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TetrES CONSULTANTS INC. Solutions for a Sustainable Environment

Remediation of the East Tailings Management Area
Lynn Lake, Manitoba

VIRIDIAN

Manitoba

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Lynn Lake

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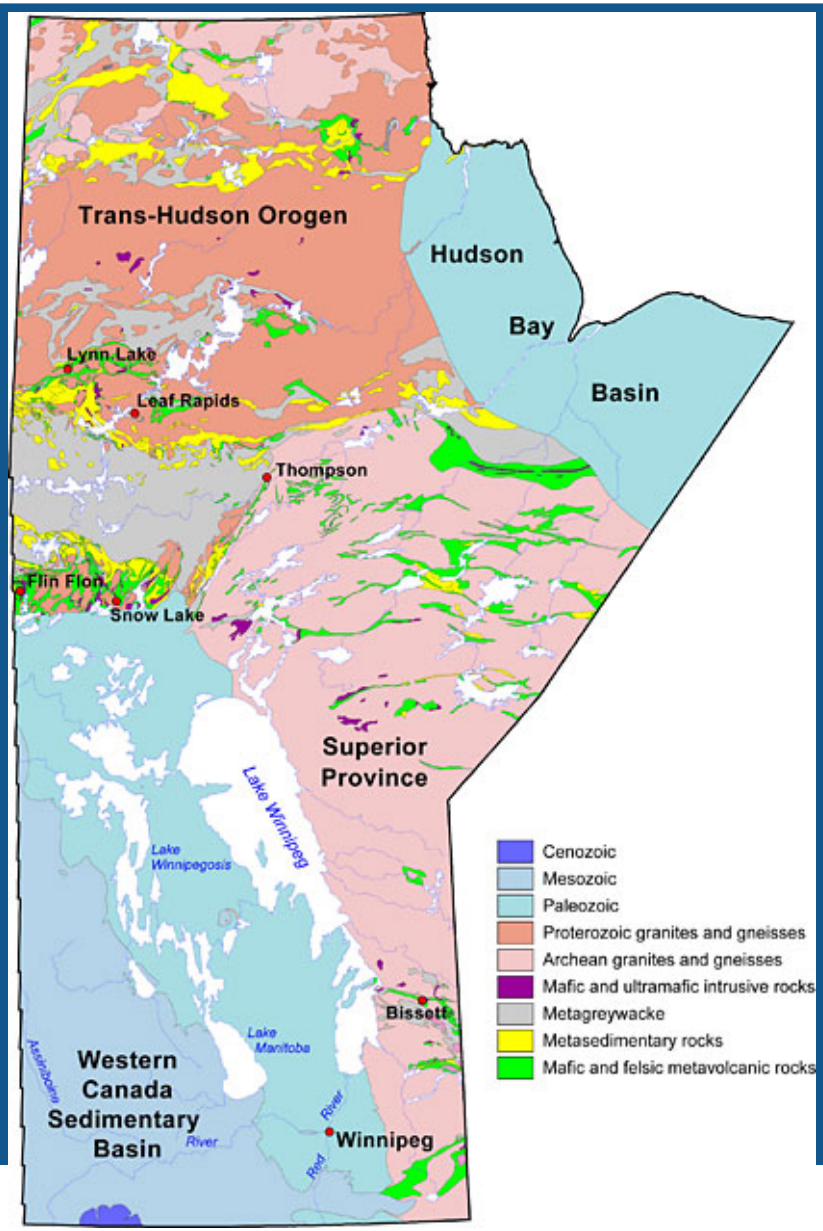

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ETMA History

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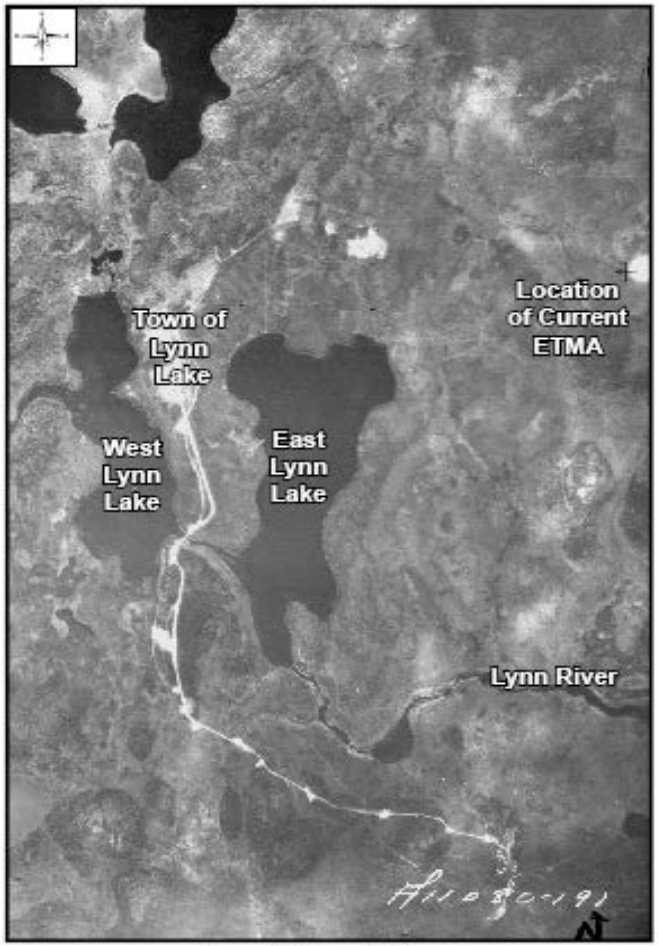
- Mining/milling at Lynn Lake from 1953 to 1976
- Tailings piped to the East Tailings Management Area (ETMA)
- ~ 20 M tonnes of tailings deposited over 200 ha

History



Lynn Lake - 1948

Lynn Lake - 1978

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Aerial Photography of the Lynn Lake Area Illustrating Infilling of East Lynn Lake by WTMA Mining Activities

Figure 1-4

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History

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Since Operations ended…..

- Numerous studies of tailings and Lynn River
- Environmental risk assessment by Dillon
- University of Waterloo tailings geochemistry
- Supplemental characterization, aquatic health and ecological risk assessment by TetrES
- Ongoing site management studies by TetrES & UMA

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History

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In 2006 an agreement was signed by Province of Manitoba and Viridian to develop and implement a "Site-Management Plan"

- UMA and TetrES provided support in plan development
- The Site-Management plan was accepted in 2007

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Site-Management Plan

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Plan Objectives are to:

- Mitigate environmental impacts of ETMA on Lynn River
- Address community concerns related to dust entrainment

Initial Plan will evolve as data accumulate & knowledge grows

- Plan involves pilot testing of some components to determine whether effectiveness sufficient to be included in evolving Plan

