Towards Closure of the Fire Road Mine

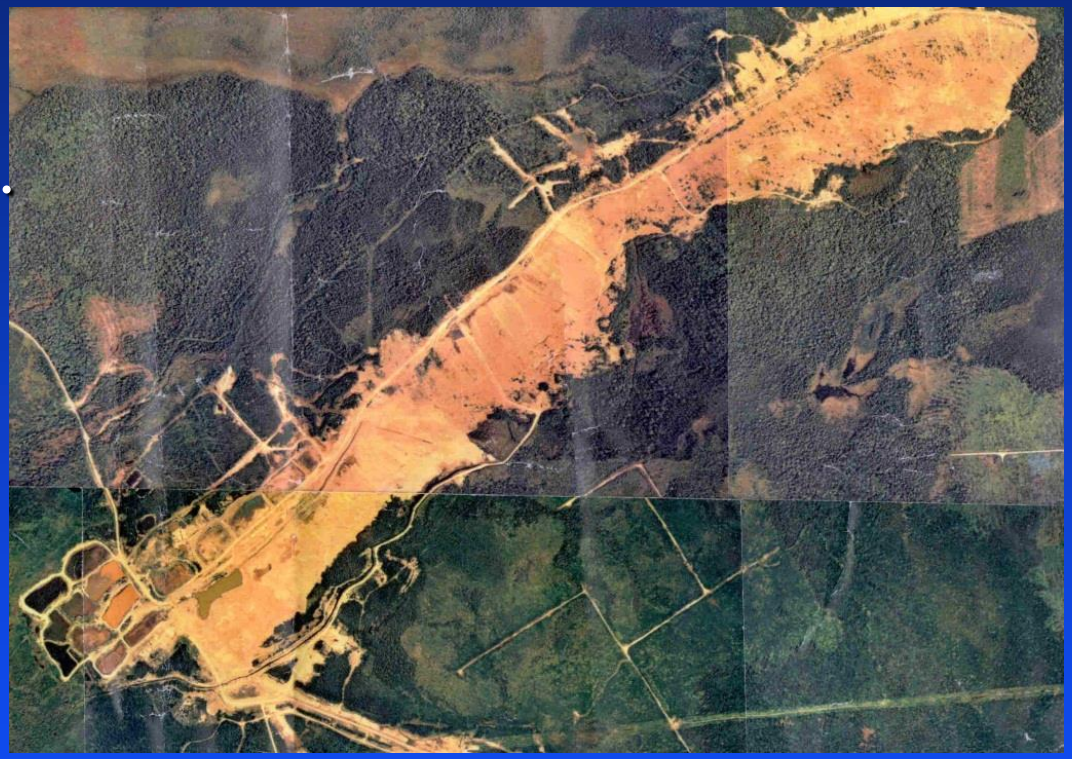
M. Coleman[2], K. Butler[3], E. Mott[3], K. Phinney[1], and S. Pelkey[4]

[1] Consulting Chemist/ Chemical Engineer
[2] NB Power
[3] University of New Brunswick, Dept. of Earth Sciences
[4] Gemtec Consulting Engineers

Mine Location

Background

- Mined 1982-1985;
  - 250 acres site.
- AMD since mid-80's.
- Hydrated lime
  - 4 acre sludge ponds/yr
- Sludge disposal
- Company ceased operations 2009



