The East-Sullivan Mine Site :

Merging Prevention and Treatment of Acid Mine Drainage

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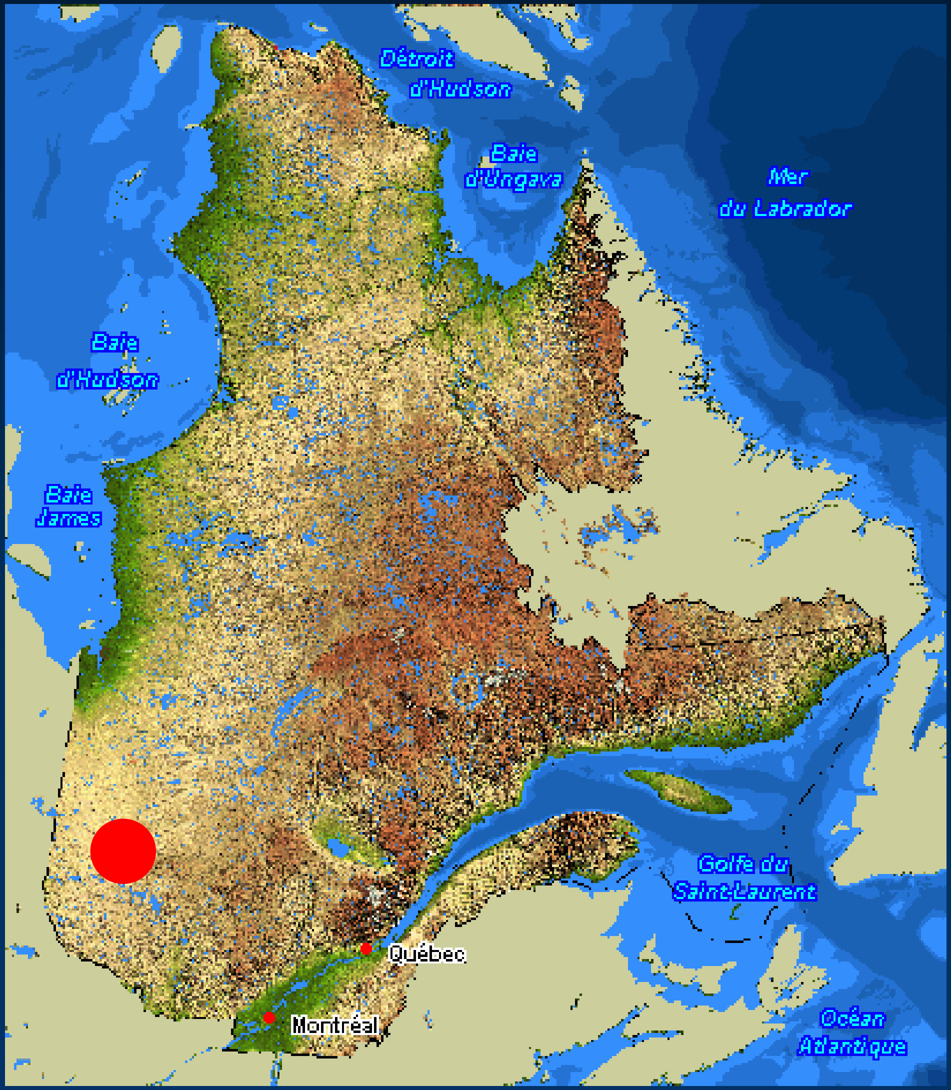
The East-Sullivan Mine Site

Val d'Or
North-Western
Québec



Impoundment Characteristics

Cu, Zn (Au, Ag) Mining from 1949 to 1966

total area: 136 ha
(+ 68 ha spilled tailings)

total mass of tailings: 15 Mt

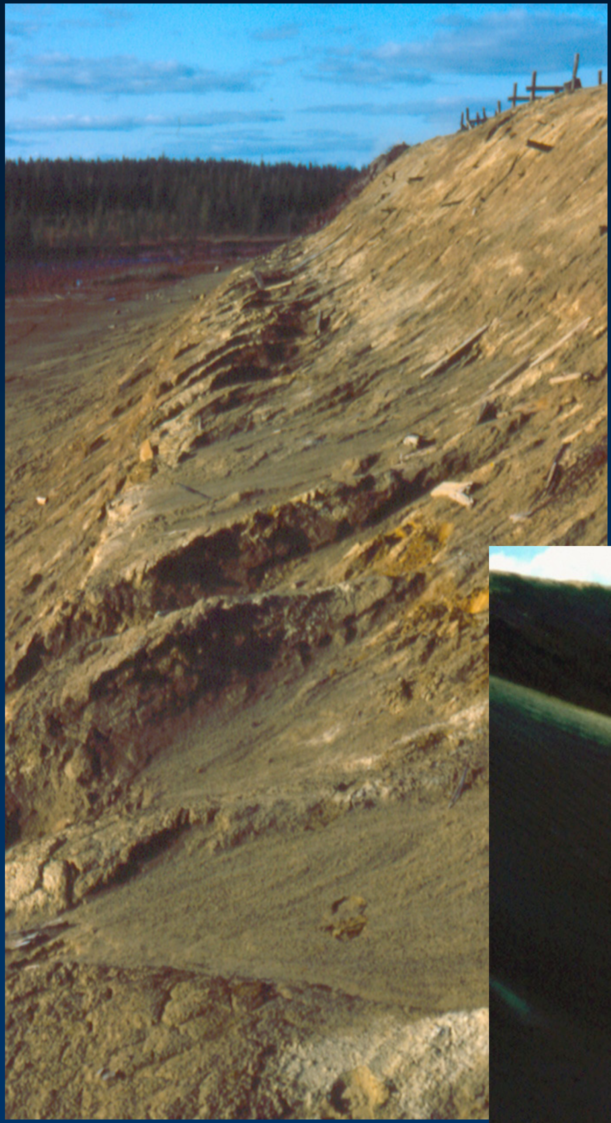
$S_{sulphide}$: 3,5% (mainly pyrite)

total acid potential:
400 350 t. $CaCO_3$

total neutralizing potential:
50 280 t. $CaCO_3$

Abandonment : 1966 to 1984

Water and Wind Erosions



Requirements for Mine Final Effluent

Acceptable pH : 6.0 – 9.5

Acceptable concentrations (mg/l) :

	monthly average	maximum in a single sample
Fe:	3,0	6,0
Cu:	0,3	0,6
Zn:	0,5	1,0
Pb, As, Ni, *etc.*:	…	…

(*Québec MDDEP*)

To achieve these criteria, the mining industry needs tools to stop metal-rich acid drainage or to treat unacceptable effluents.

Acid Mine Drainage : Reactions

$FeS_2 + {}^7/_2O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+$

(*Acidiniobacillus ferrooxidans* : X 10^3 to 10^6)

$Fe^{2+} + {}^1/_4O_2 + H^+ = Fe^{3+} + {}^1/_2H_2O$

$Fe^{3+} + 3H_2O = Fe(OH)_3 + 3H^+$

$FeS_2 + 14Fe^{3+} + 8H_2O = 15Fe^{2+} + 2SO_4^{2-} + 16\ H^+$

To stop AMD production : limit oxygen and/or water access to sulphides

Objectives

To demonstrate that:

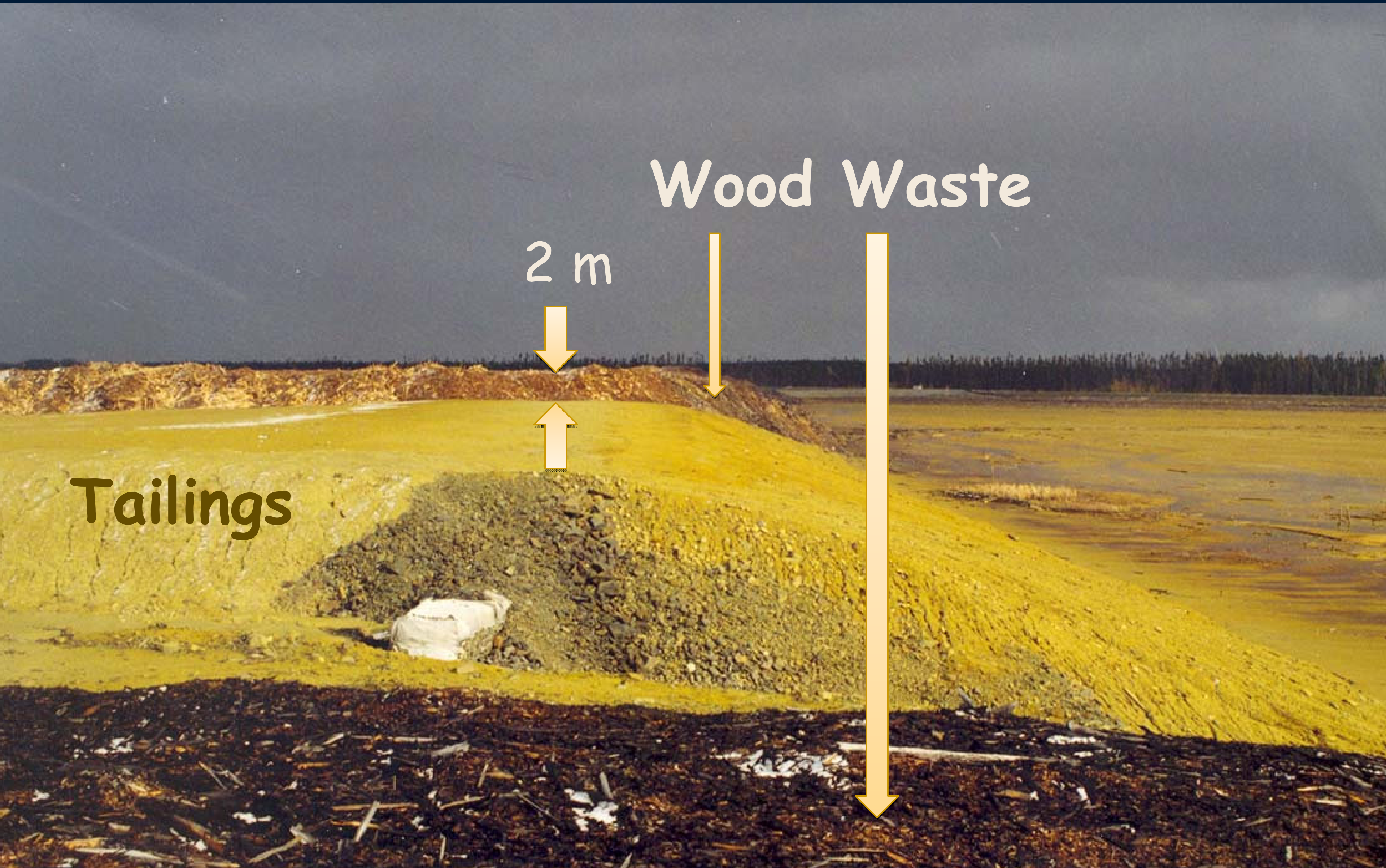
1. Organic cover does limit …

    i- atmospheric oxygen migration

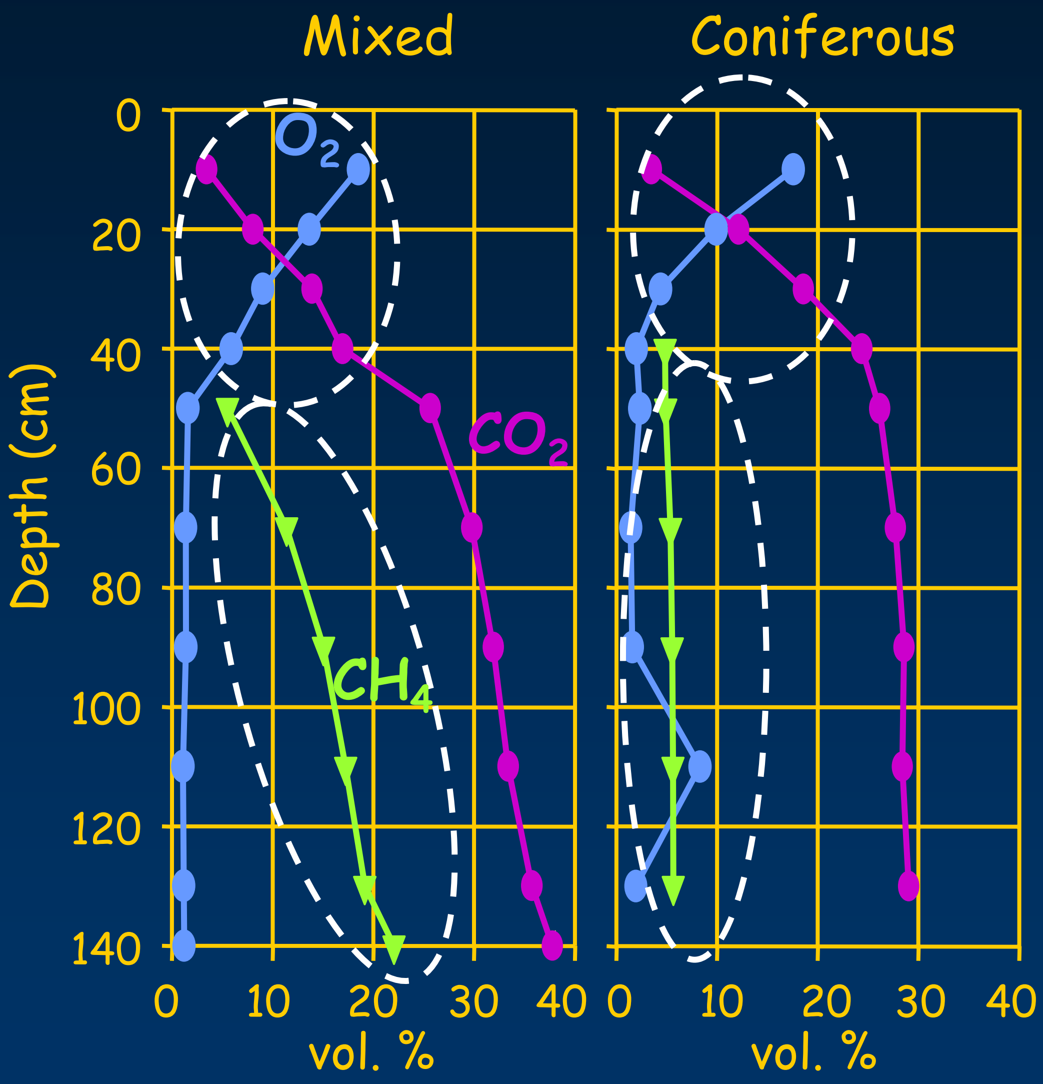
    ii- Acid Mine Drainage production

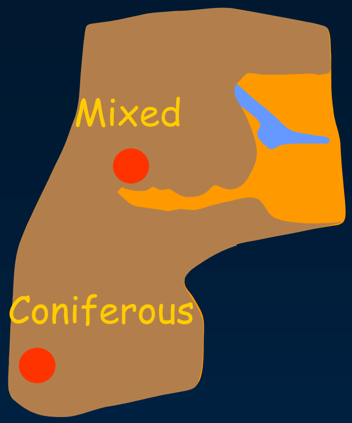
2. Recirculation through the organic cover allows AMD treatment via sulphate reduction processes