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Major Issues

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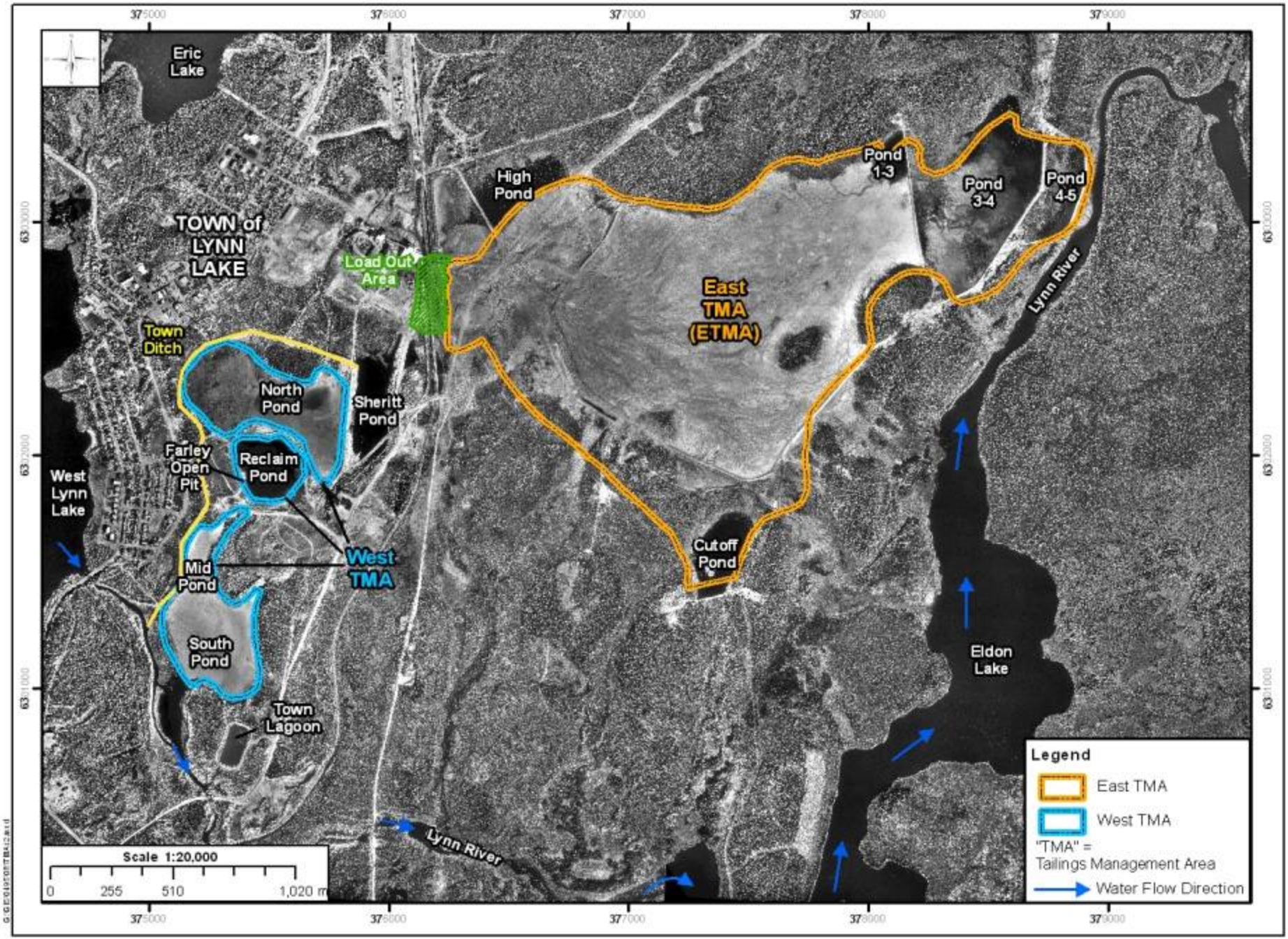
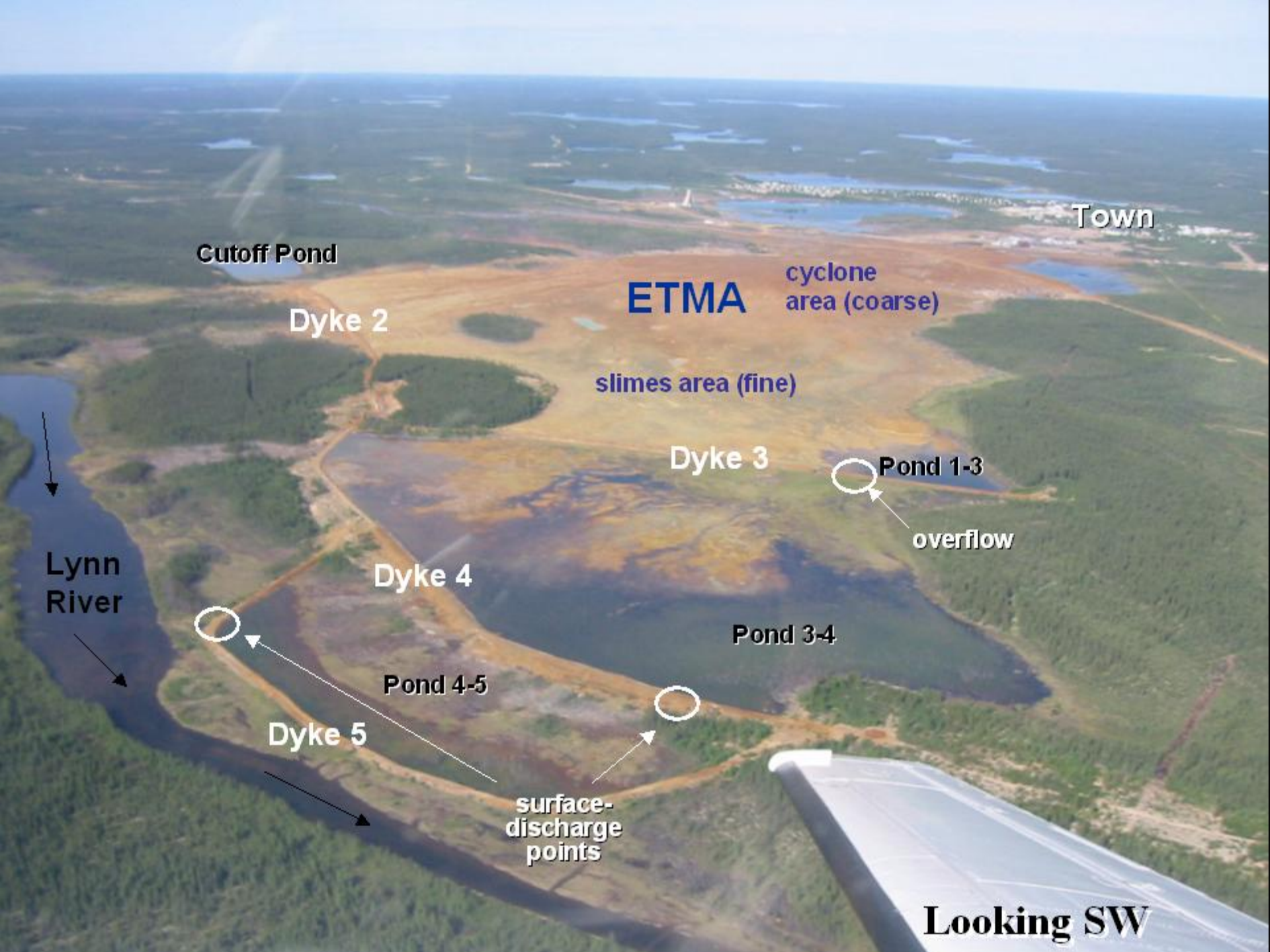
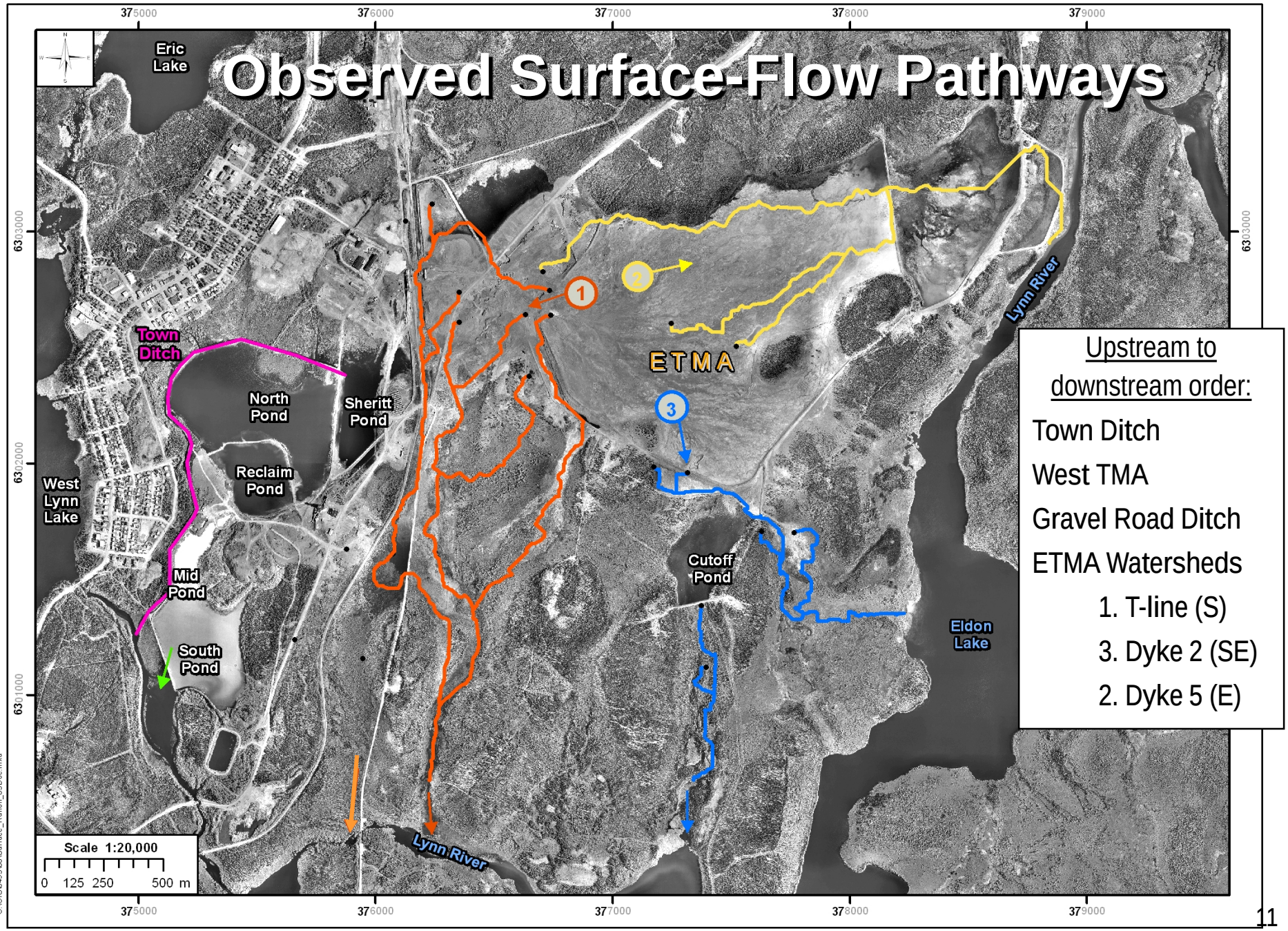
- Dyke Stability & Safety
- Acid-Mine Drainage (formed by reaction of residual tailings sulphides with air & water)
  - Surface-water runoff
  - Groundwater contamination
- Tailings dust blowing into town