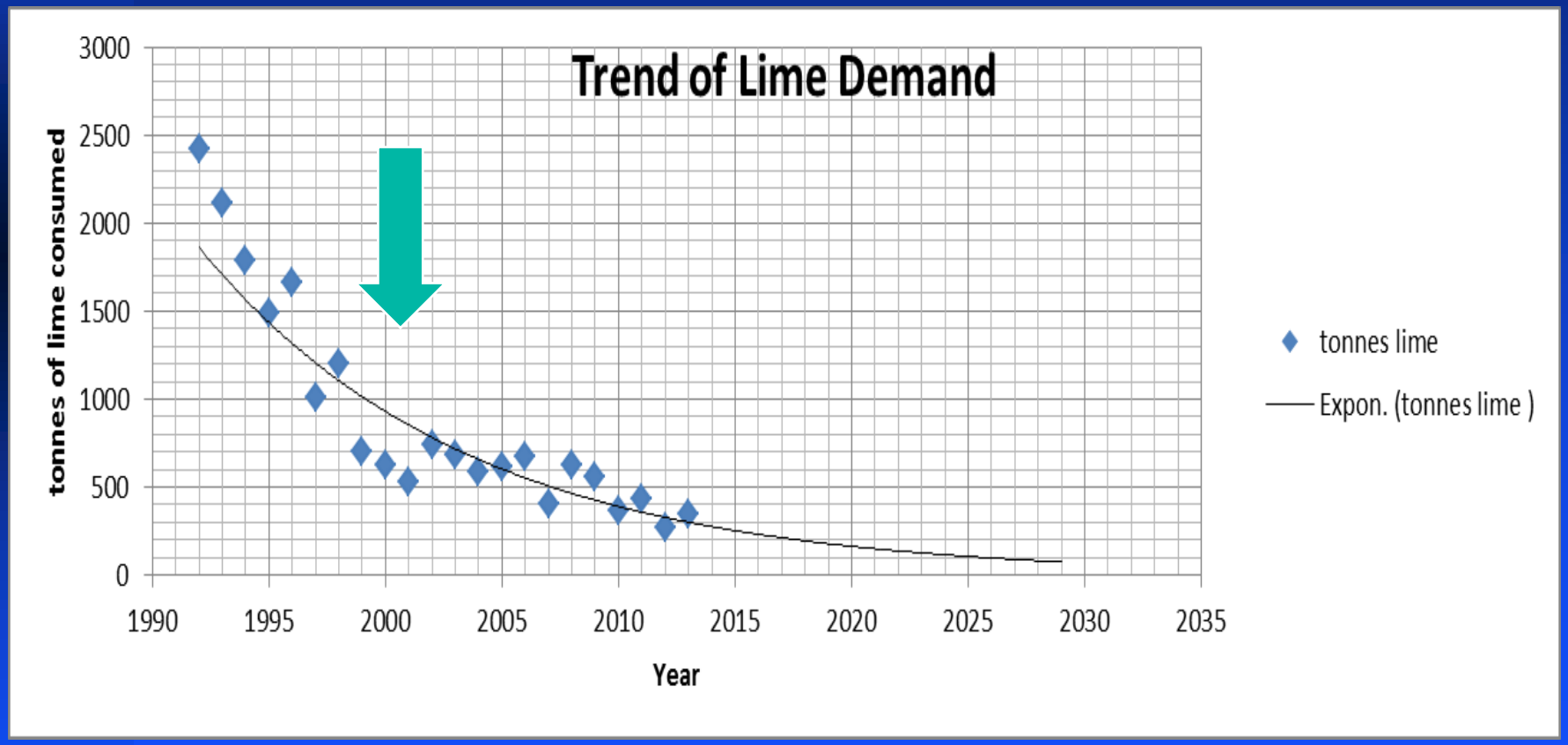
Initial Dredging Rationale

- Disposing of lime neutralization sludge into acid generating rock could provide several benefits including:
  - utilization of the excess alkalinity
  - final disposal area for sludge, still dredge cost
  - reduce diffusion of oxygen into the waste rock
  - decrease personal liability
  - minimize land disturbance.

