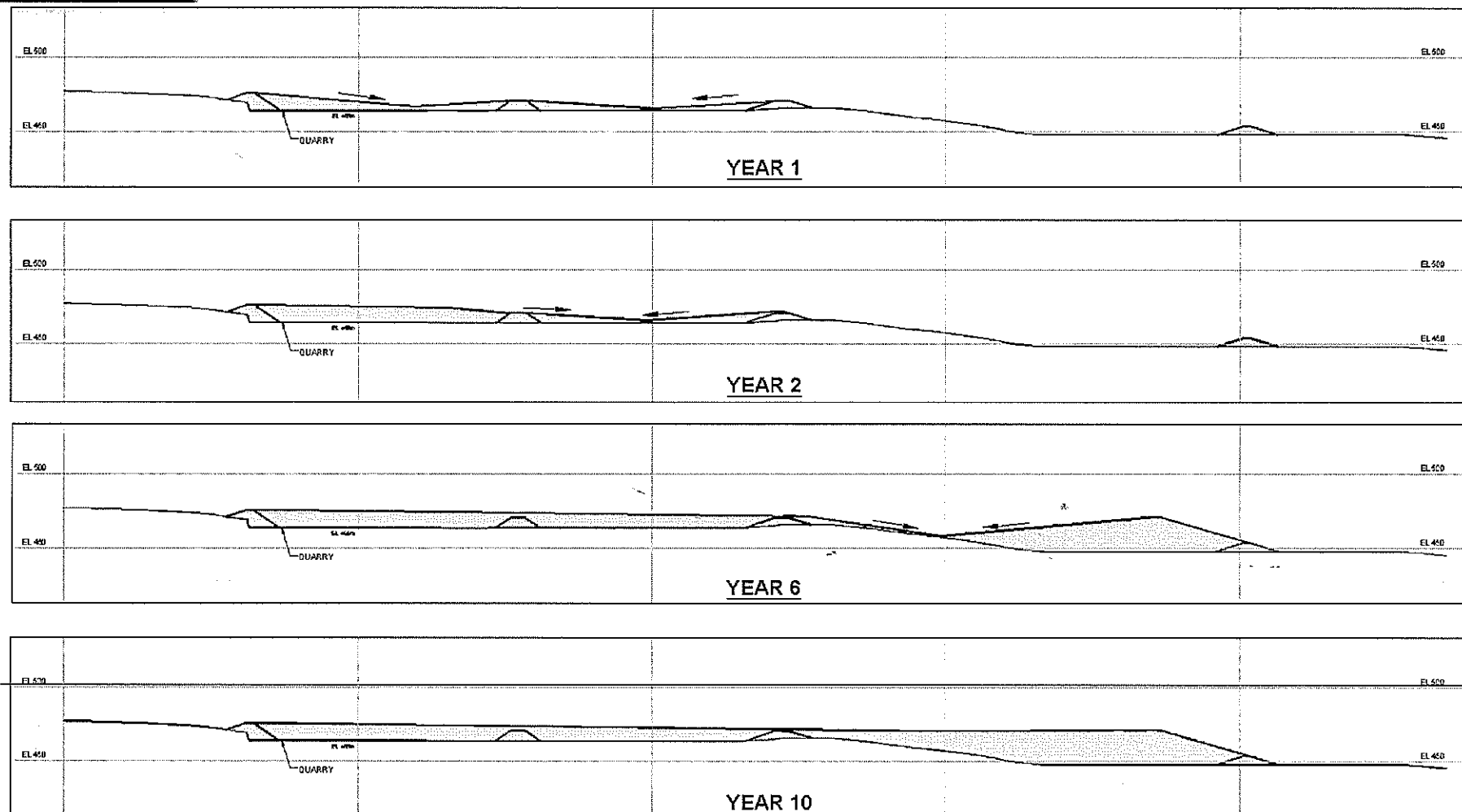
## Paste Tailings Pile



# North Pile Setting



# North Pile Sections



→ PK DEPOSITION  
 [Shaded Box] COMPLETED AREAS

0 20 40 60 80 100  
 Scale in Meters

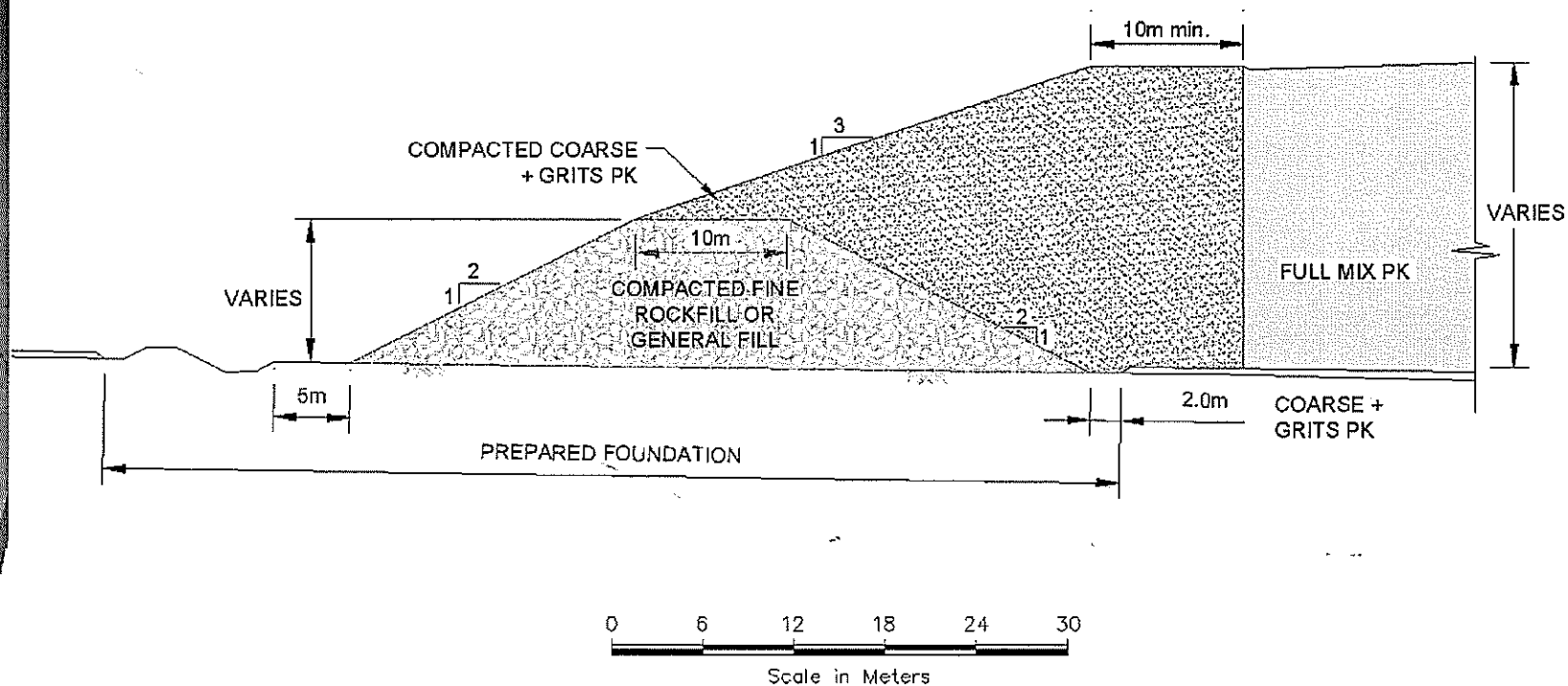
## North Pile Stability

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- ◆ Pore pressure development
- ◆ Freeze / thaw characteristics



# North Pile Stability

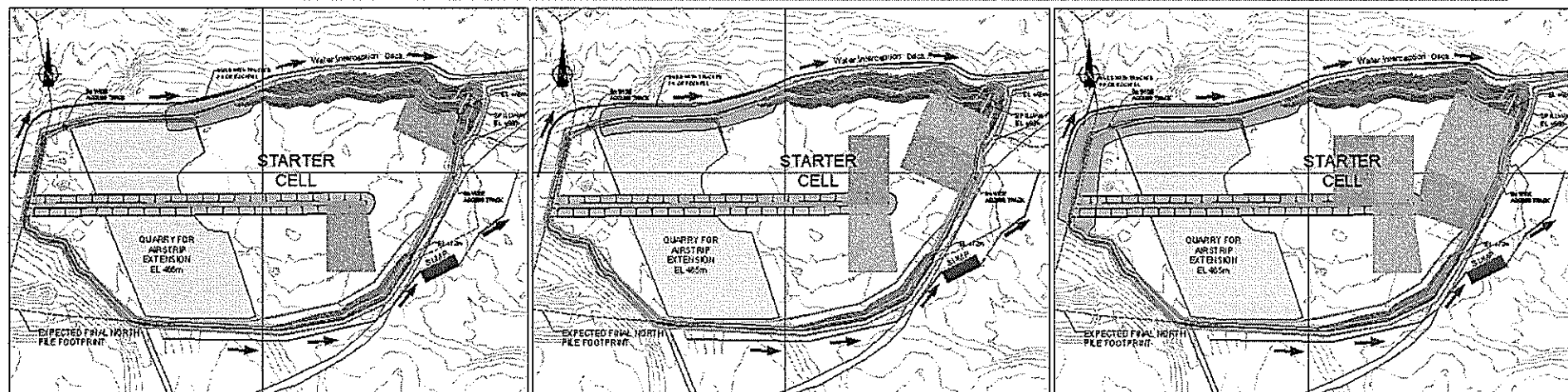


## Project Operation Scenarios

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- ◆ Discharge methodology
- ◆ Internal pond management
- ◆ Perimeter ditch design and efficiency
- ◆ Identification of non-potentially acid generating (non-PAG) materials
- ◆ Impact of moving PAG underground

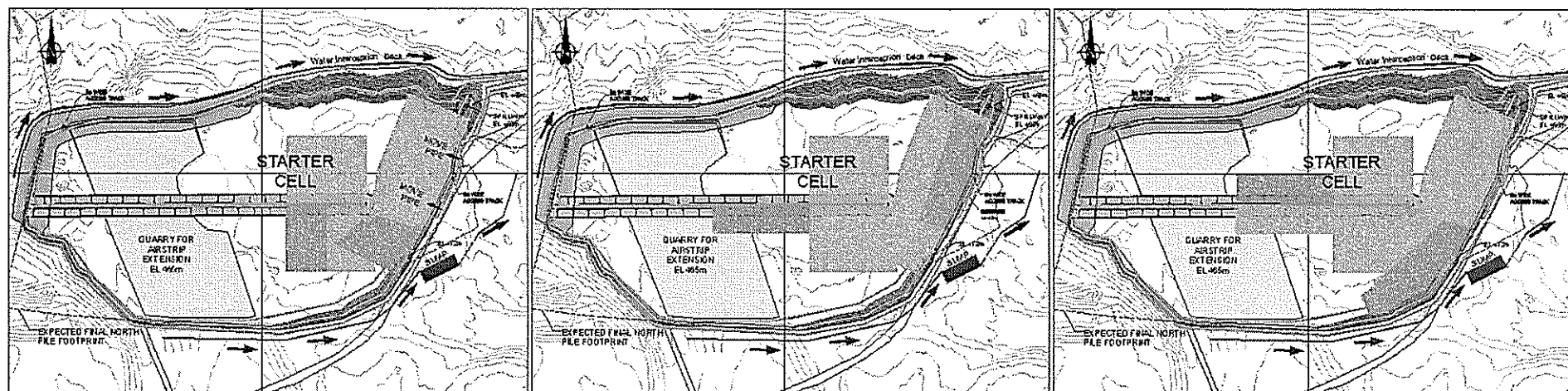
# Discharge Methodology



JUNE 2003

JULY 2003

AUGUST 2003



SEPTEMBER 2003

OCTOBER 2003

NOVEMBER 2003



ASSUMED PK BEACH SLOPE (SUMMER)