Eric Lake
TOWN of LYNN LAKE
Load Out Area
High Pond
Pond 1-3
Pond 3-4
Pond 4-5
East TMA (ETMA)
Lynn River
Town Ditch
North Pond
Sheritt Pond
Farley Open Pit
Reclaim Pond
West Lynn Lake
West TMA
Mid Pond
South Pond
Town Lagoon
Cutoff Pond
Eldon Lake
Lynn River
Scale 1:20,000
0 255 510 1,020 m
Legend
East TMA
West TMA
"TMA" = Tailings Management Area
Water Flow Direction


Town
Cutoff Pond
ETMA
cyclone
area (coarse)
Dyke 2
slimes area (fine)
Dyke 3
Pond 1-3
overflow
Lynn
River
Dyke 4
Pond 3-4
Pond 4-5
Dyke 5
surface-
discharge
points
Looking SW


Observed Surface-Flow Pathways
Eric Lake
Town Ditch
North Pond
Sheritt Pond
Reclaim Pond
West Lynn Lake
Mid Pond
South Pond
ETMA
1
2
3
Lynn River
Cutoff Pond
Eldon Lake
Upstream to downstream order:
Town Ditch
West TMA
Gravel Road Ditch
ETMA Watersheds
1. T-line (S)
3. Dyke 2 (SE)
2. Dyke 5 (E)
Scale 1:20,000
0 125 250 500 m
375000
376000
377000
378000
379000
6303000
6302000
6301000

Site Management

Immediate need to manage surface-water runoff metal loadings along SW, S, & SE pathway(s) to river

Immediate need to mitigate wind erosion & reduce dust entrainment

Immediate need to test feasibility of some selected management options before committing to conceptual design(s)

- e.g., Permeable Reactive Barrier, Upstream/Headwater Diversion, Cap/Cover, Engineered Wetlands…

Other elements of Long-Term Plan address groundwater-plume migration & other challenges

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Completed Activities

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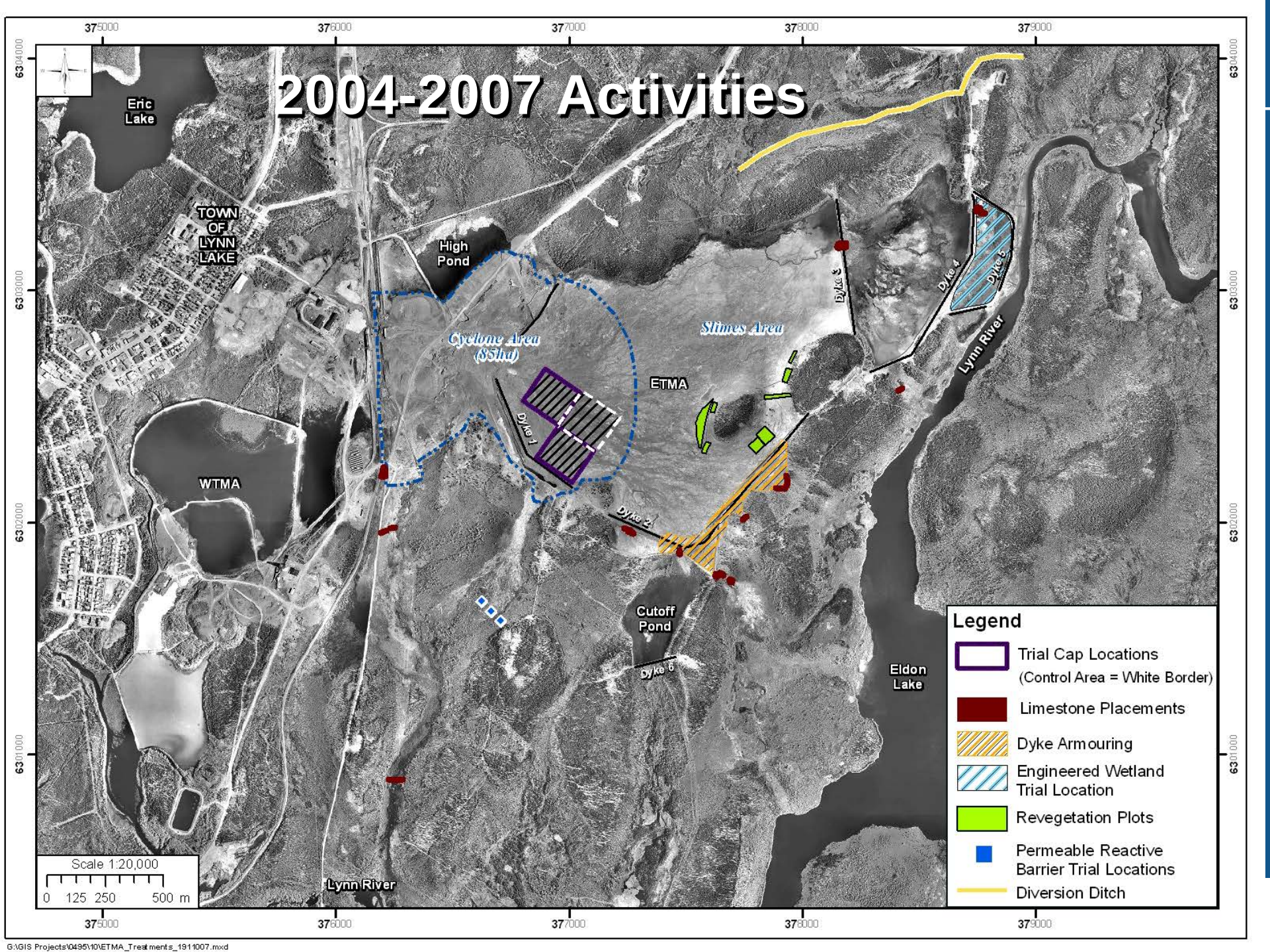
Site Characterization & Environmental Risk Assessment	2002 until present
Revegetation trials	2004 until present
Dyke-Stability Repairs	2004 & 2006
Upstream clean-water diversion trial construction	Winter 2006/Spring 2007
Permeable Reactive Barrier trial construction	Winter 2006/Spring 2007
Active Treatment Option review	Spring-Summer 2007
Cap/cover trial design & construction	Winter 2006-Spring 2008
Trial Engineered Wetland – Stage 1 (limestone placement) construction	Spring 2008