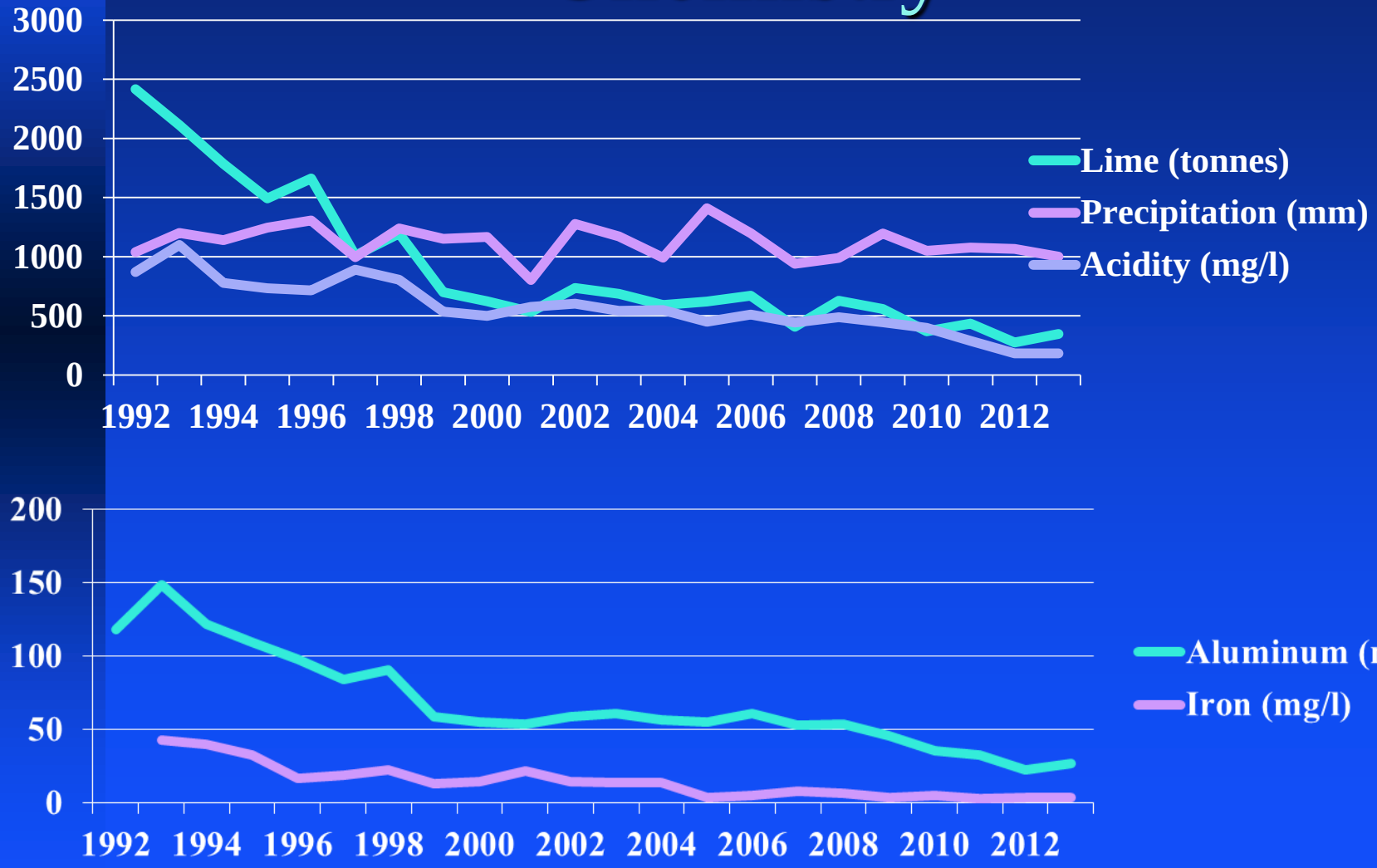
Current Site Conditions

How much longer?