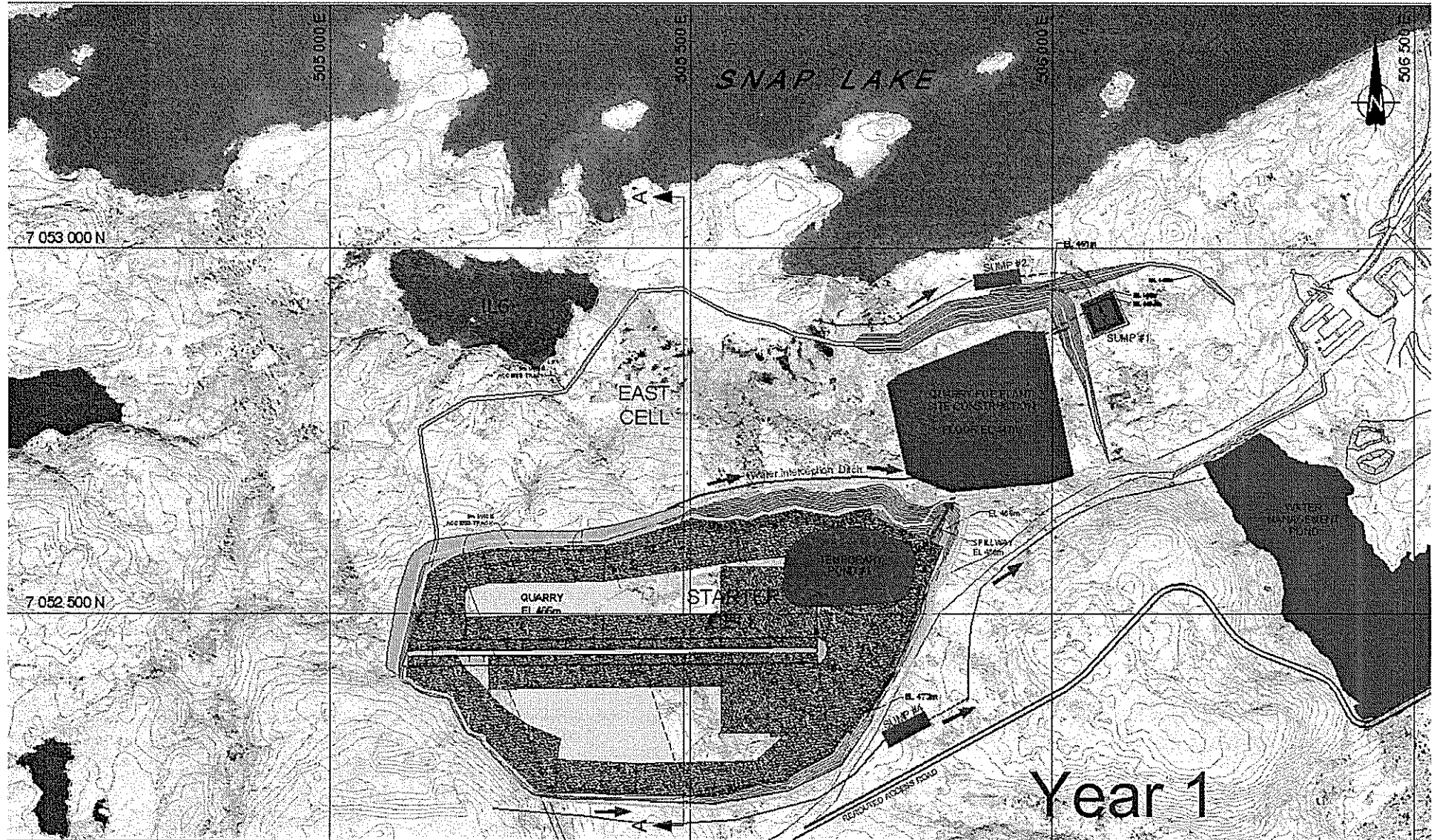


ASSUMED PK BEACH SLOPE (WINTER)

LEGEND

ACTIVE DEPOSITION

# Internal Pond Management



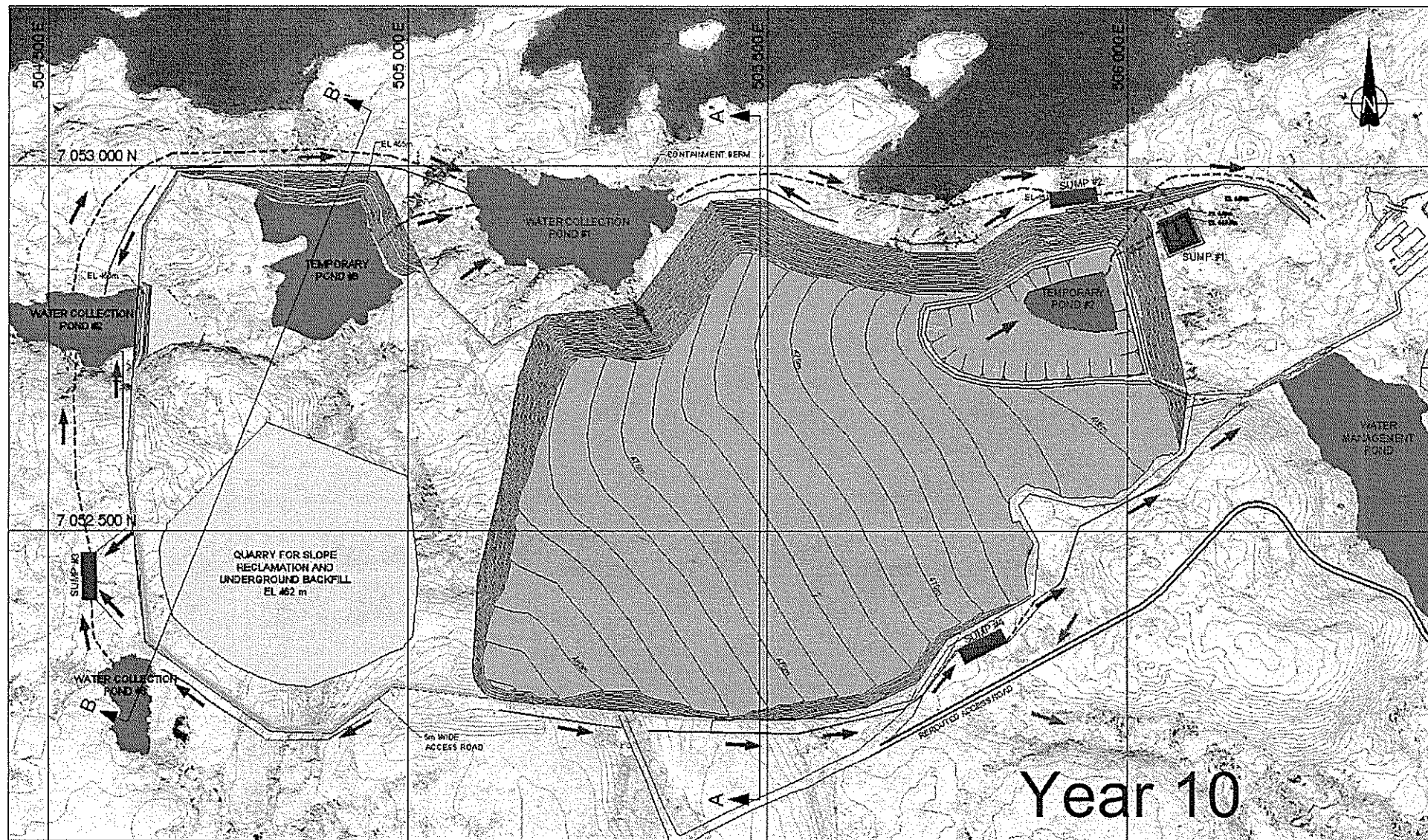
**LEGEND:**

- PK DISTRIBUTION LINE
- CONTACT WATER INTERCEPTION DITCH
- PUMPED FLOW
- NON-CONTACT WATER DIVERSION

0 50 100 150 200 250  
Scale in Meters

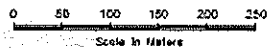


# Internal Pond Management

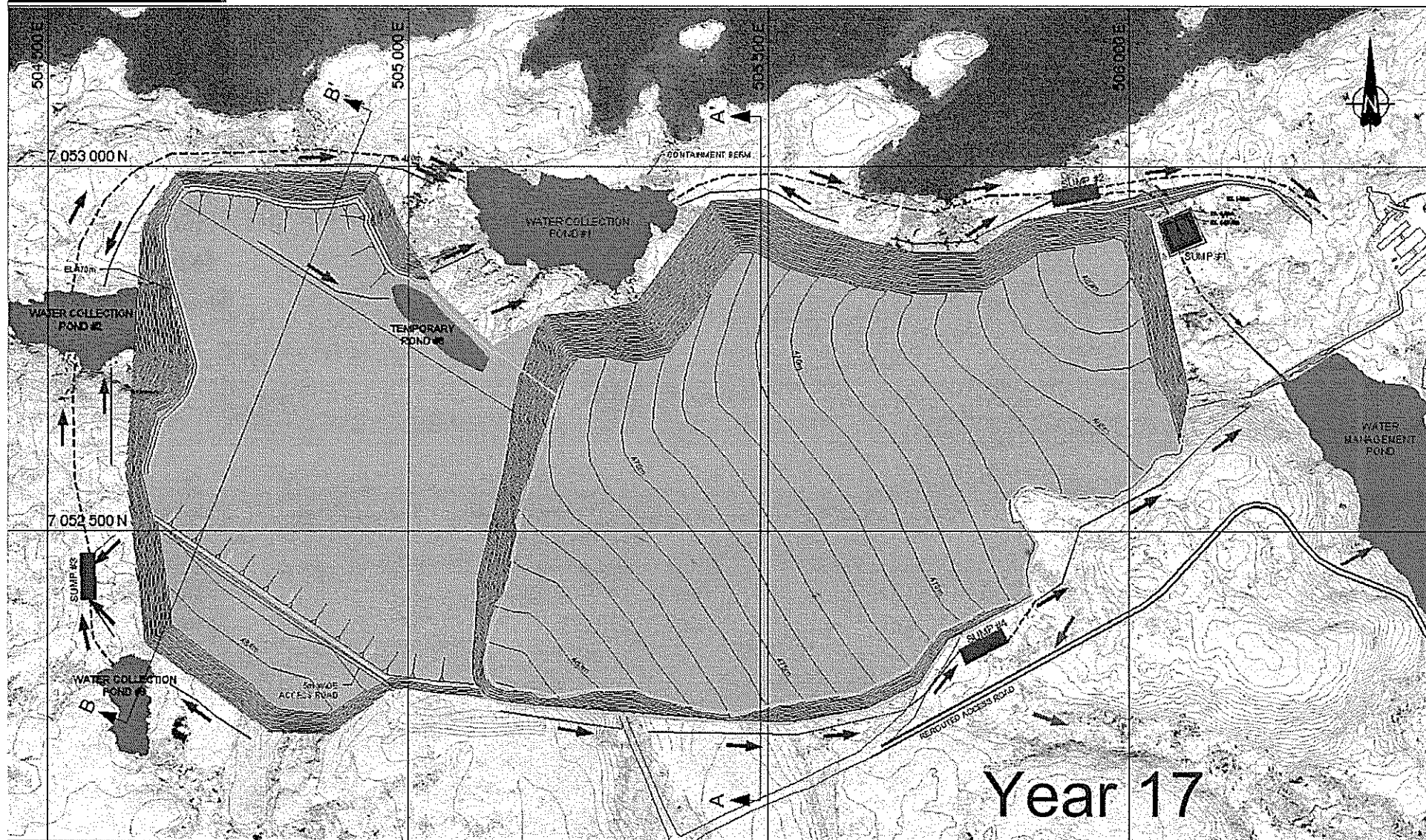


**LEGEND:**

- PK DISTRIBUTION LINE
- CONTACT WATER INTERCEPTION DITCH
- PUMPED TO SEDIMENTATION POND #1
- NON-CONTACT WATER DIVERSION