2004-2007 Activities
375000
376000
377000
378000
379000
6304000
6303000
6302000
6301000
Eric Lake
TOWN OF LYNN LAKE
High Pond
Cyclone Area (85ha)
Slimes Area
ETMA
WTMA
Dyke 1
Dyke 2
Dyke 3
Dyke 4
Dyke 5
Dyke 6
Lynn River
Cutoff Pond
Eldon Lake
Legend
Trial Cap Locations
(Control Area = White Border)
Limestone Placements
Dyke Armouring
Engineered Wetland Trial Location
Revegetation Plots
Permeable Reactive Barrier Trial Locations
Diversion Ditch
Scale 1:20,000
0 125 250 500 m
G:\GIS Projects\0495\10\ETMA_Treatments_1911007.mxd

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Potential site management

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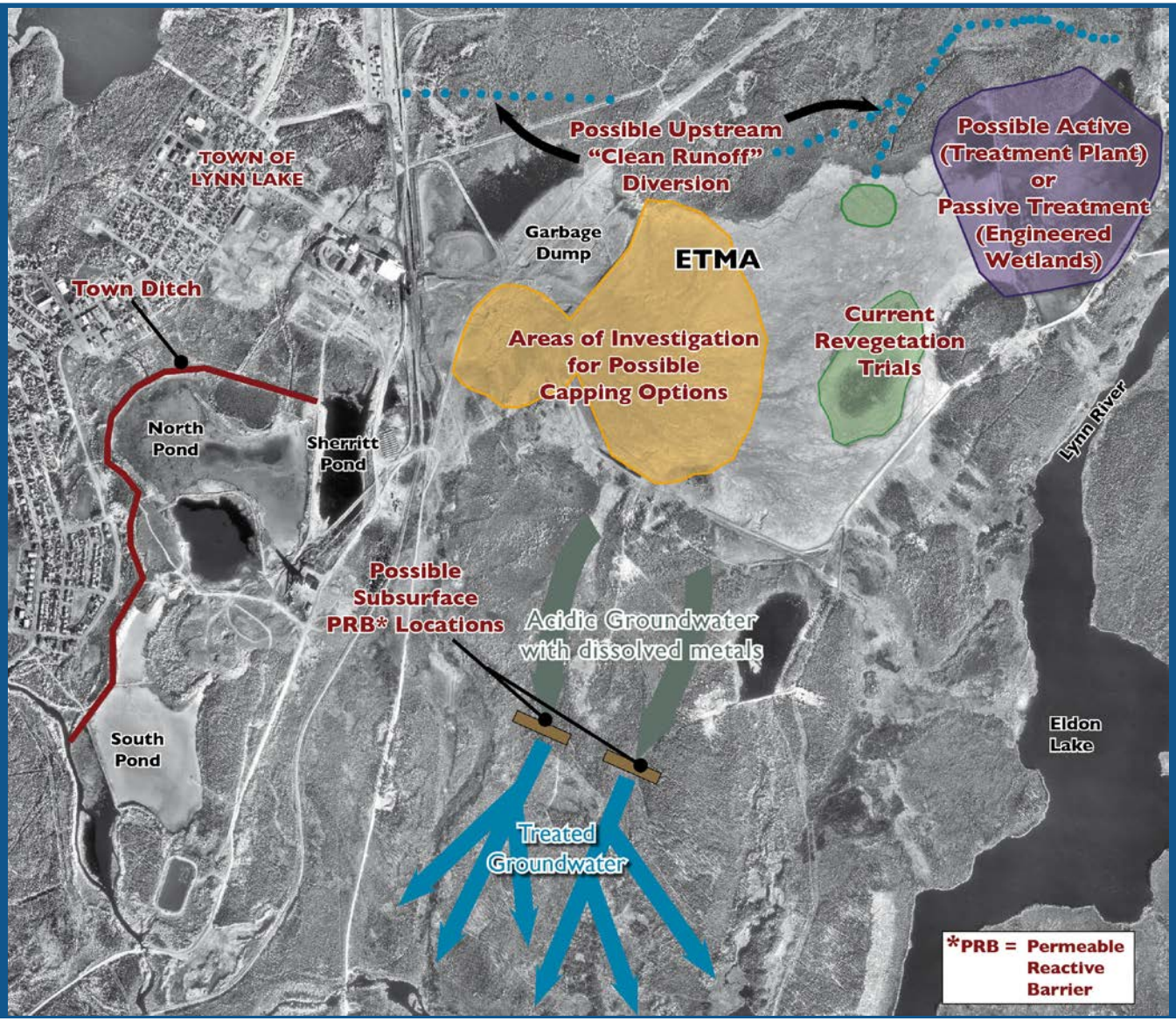
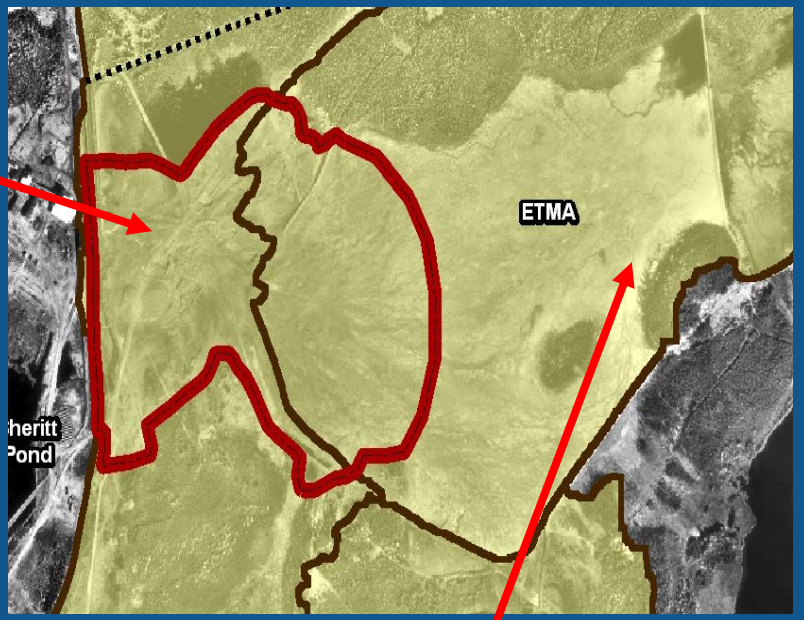


Capping or Cover (2 types required)

Coarse Tailings

- Store & release cover design
- Design should reduce net percolation & control dust
- Metals bound in hardpan
- Tailings must be kept aerobic to prevent remobilization
- Cover could lower groundwater in fine tailings



Fine Tailings

- Largely un-oxidized
- Capillary break or infiltration barrier to maintain anaerobic conditions