New Approach to Restoration : Organic Cover



Pore Gases in Organic Cover

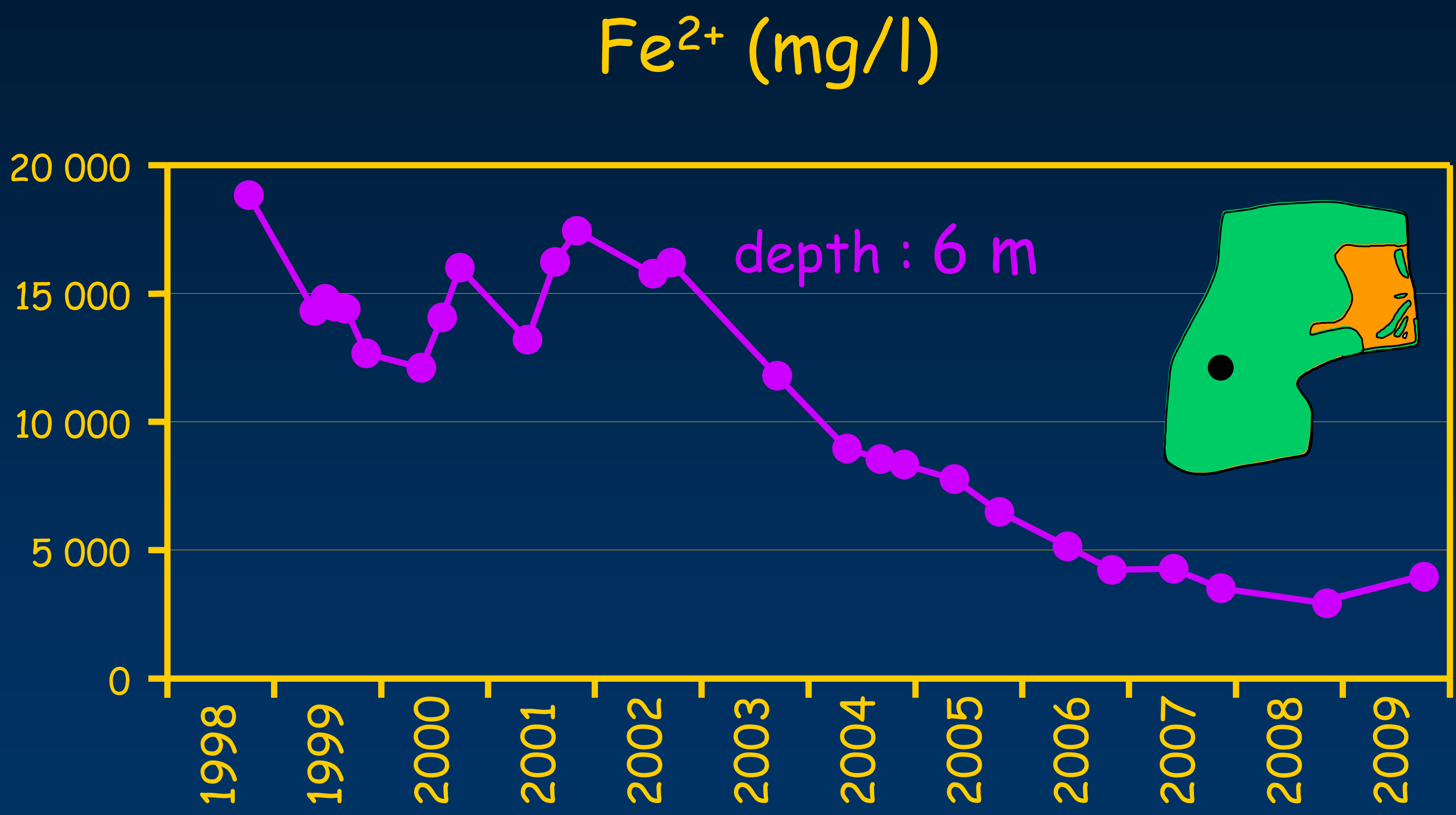




1)
Oxidation of organic matter :
mirror image of O_2 and CO_2
2)
Methanogenesis :
confirmation of anoxic milieu

O_2 consumed :
PYRITE OXIDATION IS HALTED

Groundwater Quality : Core of Plume



Treatment of AMD by Sulphate Reduction

- **The problem :**

  low water quality

  Acid — H^+

  Mine — Me^{2+} and Me^{3+}

  Drainage

- **A solution :**

  reduction of sulphates

  - production of alkalinity
  - sulphides rather than hydroxides precipitation

- **Driving principle :**

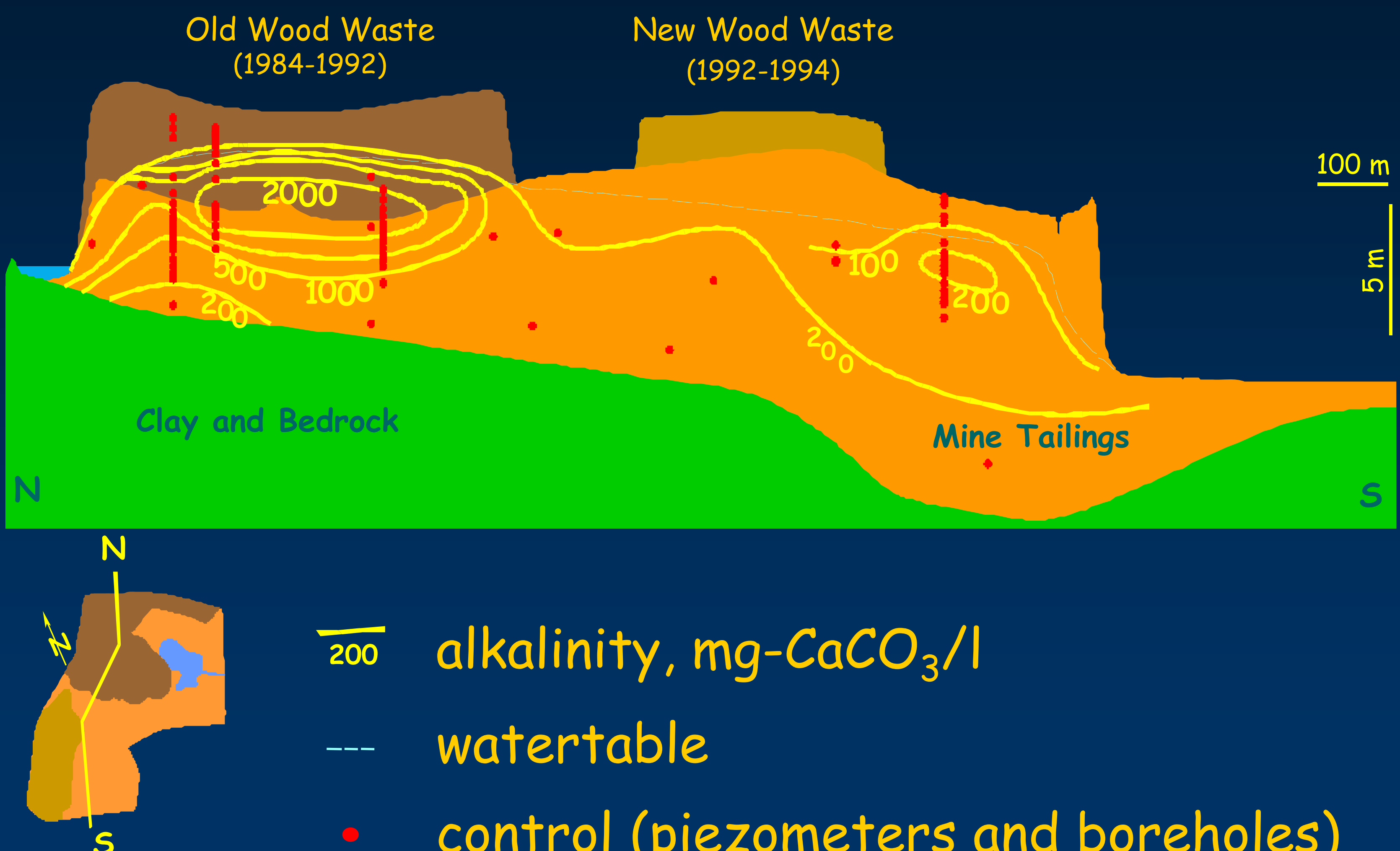
  redox reaction (*Desulfovibrio sp.*)

  $SO_4^{2-} + 2CH_2O = H_2S + 2HCO_3^-$

  sulphate reduction : precipitation of metal sulphides

  $Me^{2+} + H_2S = MeS + 2H^+$

Alkalinity Distribution (1994)