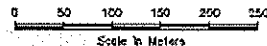


# Internal Pond Management

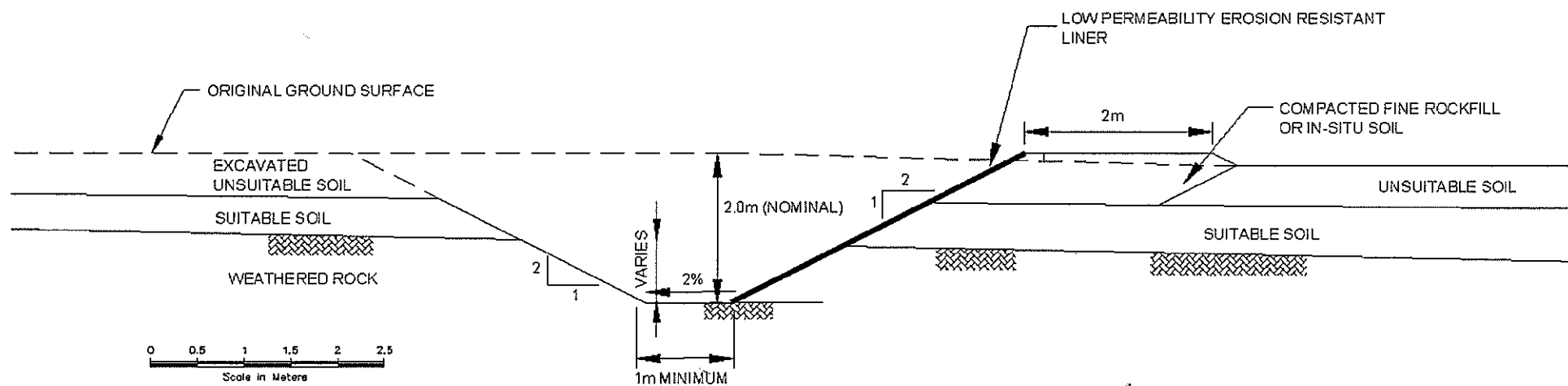


**LEGEND**

- PK DISTRIBUTION LINE
- CONTACT WATER INTERCEPTION DITCH
- PUMPED TO SEDIMENTATION POND #1
- NON-CONTACT WATER DIVERSION



# Perimeter Ditch Design





# Processed Kimberlite Material Properties:

- ◆ Grain size variation
- ◆ Pore water chemistry variation
- ◆ Pore water content variation
- ◆ Previous paste experience in permafrost environment



## Conclusions

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- ◆ Use of paste technology reduces the largest risk by eliminating the need for a large permanent pond
- ◆ Pile embankments constructed with granular materials using conventional construction techniques
- ◆ North Pile is founded on ice-free granite bedrock

# North Pile Management

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Purpose – to describe:

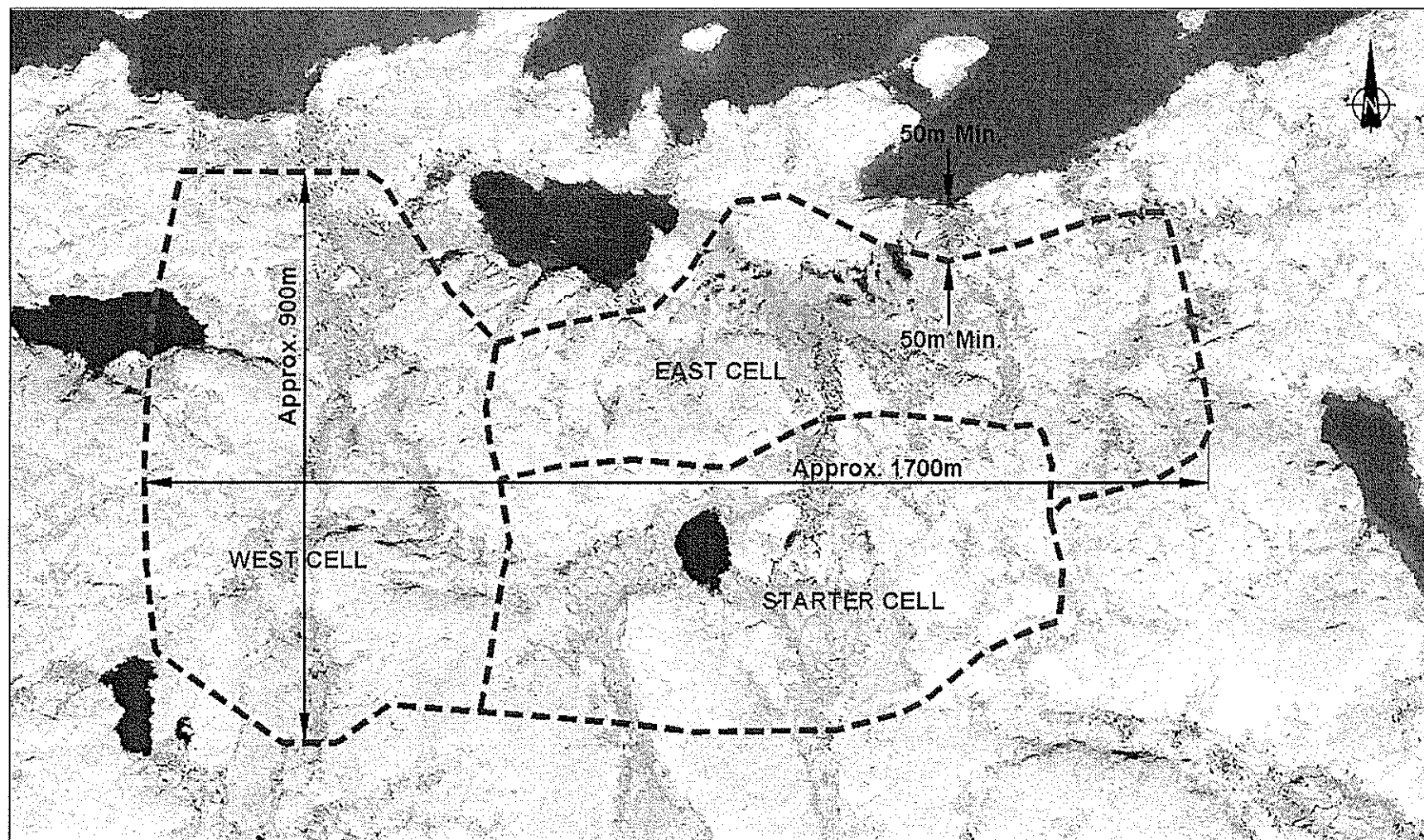
- ◆ Field test program
  - containment berms
  - pipe movements
  - cover closure
- ◆ Monitoring programs
  - processed kimberlite (PK) deposition
  - closure works

## Topic Has Been Addressed:

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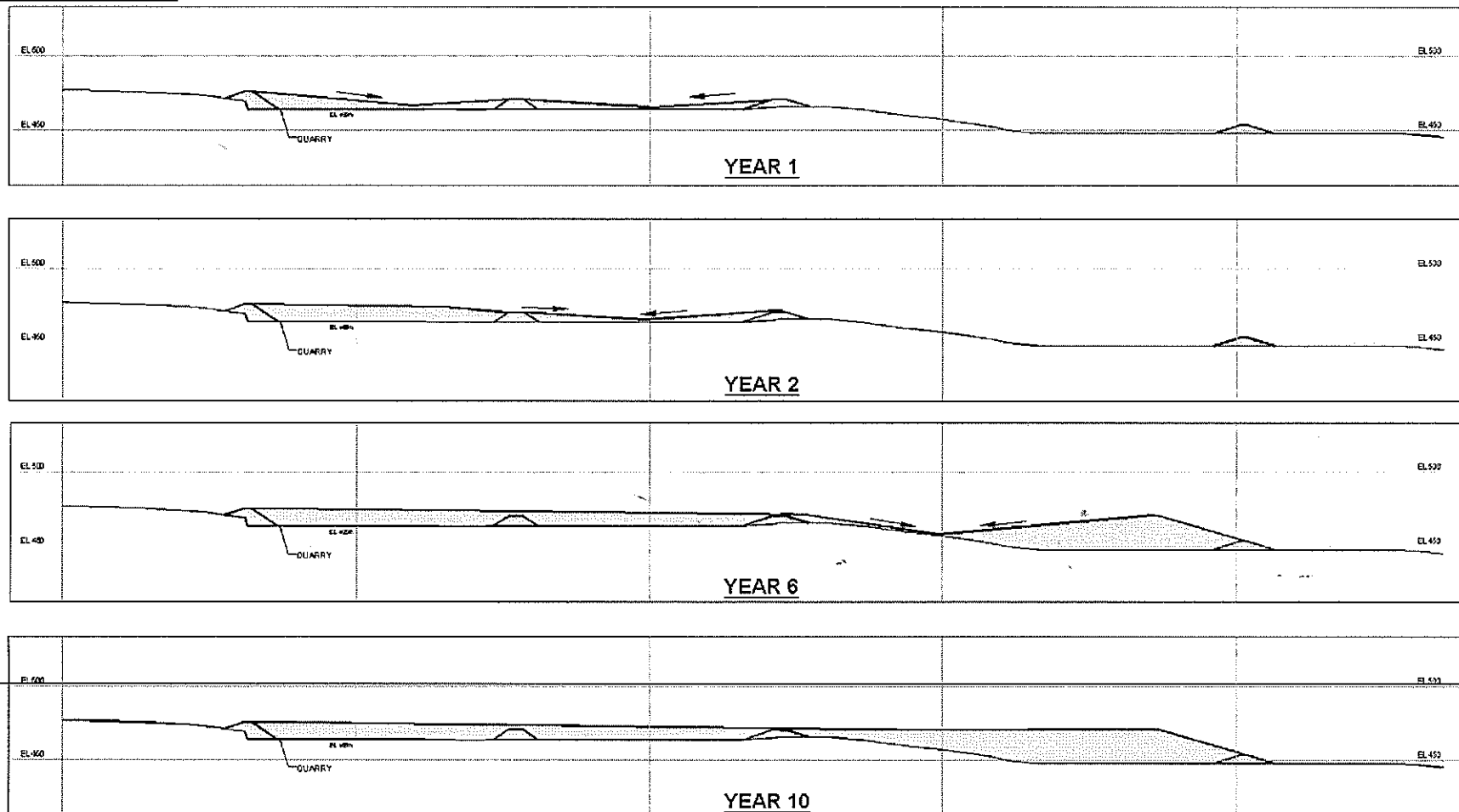
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  - Section 10.2
  - Appendix III.1
  