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Cap Trials

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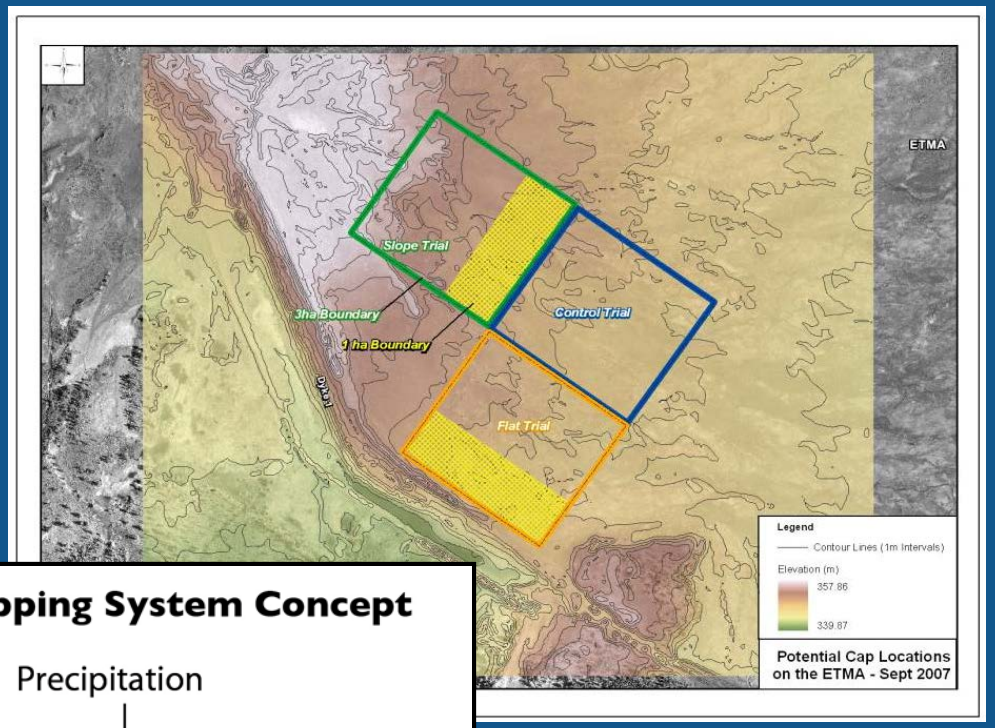
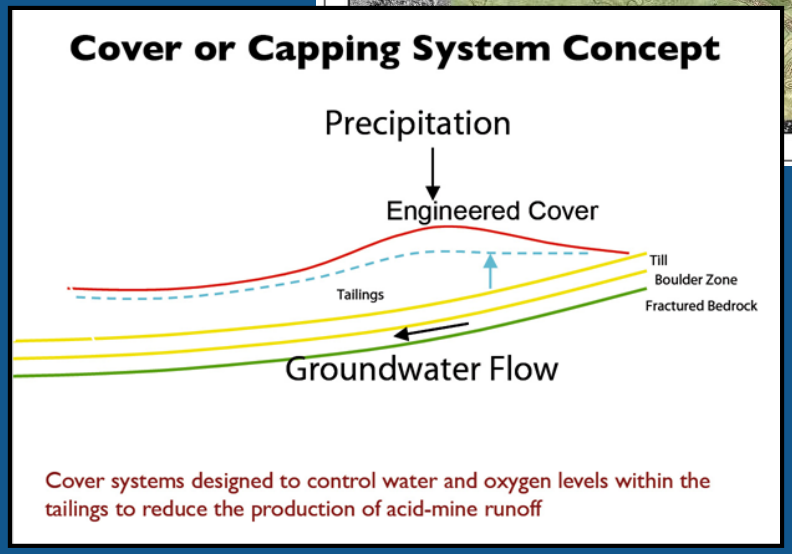
2 x 3 hectare (7.5 acre) trial cover plots constructed using 1-m thick layer of native silty till

- Trial plots vary in slope
- Half of each plot will be amended with organic material to encourage vegetation growth





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Cap Trials (cont'd)

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Native silty till obtained locally

Cover materials were placed from December 2007 – February 2008

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Cap Trials (cont'd)

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Solutions for a Sustainable Environment

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Cap Trials (cont'd)

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Next Steps:

- Spring 2008: Final grading, seeding & instrumentation
- Fall 2008: Monitoring & full-scale design using data from trials

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Reduction in Surface Water Loading

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Clean Water Diversion

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Clean Water Diversion

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Clean Water Diversion

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Trial Permeable Reactive Barrier (PRB)

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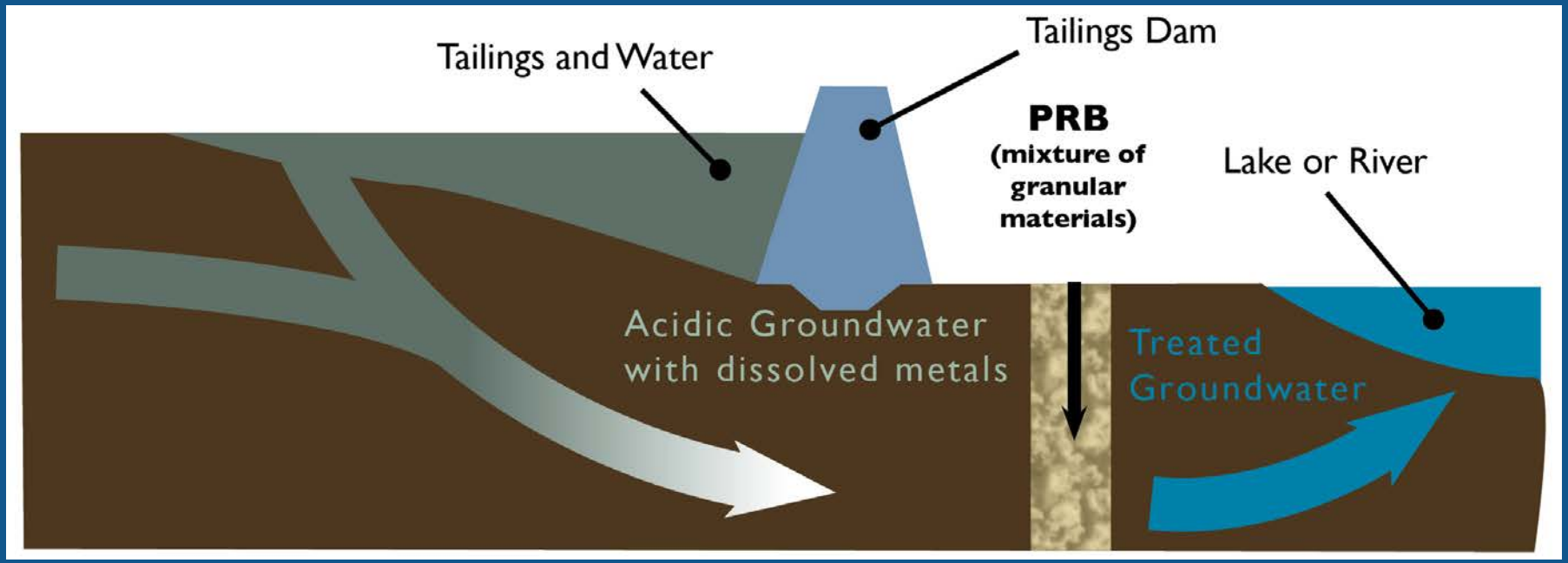
- Typical materials used in PRB walls include fresh and aged wood chips, compost, crushed limestone, iron filings