Decreasing Lime Demand in Mine Water Chemistry



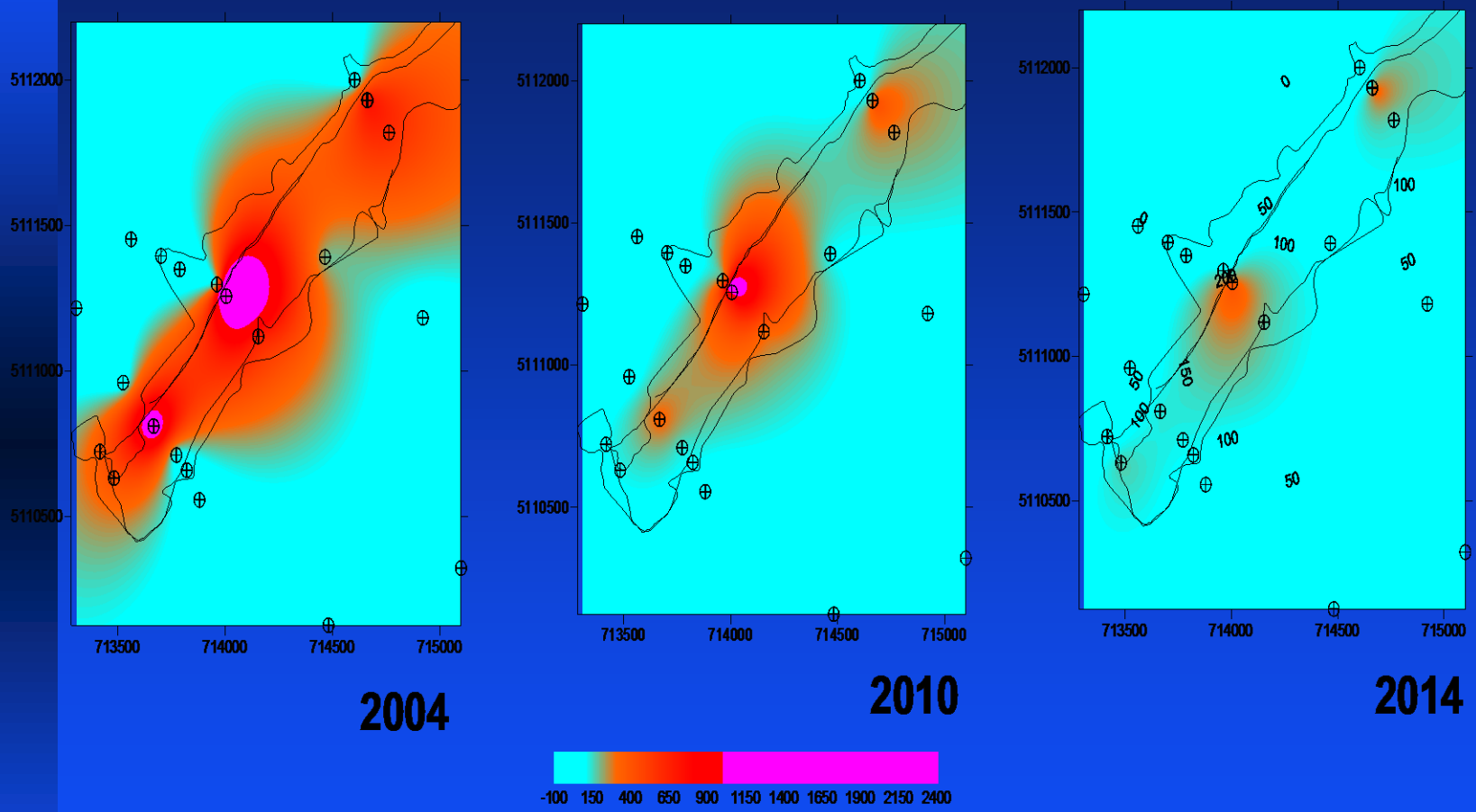
Decreasing Acidity in Mine Water Chemistry



Objective

- Can we map where the acid is being generated?
  - Ground water chemistry; annual well sampling
  - Map the variations in electrical conductivity/resistivity across the mine site (geophysics)
- Potential spot treatment of higher acid generating areas?