- ◆ Responses to Information Requests
  - IRs 2.2.3, 2.2.10, 2.4.7, 2.4.8, 2.4.20, 2.4.26, 2.4.27, 2.4.28, 2.4.29, 2.4.30, 2.4.31, 2.5.12, 2.5.26

# North Pile Setting





# North Pile Sections



→ PK DEPOSITION  
 [Shaded Box] COMPLETED AREAS

0 20 40 60 80 100  
 Scale in Meters

# Adaptive Management Process

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- ◆ Preliminary design
- ◆ Environmental assessment (EA)
- ◆ Detail design using EA feedback
- ◆ Construct and operate North Pile
- ◆ Monitor North Pile performance
- ◆ Refine design and operation
- ◆ Progressive closure
- ◆ Monitor during mine life (minimum 15 years)
- ◆ Adjust closure plan

## Starter Cell Program

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- ◆ Deposition slopes – winter and summer
- ◆ PK slope movement
- ◆ Frozen and unfrozen layers
- ◆ Pore pressures in PK
- ◆ Bleed water from PK
- ◆ Seepage collection system
- ◆ Field test program

## Starter Cell Program

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- ◆ Temperature – thermistors
- ◆ Pore pressure – vibrating wire piezometers
- ◆ Deposition slope – survey
- ◆ Slope movement – periodic survey
- ◆ Flow measurements
- ◆ Construction – test fills



## Closure

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- ◆ Progressive reclamation starting about year 3
  - when starter cell complete
- ◆ Program same as starter cell program. In addition, surface erosion and dust will be monitored

## Conclusions

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- ◆ North Pile Management Plan includes monitoring and field tests to confirm construction methods
- ◆ Design includes progressive closure of North Pile
- ◆ North Pile cover performance can be monitored for at least 15 years during mine operations

## North Pile Thermal Regime

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Purpose – to describe:

- ◆ Thermal properties
- ◆ Thermal gradient
- ◆ N factors
- ◆ Climate change
- ◆ Adequacy of air temperature modeling
- ◆ Rate of freezeback

## Topic Has Been Addressed:

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- ◆ Environmental Assessment Report
  - Section 10.2
  - Appendix III.1
  
- ◆ Responses to Information Requests
  - IRs 1.11, 2.2.9, 2.4.8, 2.4.28, 2.4.30, 2.4.34, 2.4.35, 2.6.18, 2.4.35
  - IRs 3.8.2, 3.4.7, 3.4.16, 3.4.17, 3.8.2



# Thermal Setting

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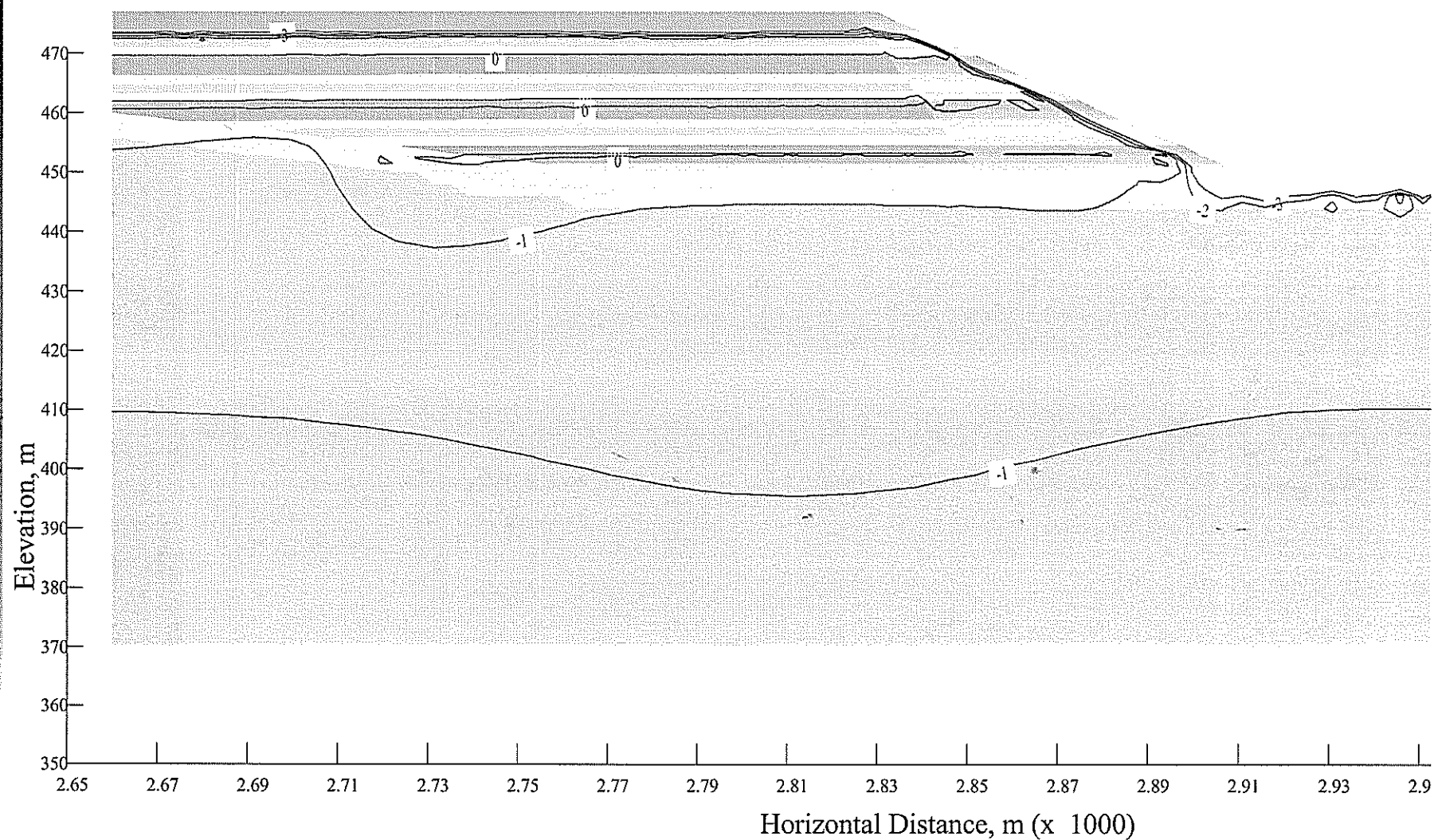
- ◆ Arctic permafrost environment
- ◆ Mean annual temperature  $-8^{\circ}\text{C}$
- ◆ Mean annual precipitation 370 mm
- ◆ Thin soil layer over granite bedrock
- ◆ Ice-free bedrock

## Status of Design

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- ◆ Thermal model part of engineering study
- ◆ Purpose:
  - to provide sufficient information to understand critical issues and general performance of the North Pile
  - to allow design concepts to be developed and agreed upon
  - to demonstrate sufficient storage capacity
  - to demonstrate deposition plan flexibility to accommodate changing operating conditions
- ◆ Detailed engineering to be done