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PRB installation

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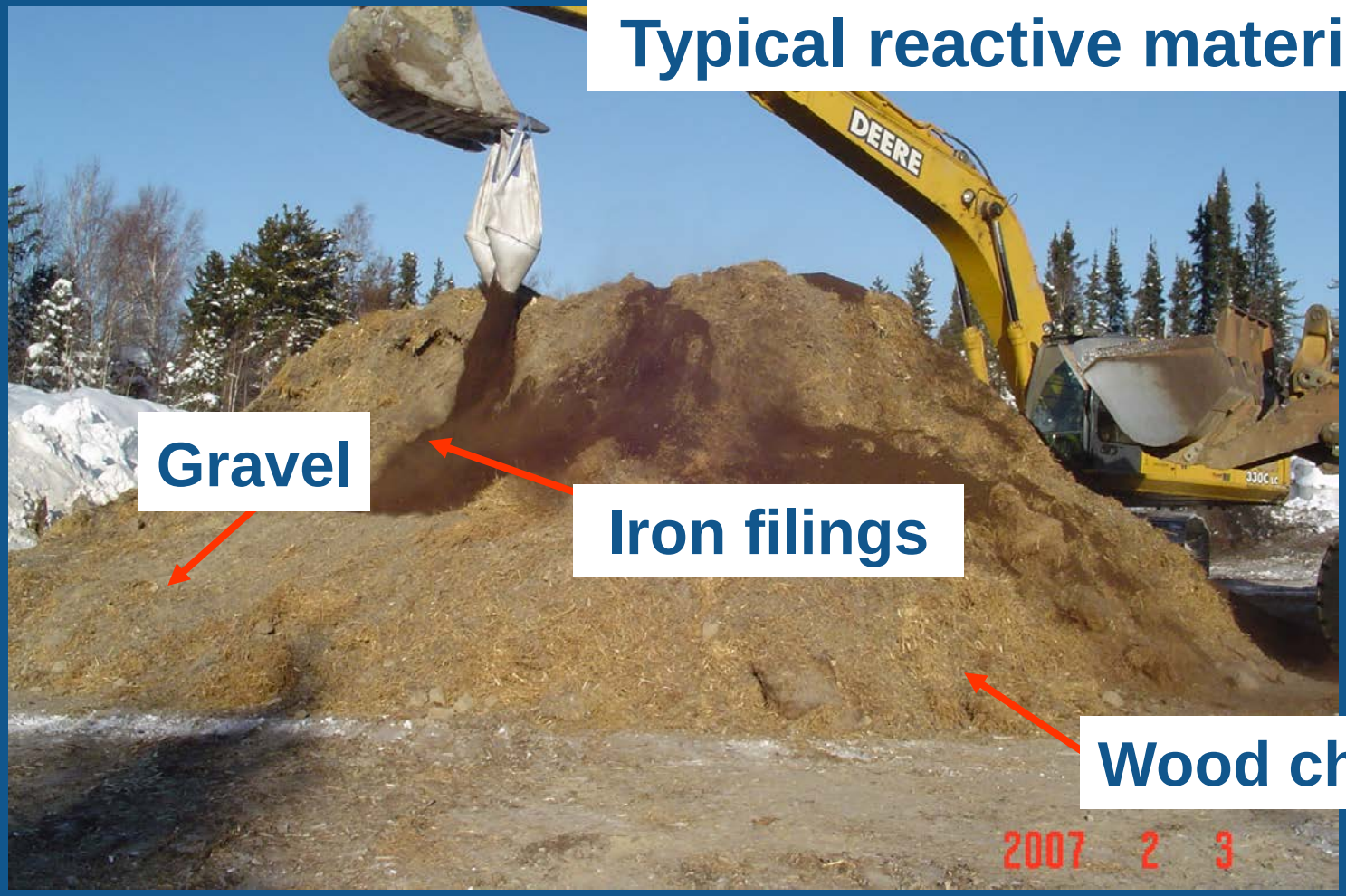

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PRB installation

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PRB installation

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Treatment Wetland

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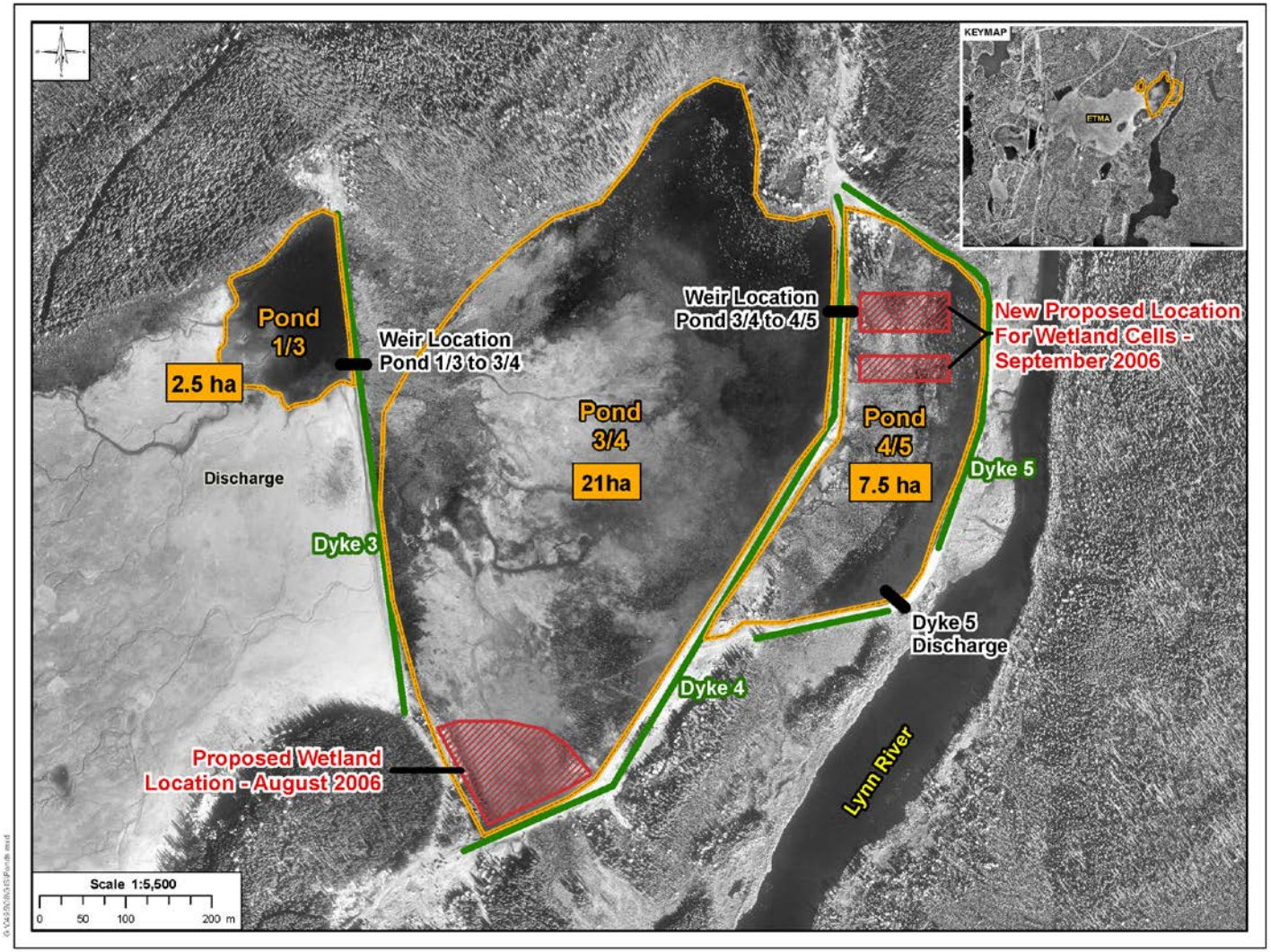