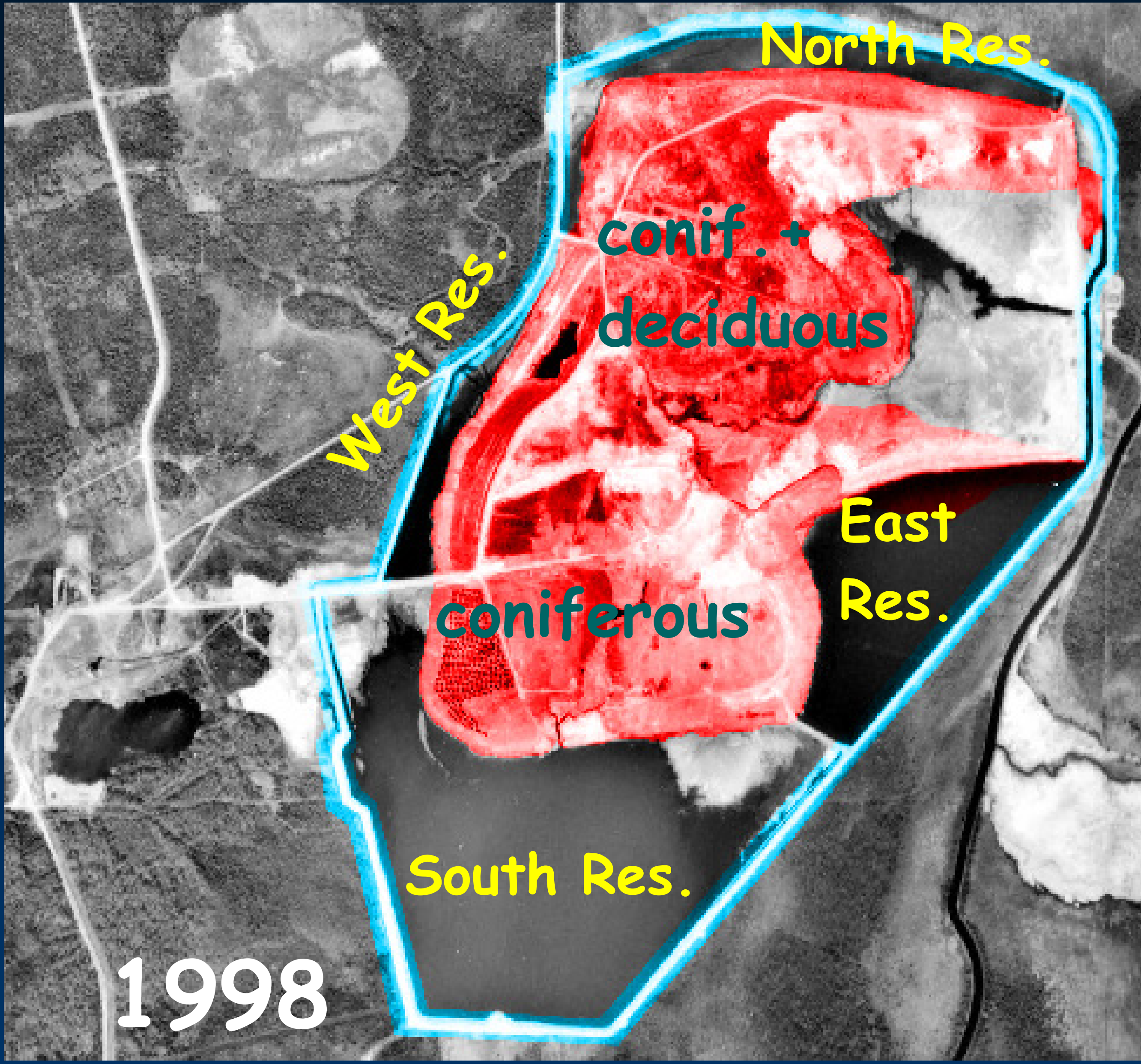
200 alkalinity, mg-$CaCO_3$/l

--- watertable

• control (piezometers and boreholes)