# Thermal Model

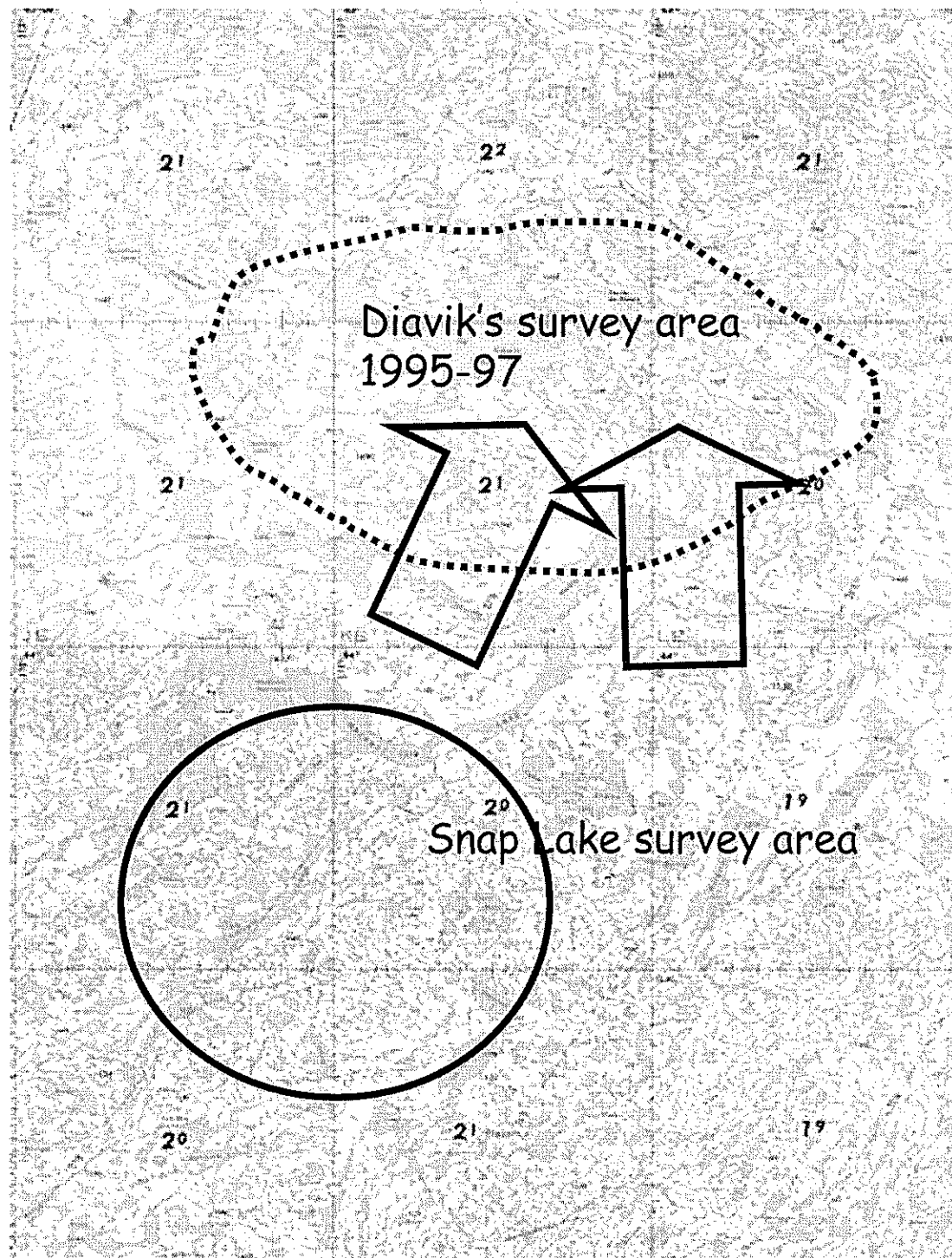


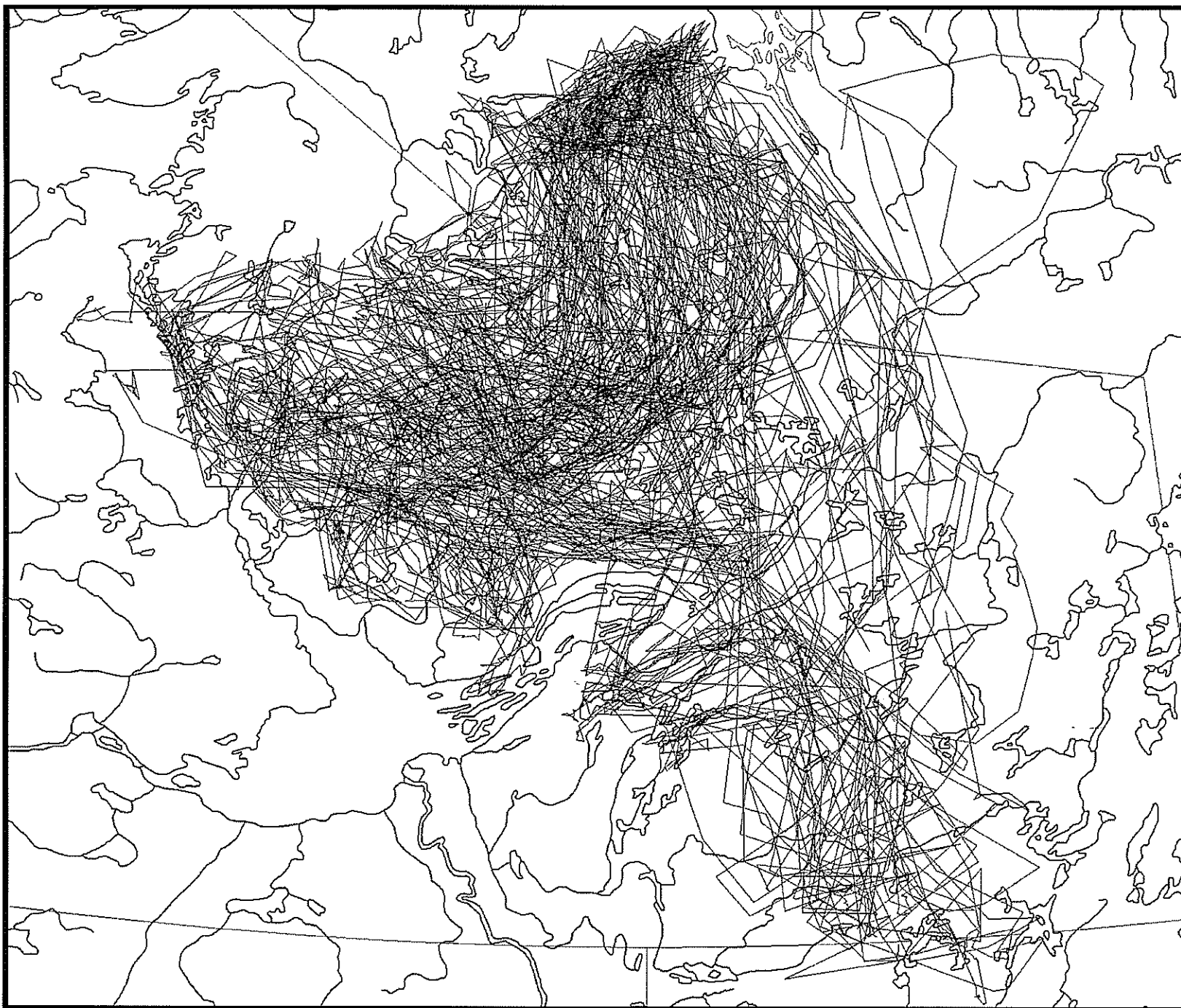
## Model Results

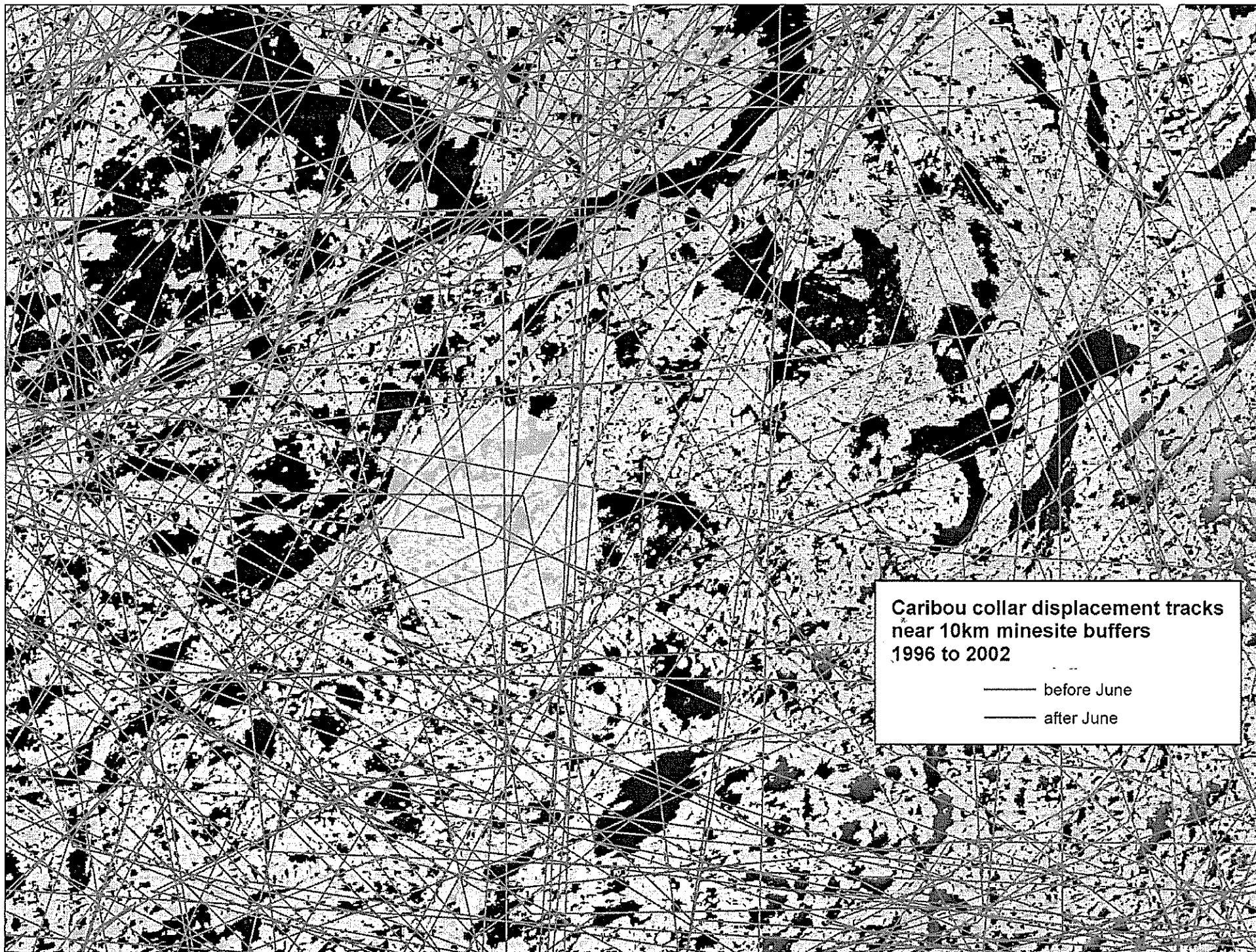
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- ◆ North Pile will have frozen and unfrozen layers during operation
- ◆ North Pile will completely freeze
  - excluding active layer
- ◆ Most of the precipitation will run off the pile surface
- ◆ If pile thaws, water surface will be near pile base
  - good for stability
- ◆ North Pile constructed on ice-free bedrock
- ◆ Frozen or thawed pile is stable