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Treatment Wetland

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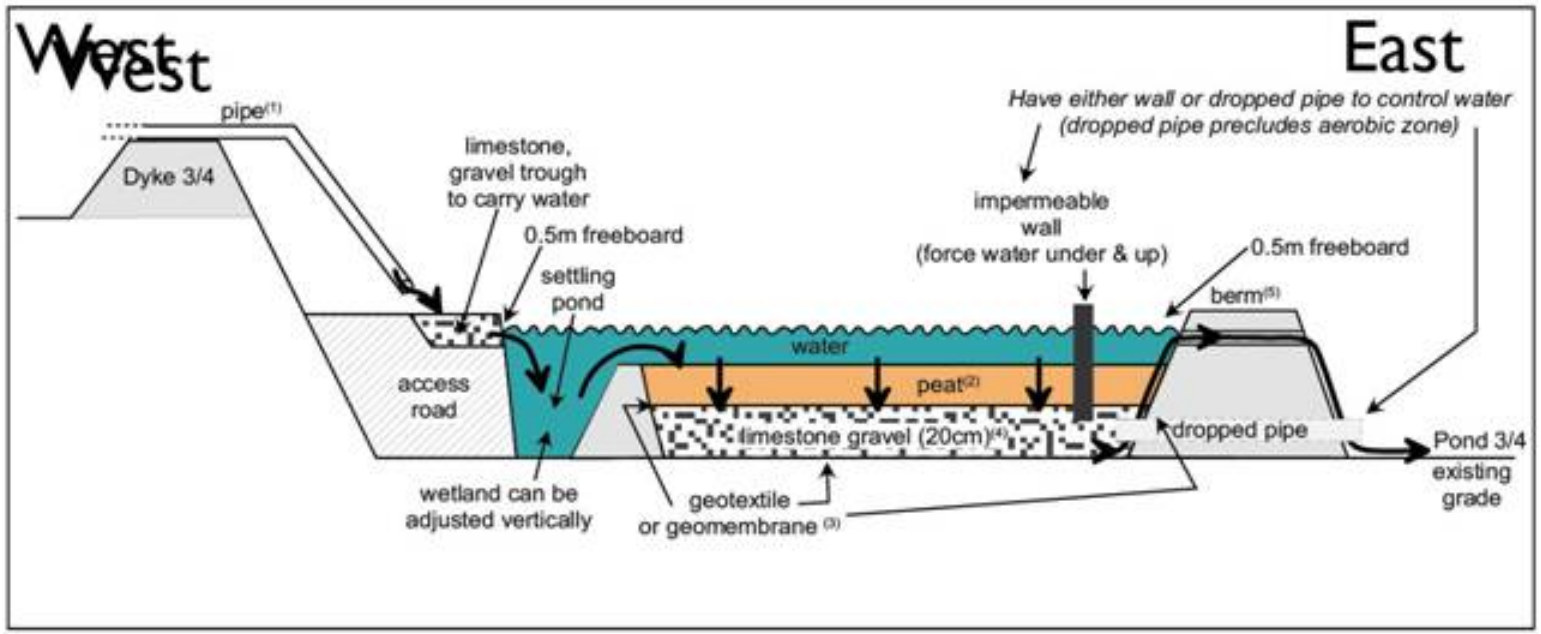

(1) Pipe is 2 km long
(2) 50 cm peat /0.M = 4500 m³ O.M. // 500 m³ limestone sand
(3) 20,000 m² (1/2 for base, 1/2 for gravel/peat interface)
(4) 2,000 m³ limestone
(5) 4 m³/m x 400 m @ 1m high =1,600 m³ crushed rock
@ 1.5m high = 2,400 m³ crushed rock

Schematic Illustration of Engineered Wetland (Side View)

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Passive Treatment: Limestone

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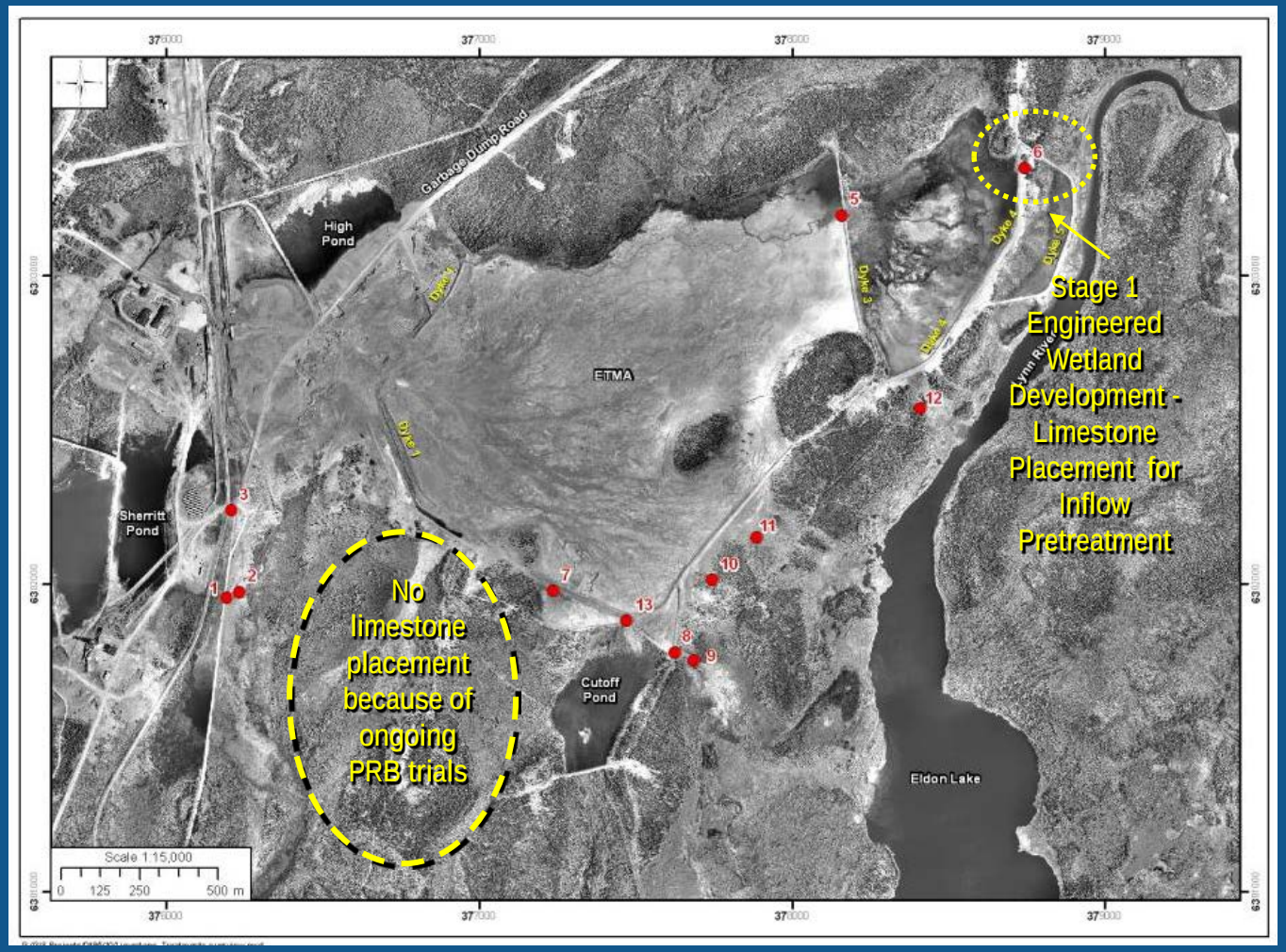
High-grade limestone spread at key locations to:

- Intercept flows
- Reduce acidity
- Reduce contaminants

Next Steps include: effectiveness monitoring &, as required, replenishment of consumed limestone



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Passive Treatment: Limestone

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Limestone spread upstream of Pond 5 as part of wetland treatment trial

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Limestone Placement (cont'd)

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Early test results show reduction in acidity

2008 Planned Activities

Activities planned for the ETMA for 2008 include continued:

- Monitoring of tailings-basin surface-water runoff & groundwater hydrology & chemistry, & associated possible ecological impacts
- Gathering of data to evaluate the effectiveness of ongoing intervention trials (e.g., permeable reactive barriers, trial cap, limestone treatments, diversion ditch, vegetation trials, etc.)
- Assessing of existing infrastructure to ensure provision of stable tailings storage
- Implementing of site interventions (e.g., extensions to trial cap, engineered wetland, further limestone placements)