Groundwater Well Monitoring

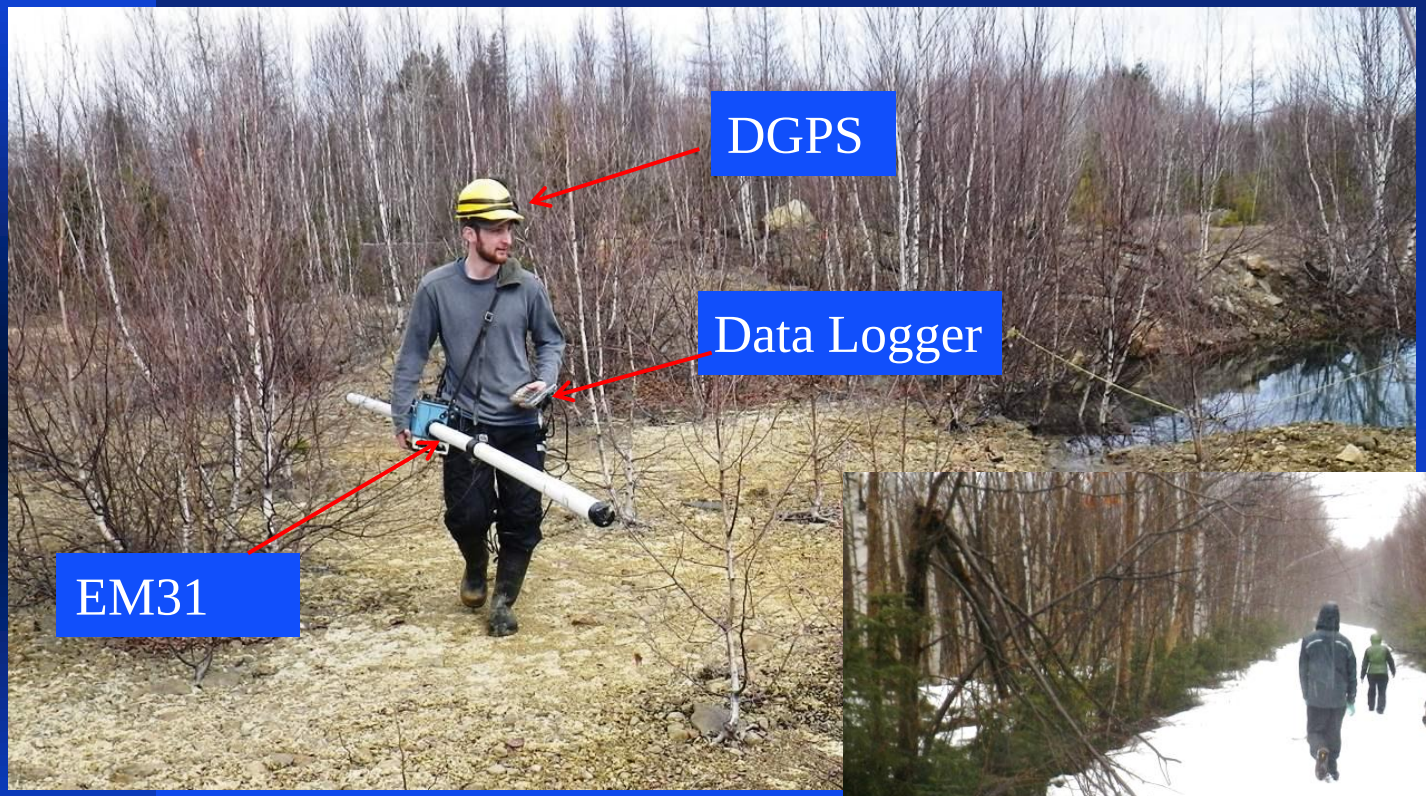


Acidity of Minewater (in mg/l as $CaCO_3$)

Geophysical Investigations

- UNB Earth Sciences Field Camp since 2000
- Electrical resistivity imaging (ERI) and electromagnetic apparent conductivity:
  - map lateral and vertical variations in AMD and sludge concentration within the mine site
- Conductivity is proportional to ion concentration, ion valence, and ion mobility.
- AMD, sludge and clays have high electrical conductivity compared to natural ground waters

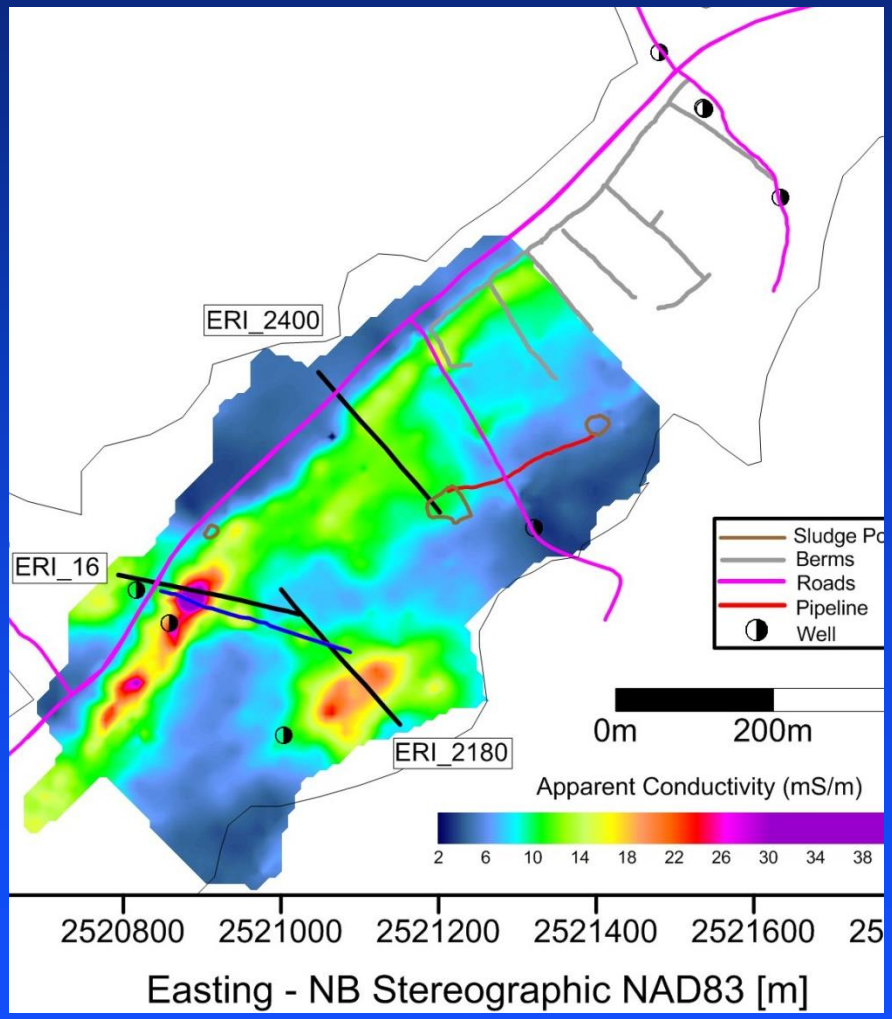
Field Camp at Fire Road Mine: EM31 Apparent Conductivity Mapping