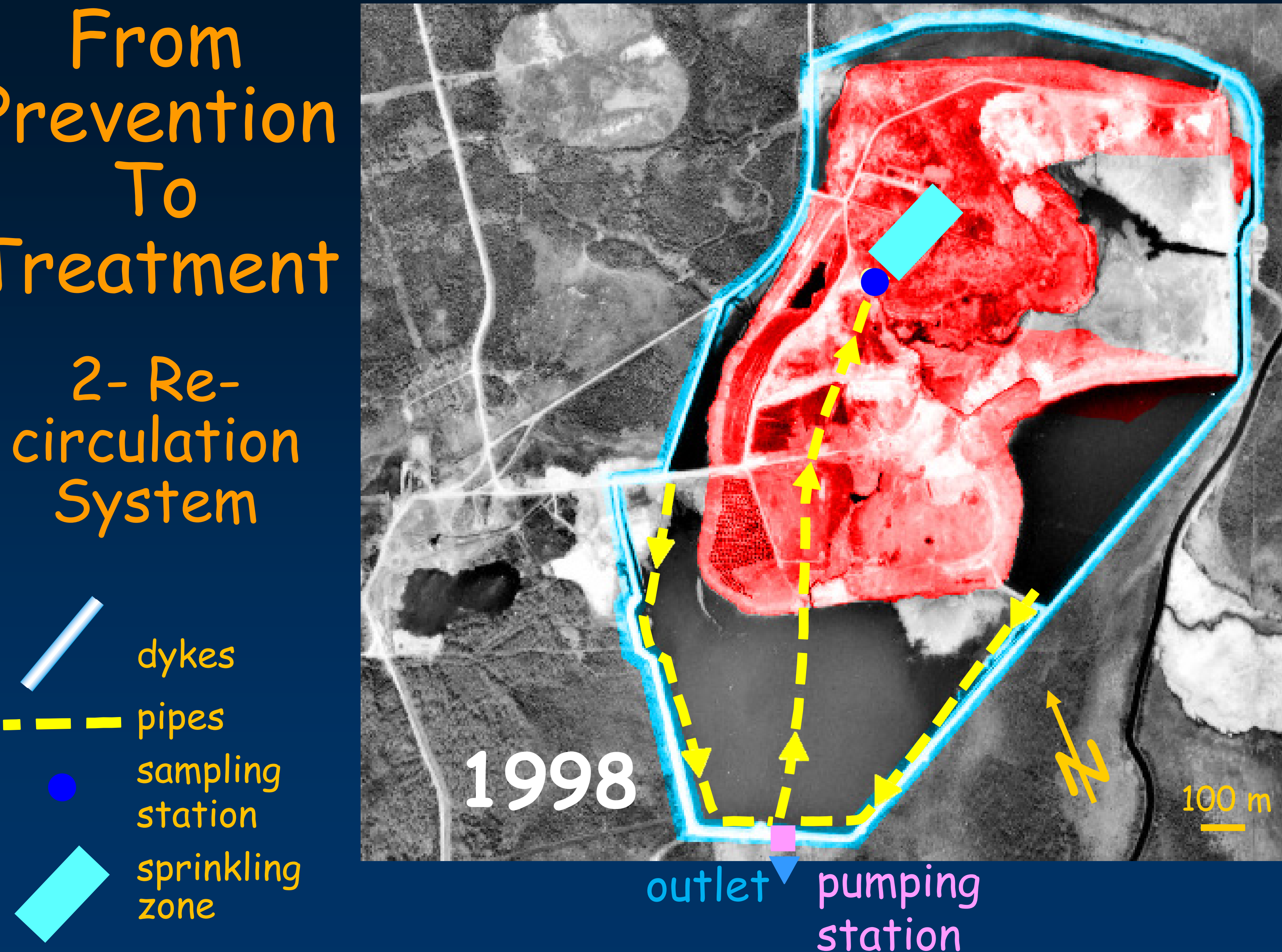
From Prevention To Treatment

1- AMD Collection

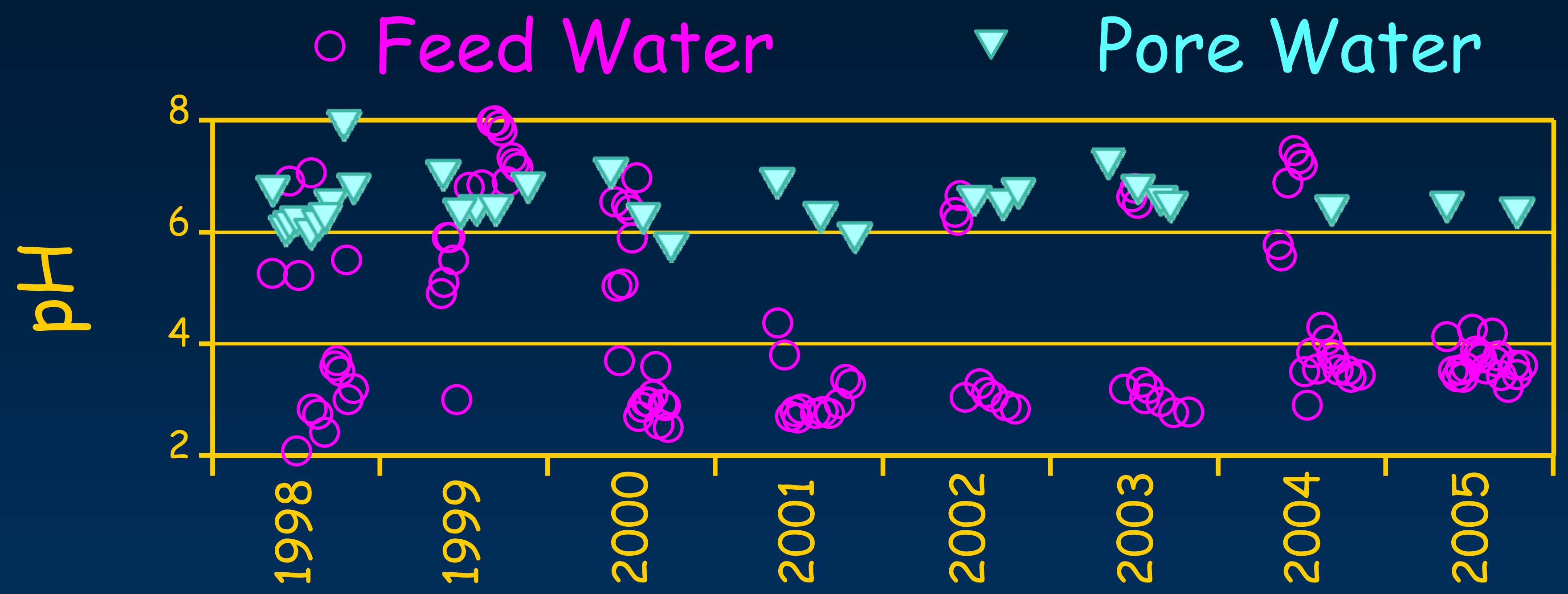