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Spring 2008

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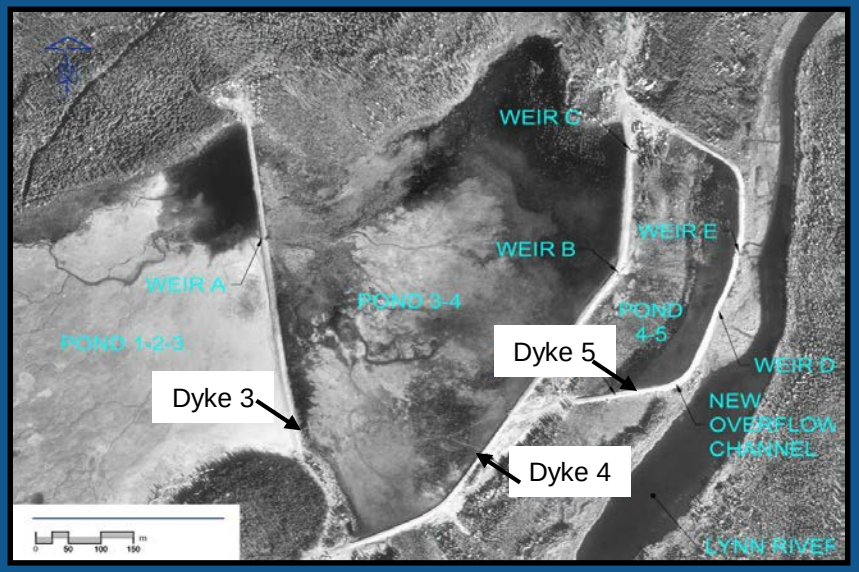
Spring-Freshet Monitoring (collection of samples & measurements of flows) April 2008

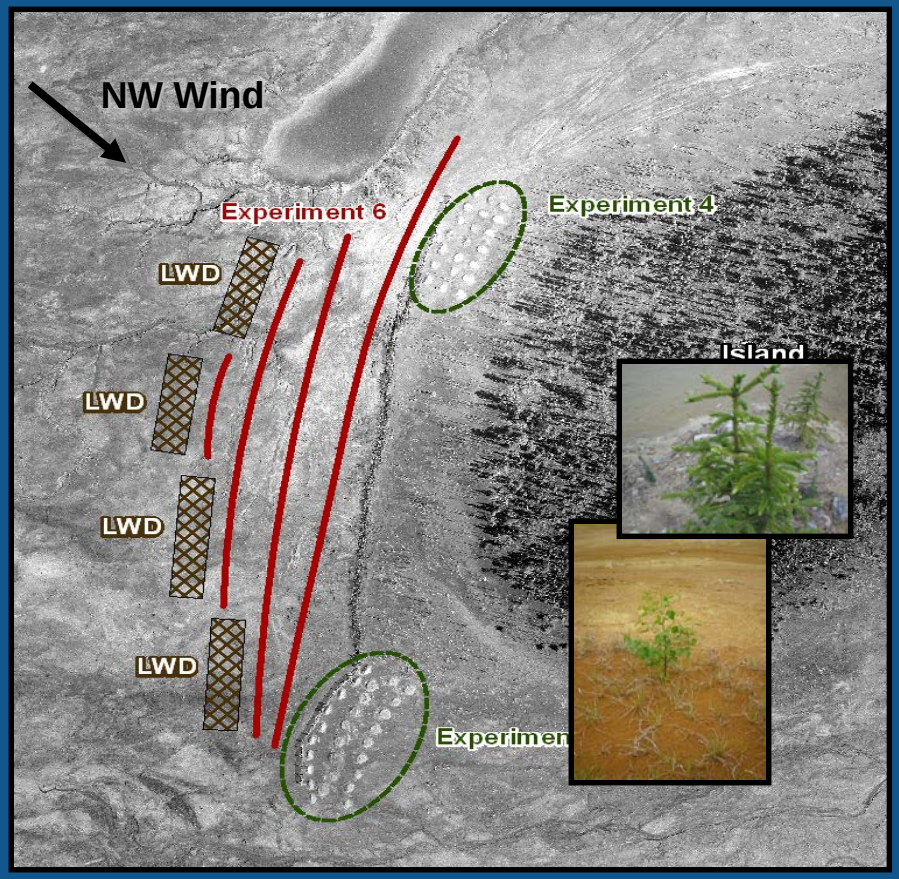


Annual Dyke-Stability Inspection June 2008

Spring 2008 (cont'd)

Placement of large woody debris (LWD) to selected locations May 2008

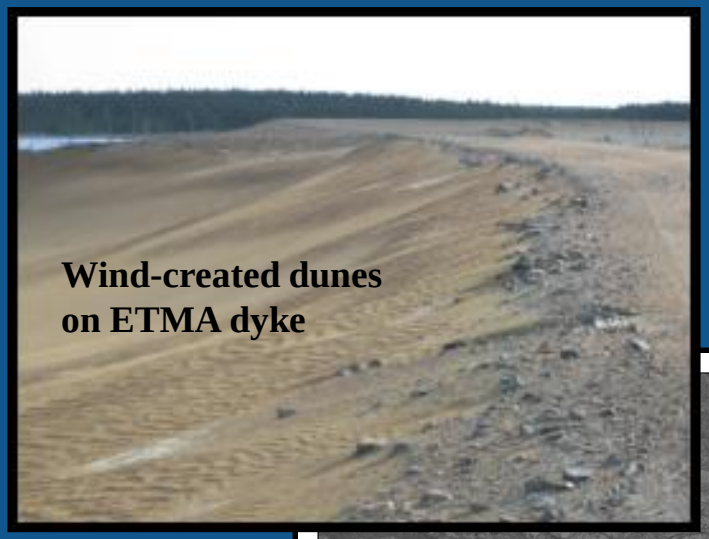
Further windrow creation May-June 2008 (for MB Forestry seedling planting in early June)

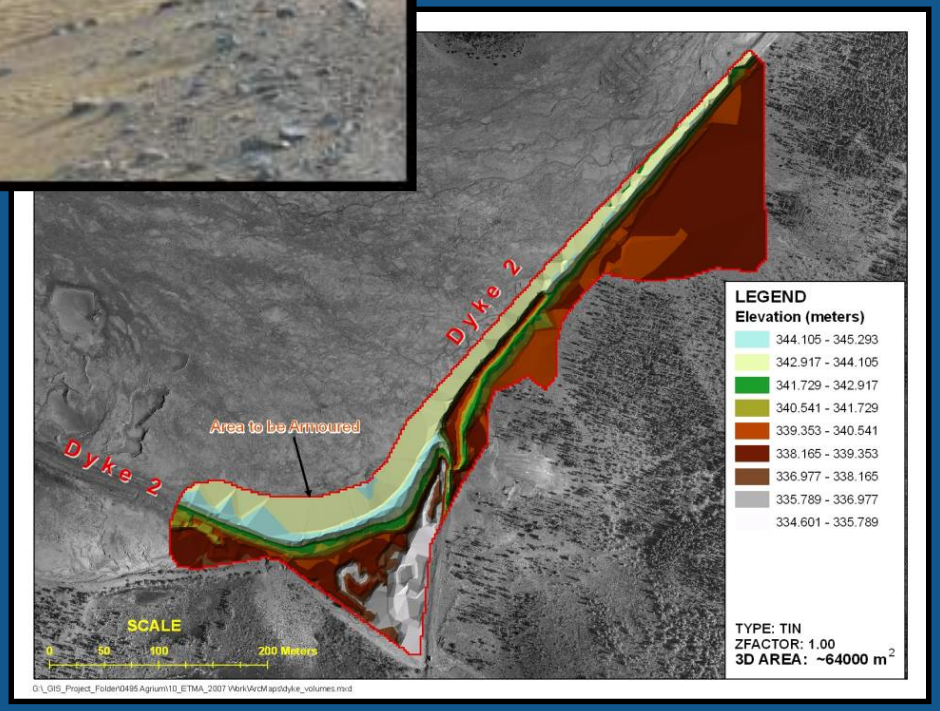


Spring-Summer 2008

Construction of Dust-Suppression Trial May-July 2008

- Covering of key locations most vulnerable to erosive winds blowing towards Town & Lynn River
- Using non-reactive crushed rock & till





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Summer 2008

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Annual surface water & groundwater fieldwork June & July 2008

Work to confirm initial results of 2007 River-Health Assessment (demonstrating healthy fishery) August 2008

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Summer 2008 (cont'd)

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Weather-dependent further construction of Engineered Wetland in Pond 4-5 – Stage 2 (trial cell)

Provision & further placement of additional limestone

Questions?