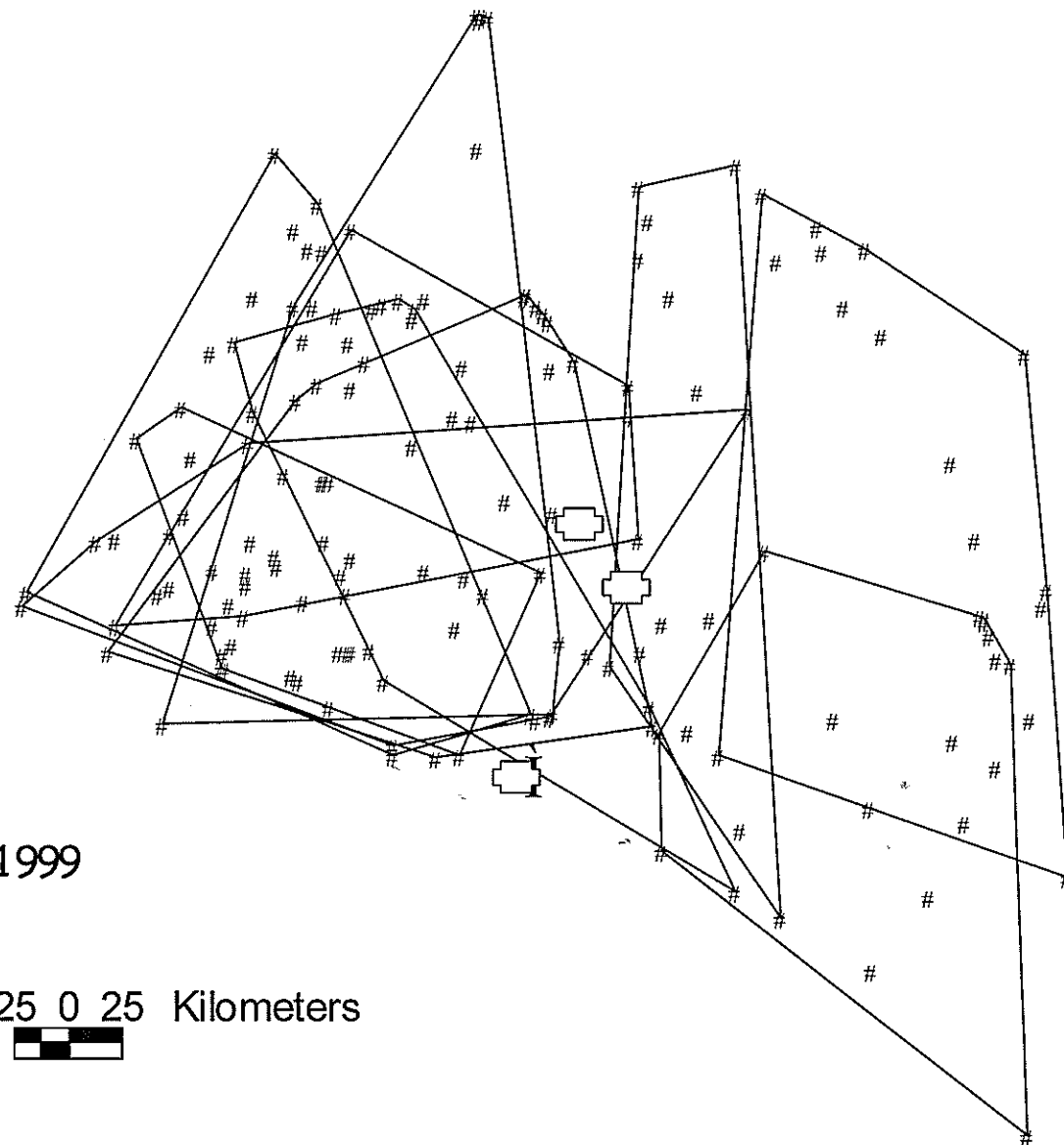




**Caribou collar displacement tracks  
near 10km minesite buffers  
1996 to 2002**

— before June

— after June



1999

25 0 25 Kilometers





Migration Snap Lake 4 caribou  
20 Mar, 2 April 1999

Winter 1998-1999

Migration BHP Ekati 4000 caribou  
May 1999

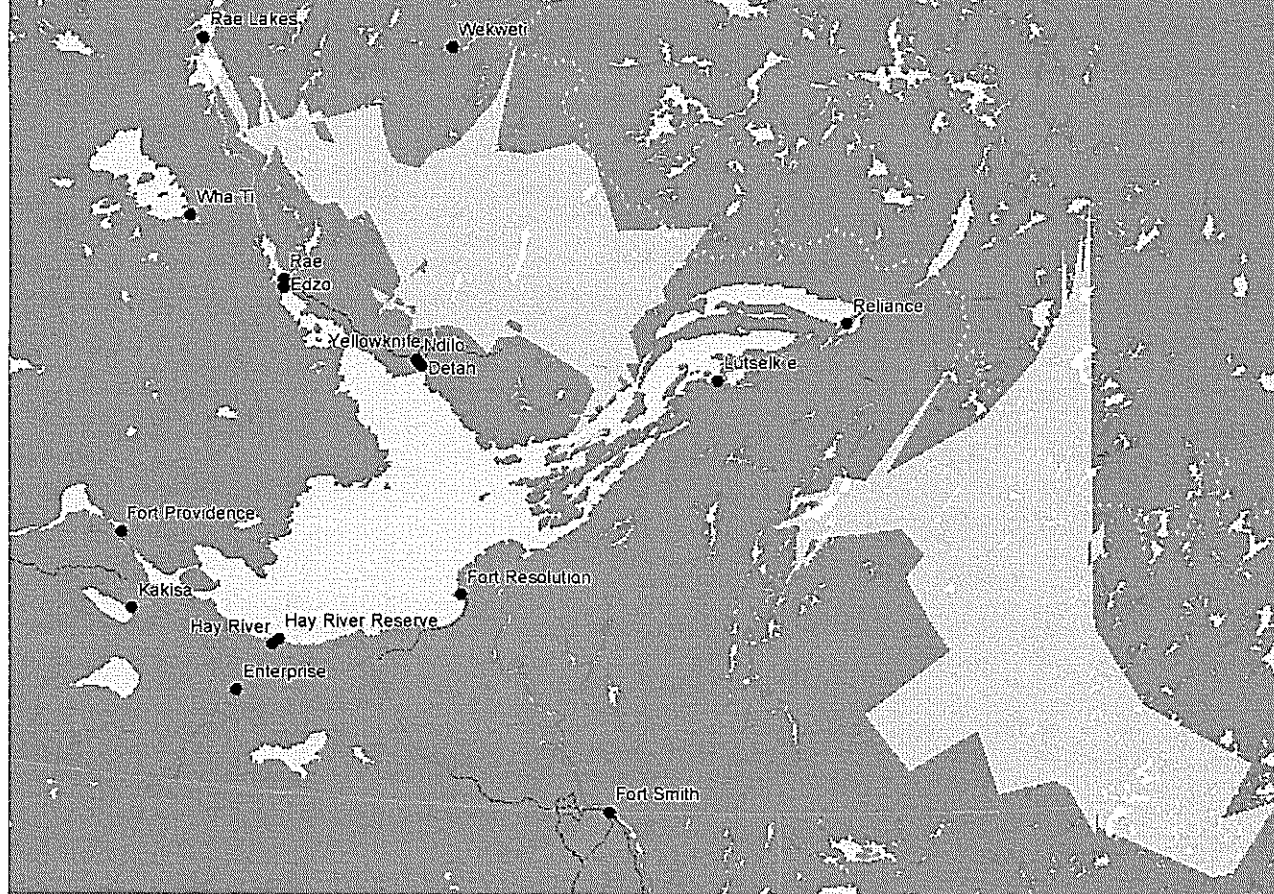




Migration Snap Lake 28 000 caribou  
11, 14 April; 4, 7, 10 May 2000

Winter 1999-2000

Migration BHP Ekati 34 000  