From Prevention To Treatment

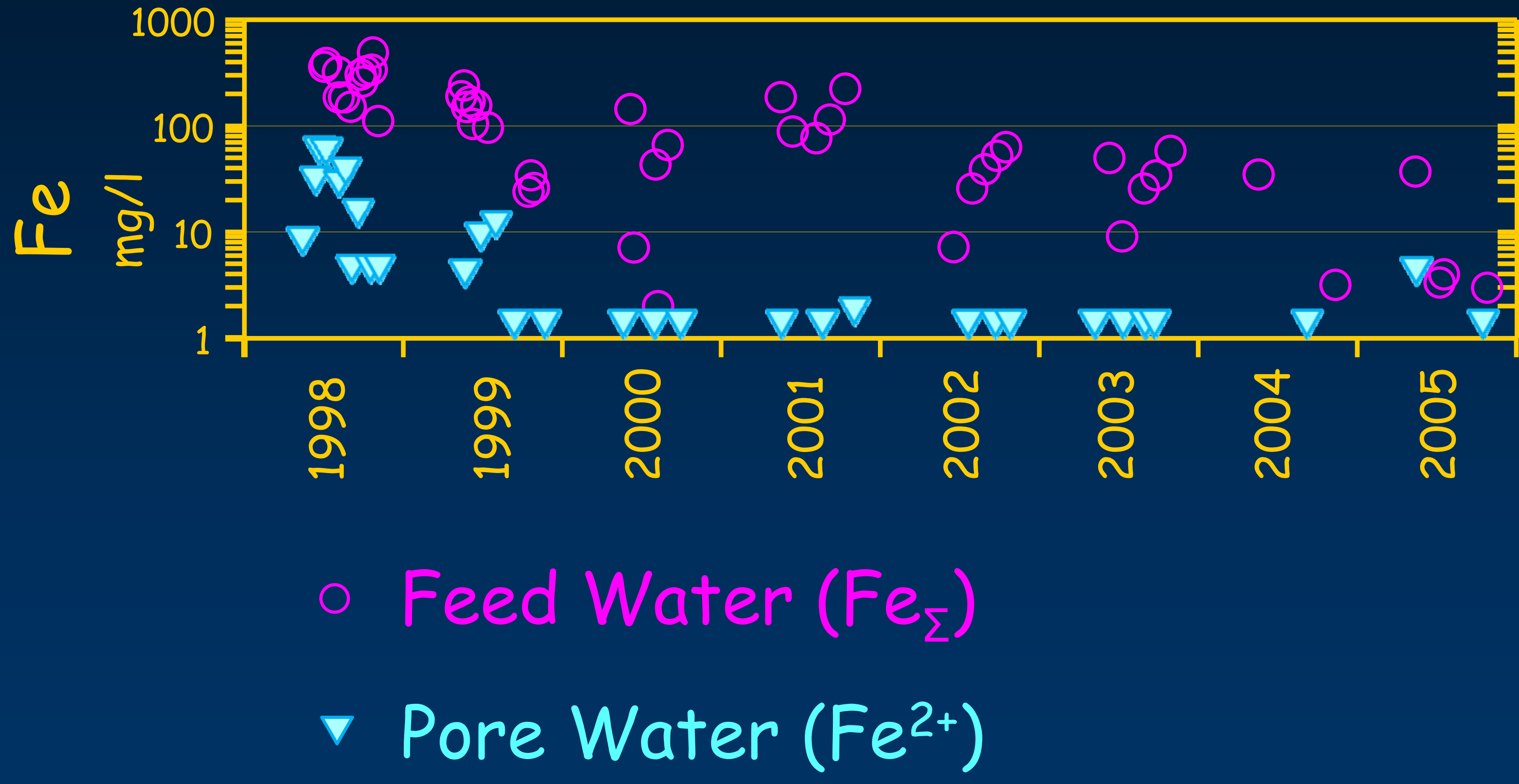
2- Re-circulation System



Feed vs Pore Waters : pH

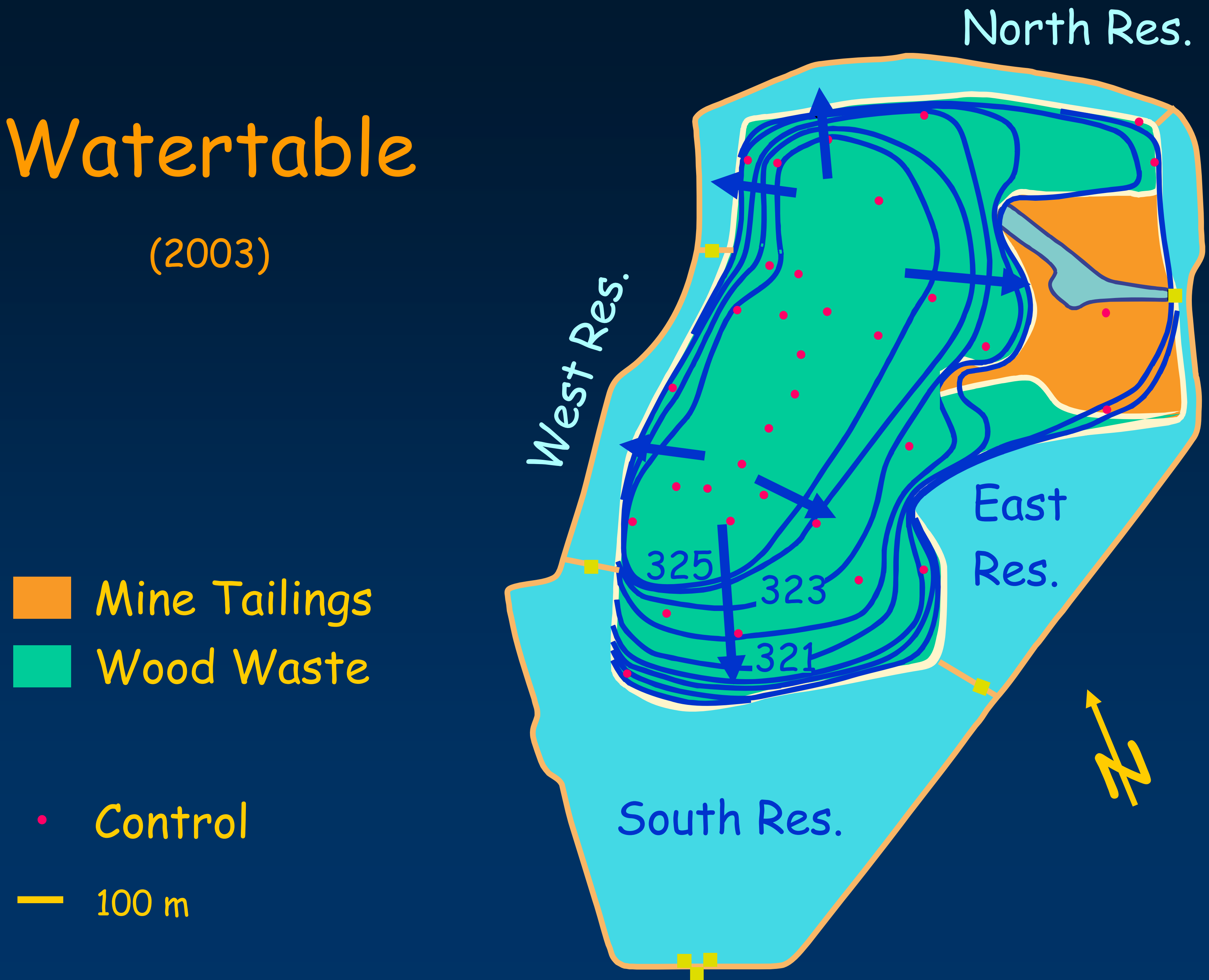


Feed vs Pore Waters : Fe

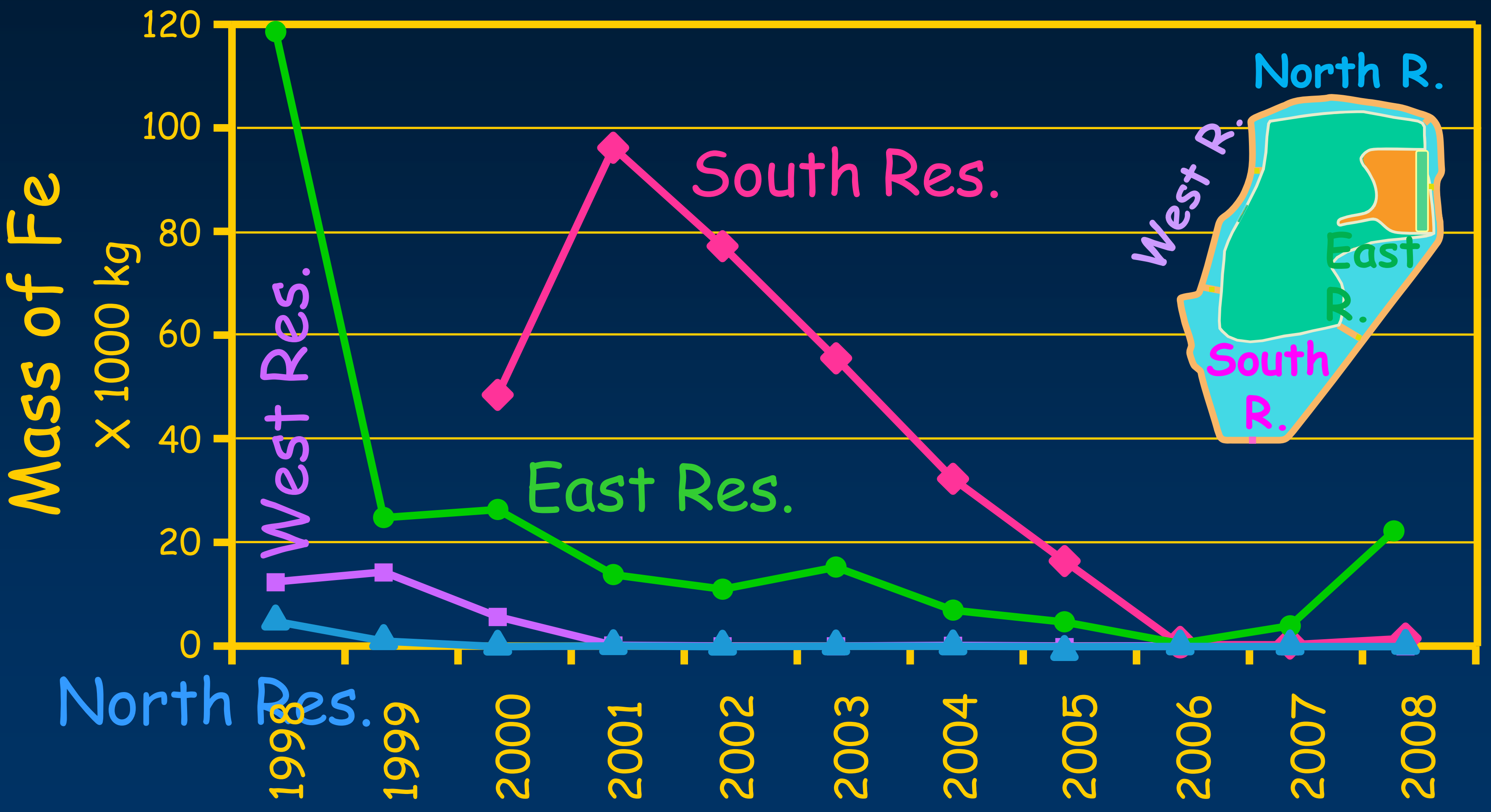


Watertable

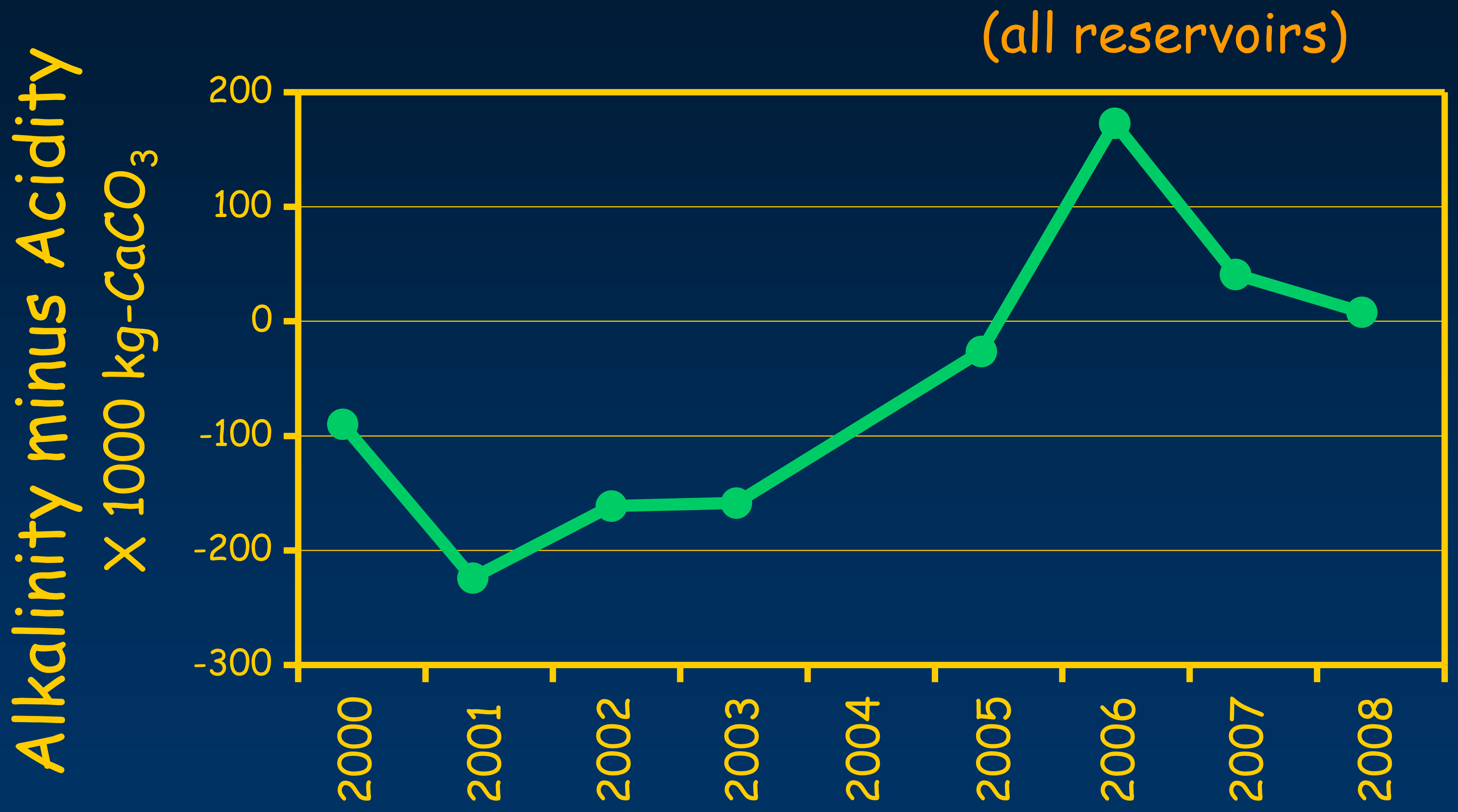
(2003)