caribou May 2000

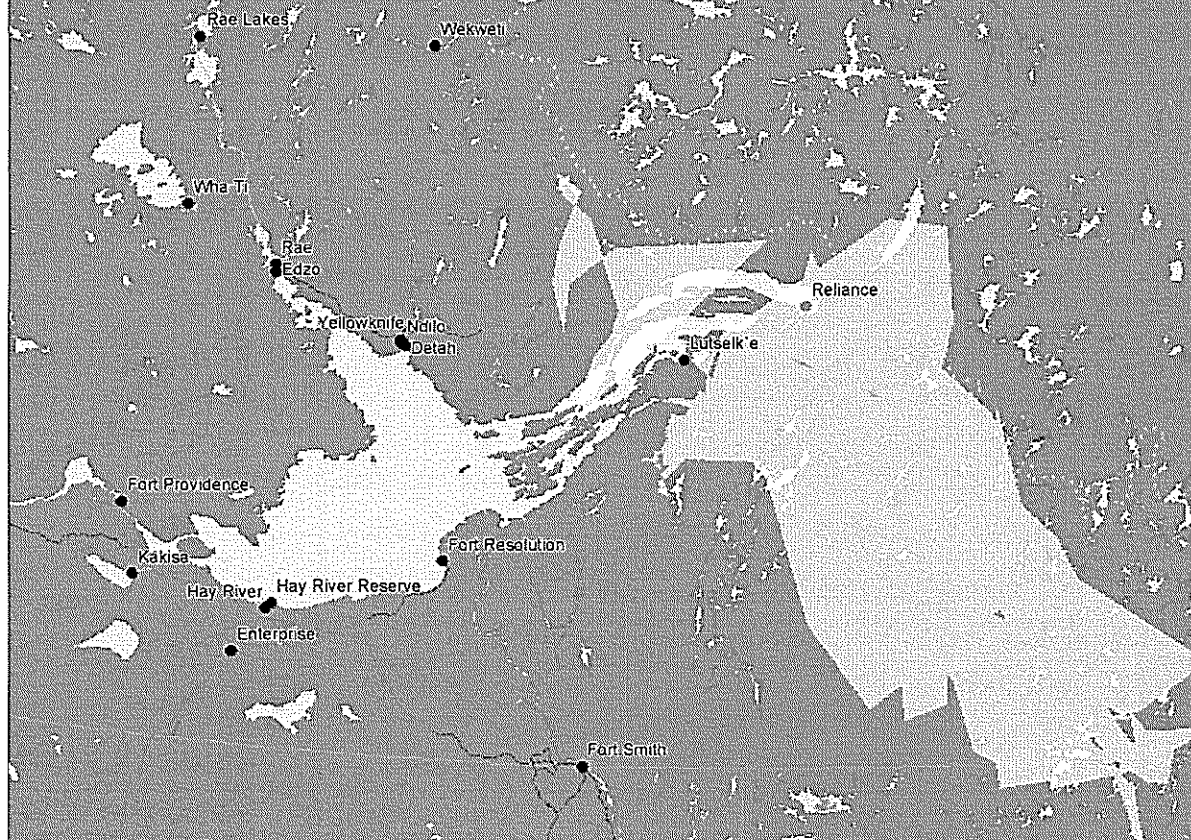




Winter 2000-2001

Migration Snap Lake 1060 caribou  
11, 16, 21 May 2001

Migration BHP Ekati 4 000  
caribou May 2001

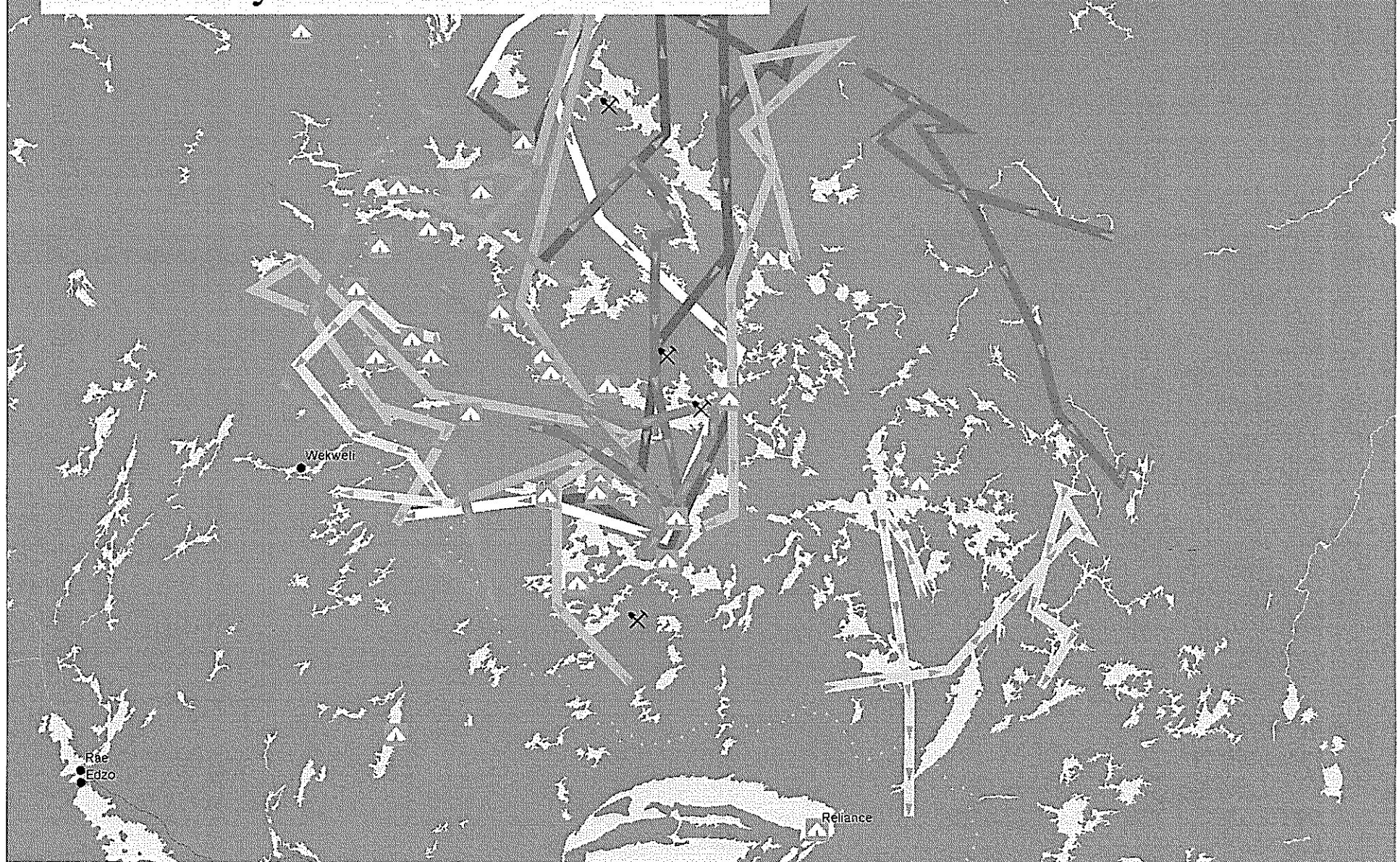




Migration Snap Lake 28 000 caribou

21-23 July 1999

August-September  
1999

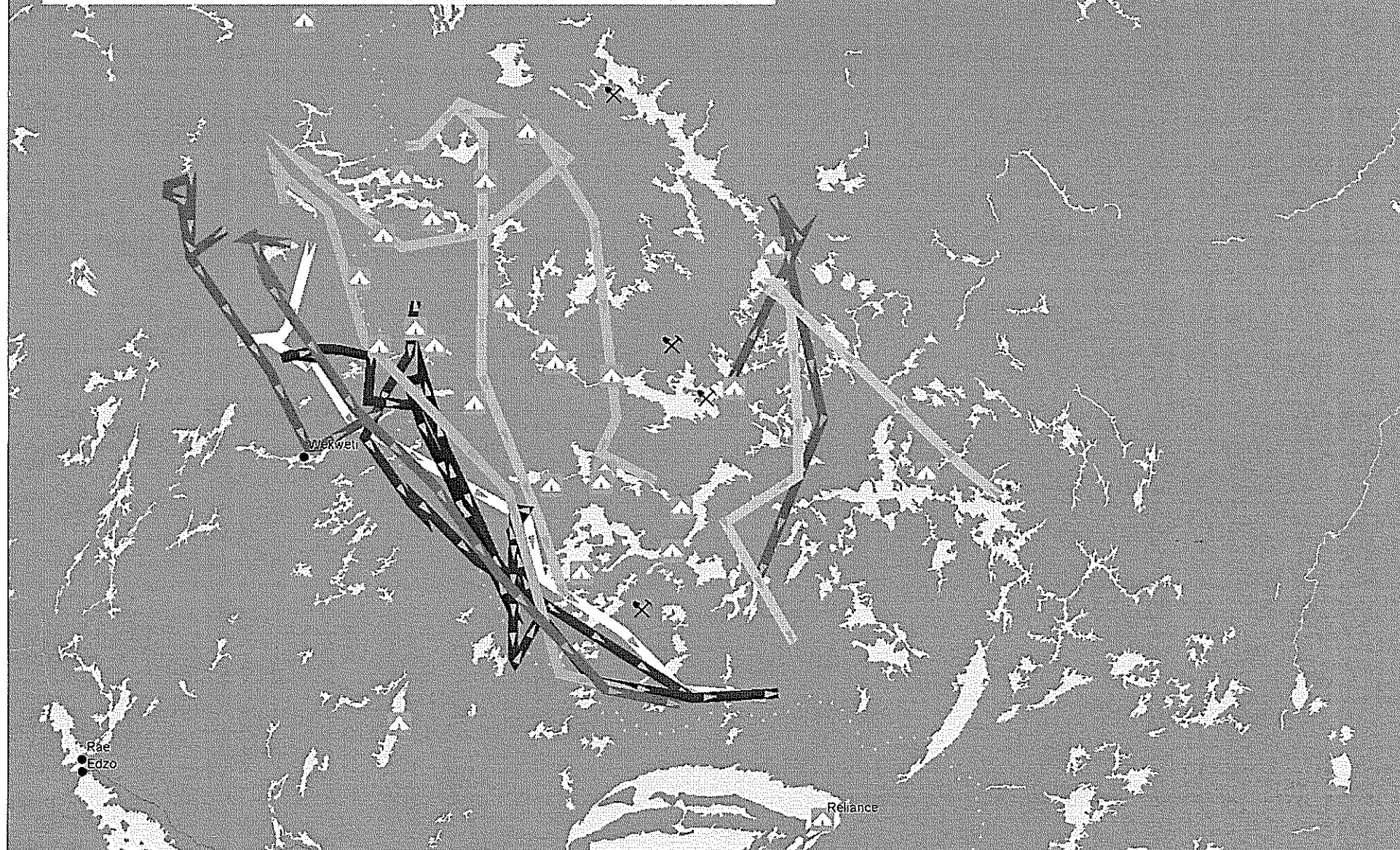




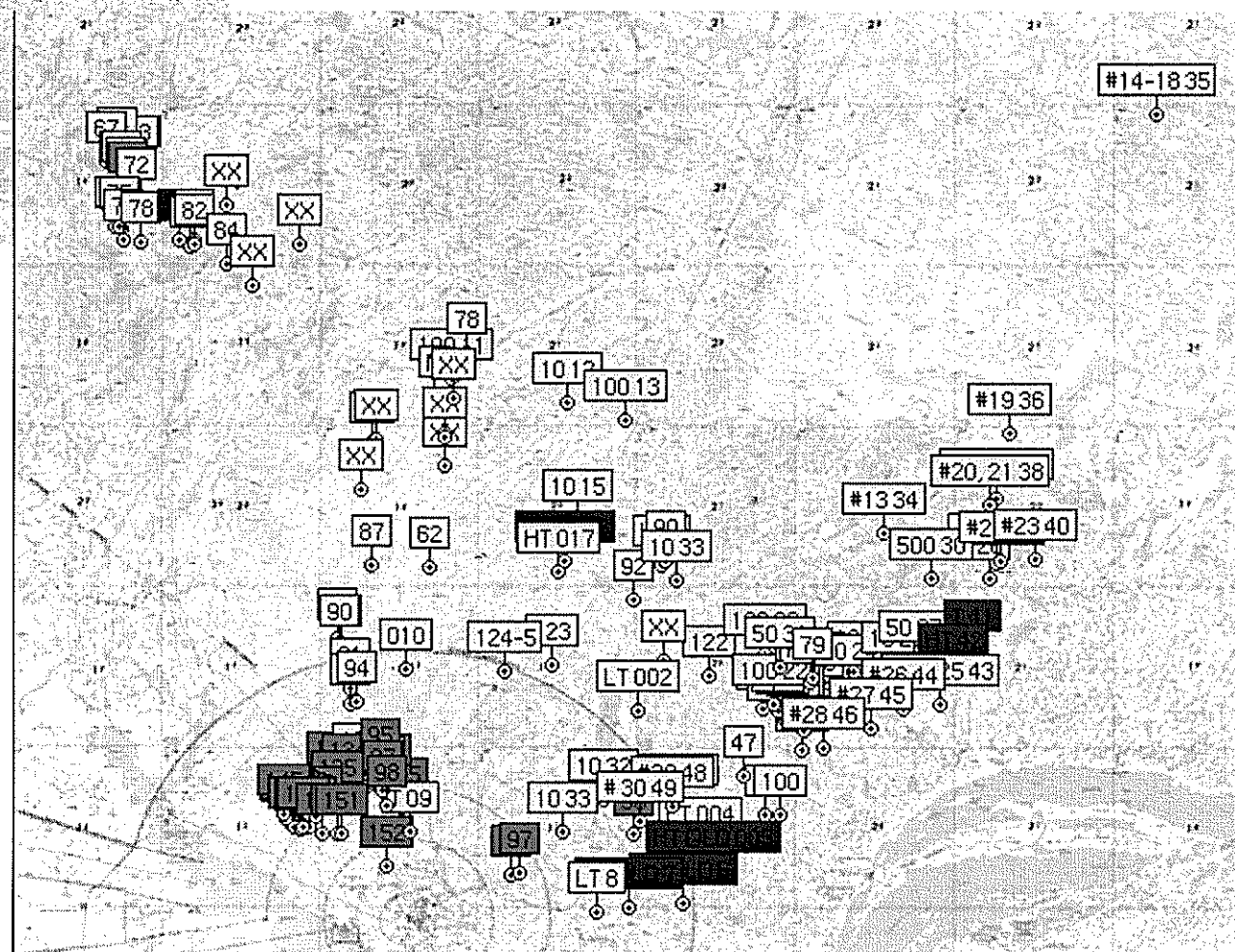
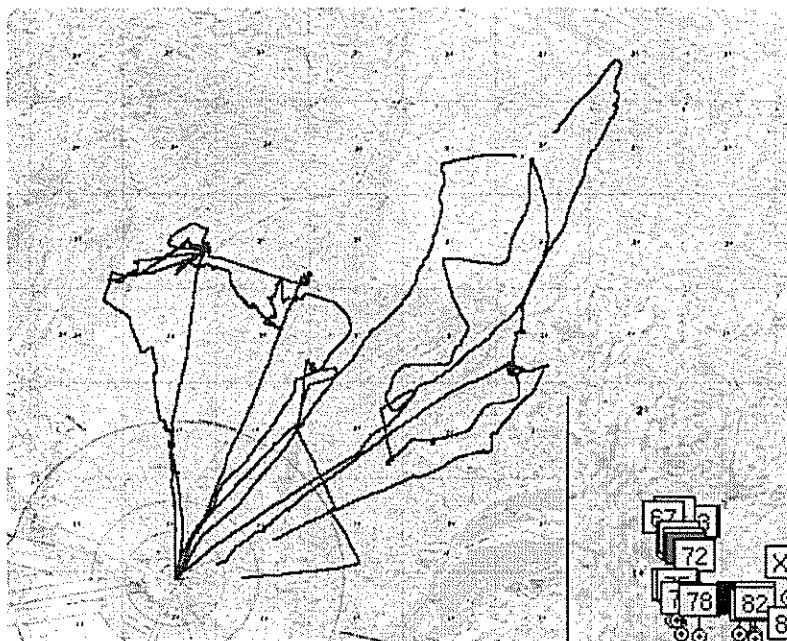
# Migration Snap Lake 2000 caribou