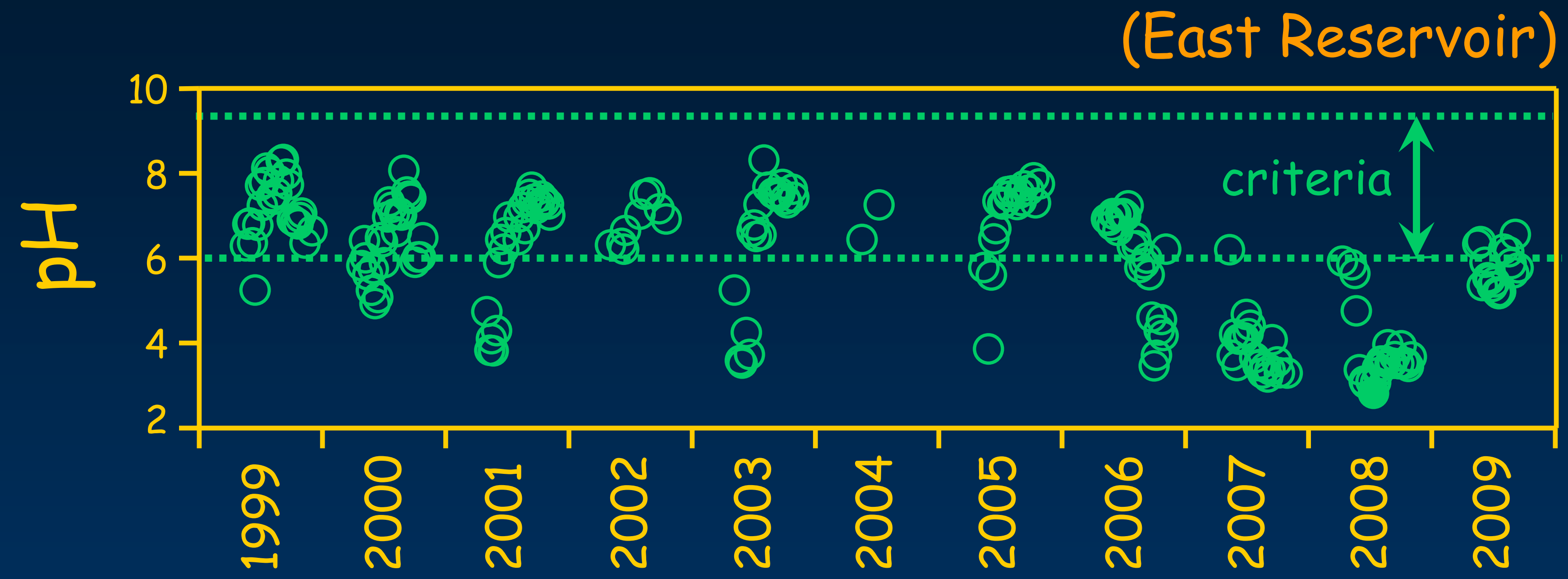
Surface Water : Mass of Fe



Surface Water : Balance of Alkalinity

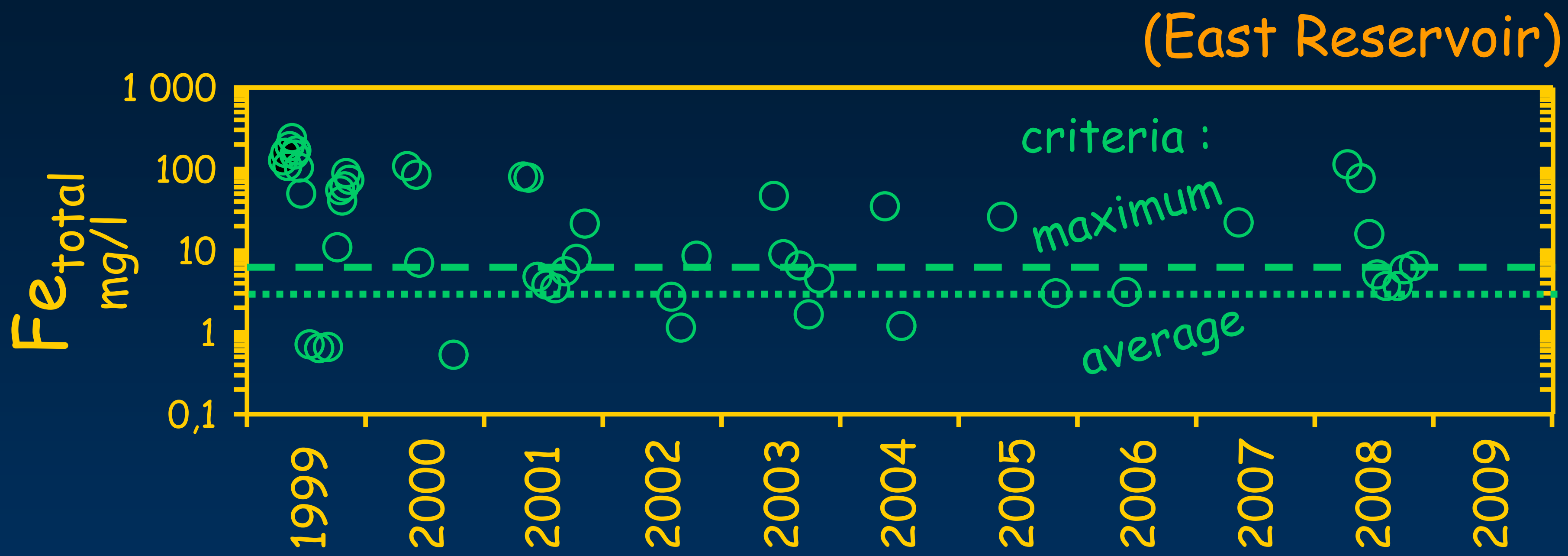


Surface Water : pH

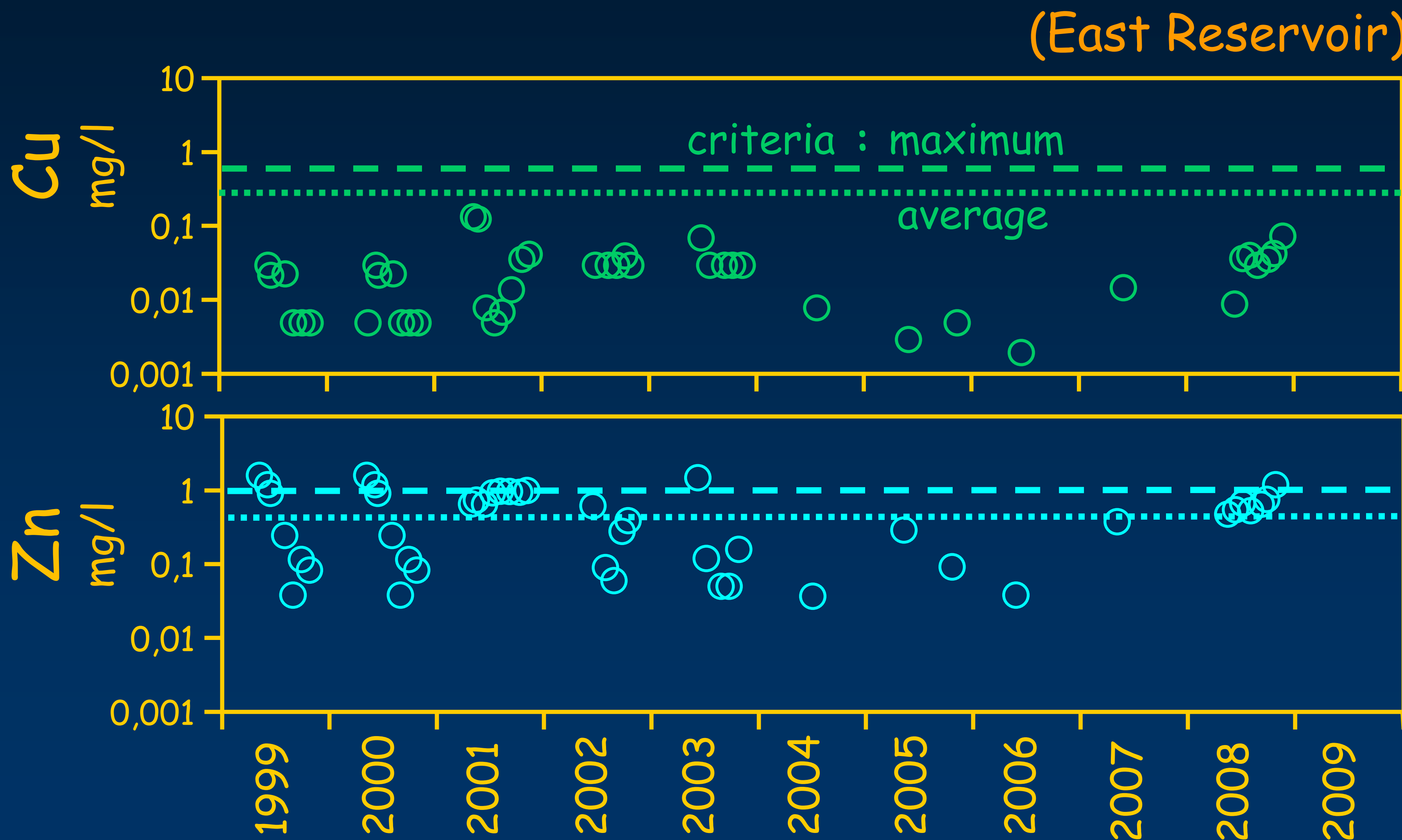


Note : Criteria are shown on the results slides of the East reservoir only as REFERENCE; the final effluent of the East Sullivan site is located south of the pumping station.

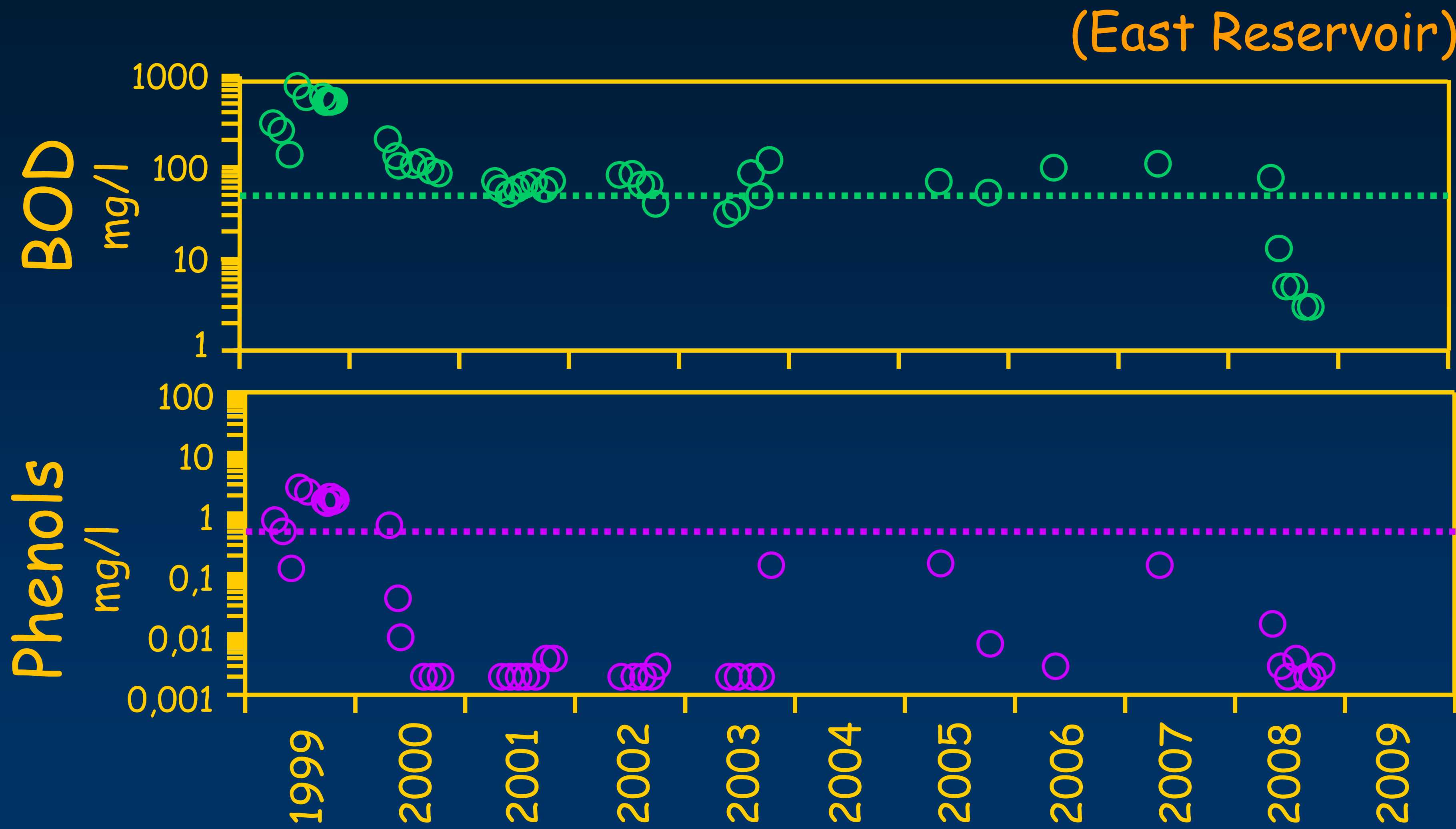
Surface Water : Fe



Surface Water : Cu & Zn



Surface Water : BOD & Phenols



How is Nature Responding?

Conclusions

Organic Cover

- stops efficiently atmospheric oxygen migration
- allows higher infiltration of water that rises the watertable, implementing a 'wet cover' condition, which acts as a back up

Conclusions

Recirculation of AMD

- allows a more rapid flushing of pore water within the impoundment
- improves the quality of the effluents via sulphate reduction reactions; in fact, since 1999 the water quality of the final effluent meets the requirements of the Ministry du Développement durable, de l'Environnement et des Parcs du Québec.

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NEDEM


Thank you for your attention !