August-September  
2000

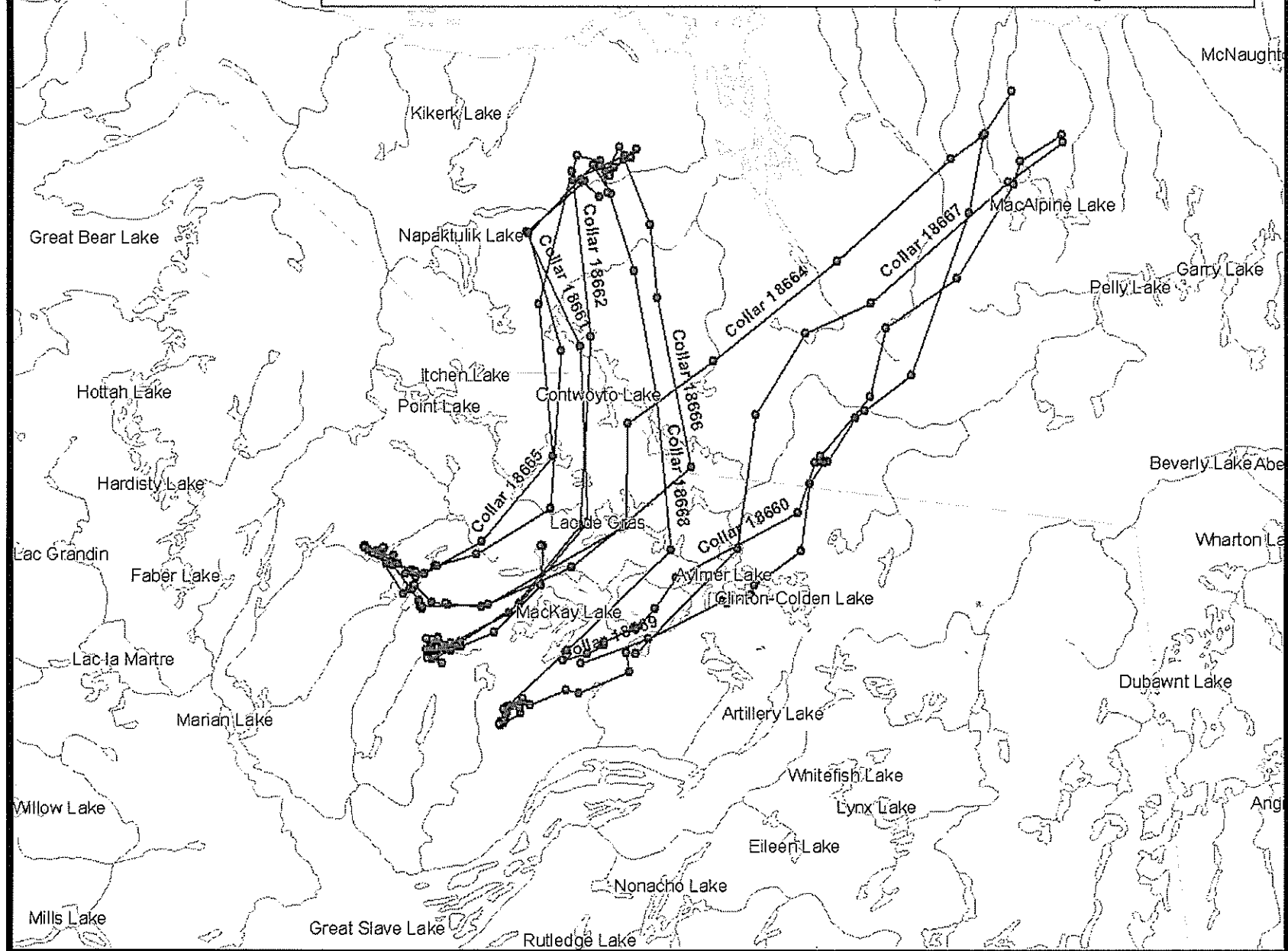
21 Jul and 17 Aug 2000

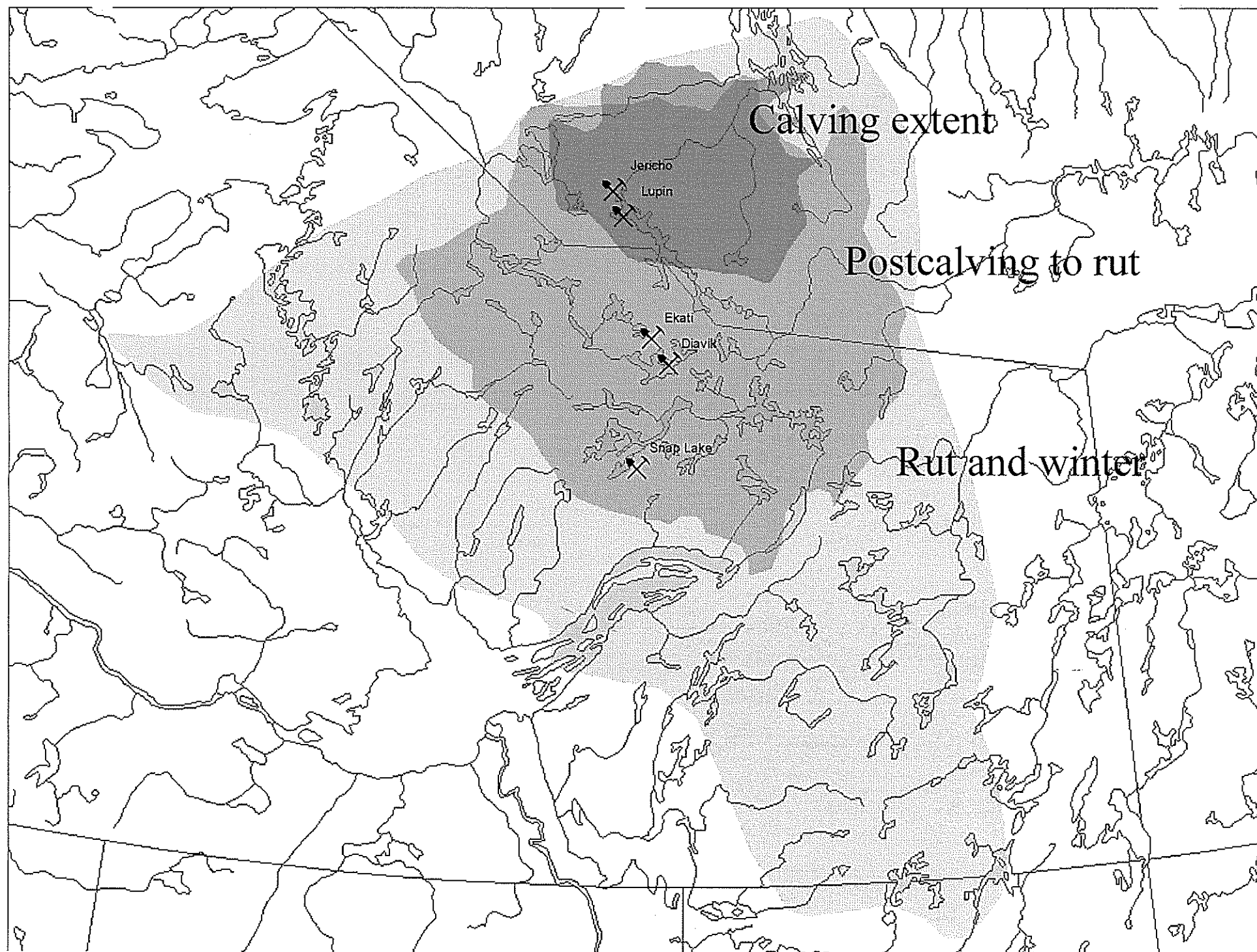




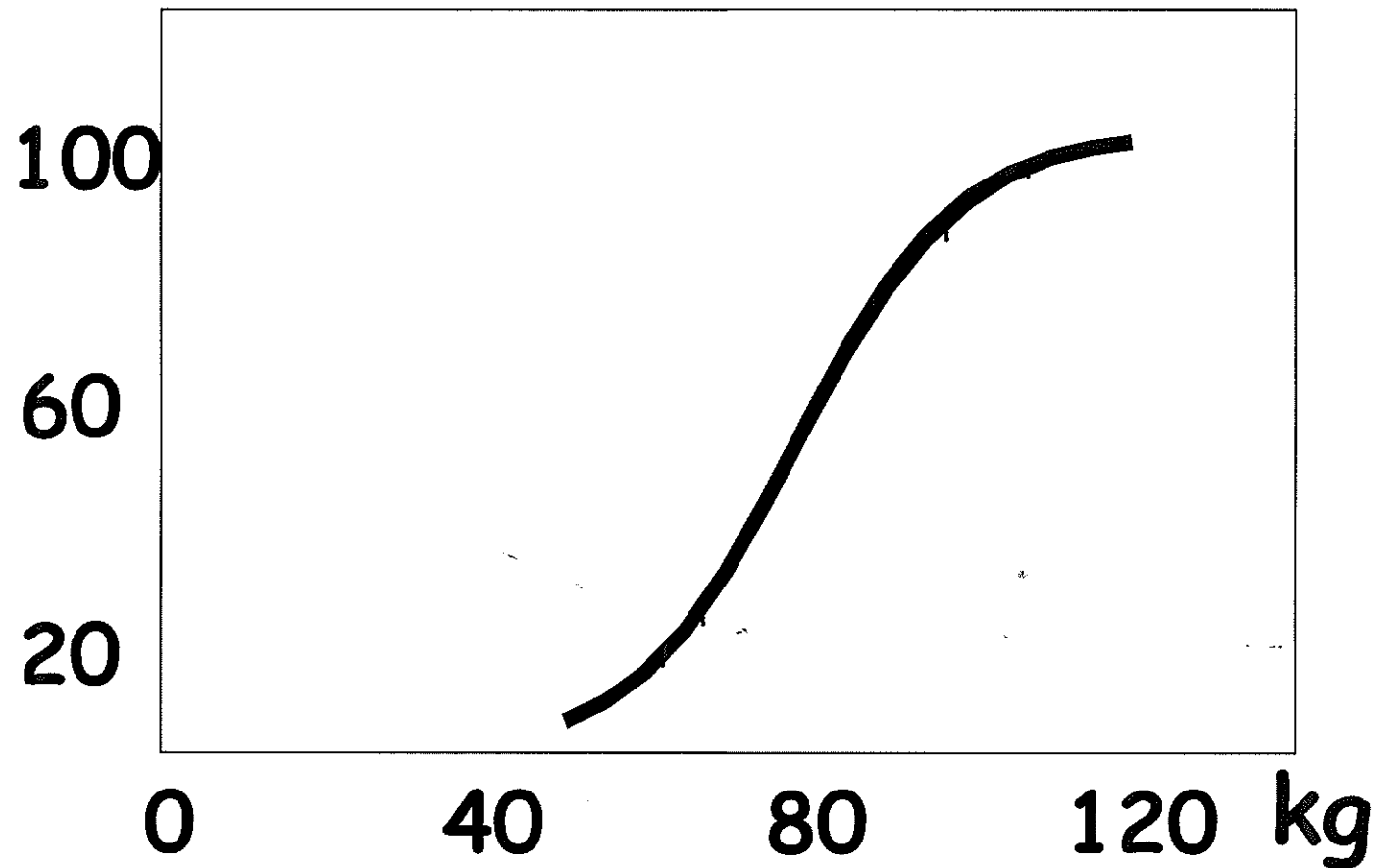


# Caribou collar movement from collaring to calving in 2002





# Likelihood of pregnancy relative to body weight



After Russell et al unpubl. data

## Design Planning

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- ◆ No large permanent tailings pond
- ◆ Carry out detailed engineering design
- ◆ Construct Starter Cell using conventional construction methods, well away from lake
- ◆ Study processed kimberlite (PK) deposition to optimize external berm construction
- ◆ Pile design will not change until pile performance using other construction techniques are successfully demonstrated in the Starter Cell



## Conclusions

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- ◆ North Pile will have frozen and unfrozen layers during operation, but will completely freeze
- ◆ North Pile will be stable whether frozen or thawed