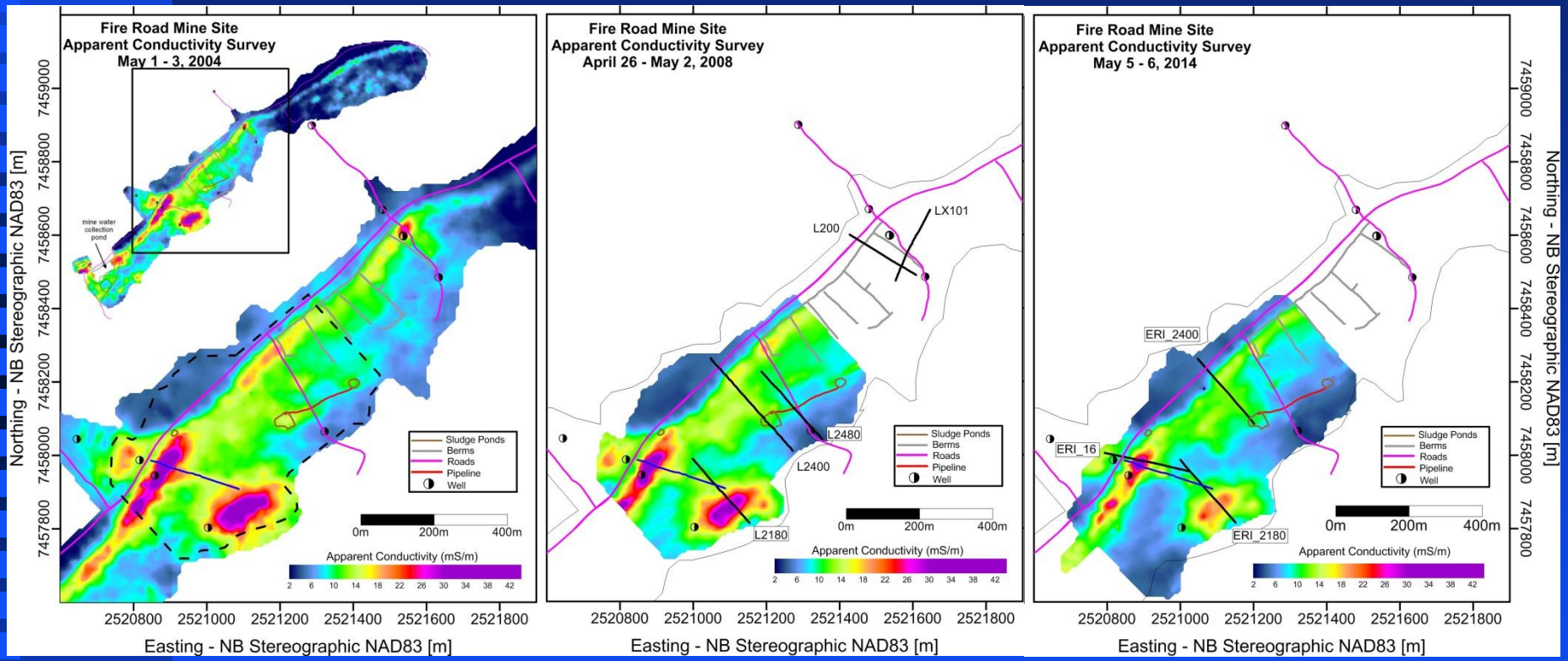
- Fluctuations with depth not defined
- +- 6m

EM31 Apparent Conductivity Map: May 2014

- Elevated conductivities along high wall
  - higher porosity (higher volume fraction of H2O) backfill
  - More porous backfill in vadose zone? Hence more O_2 infiltration and AMD production?
- Conductivities elevated with moister sludge.
  - Sludge is alkaline



Apparent Conductivity Map: Variation over Time



Electrical conductivity of the waste rock backfill appears to be decreasing over time

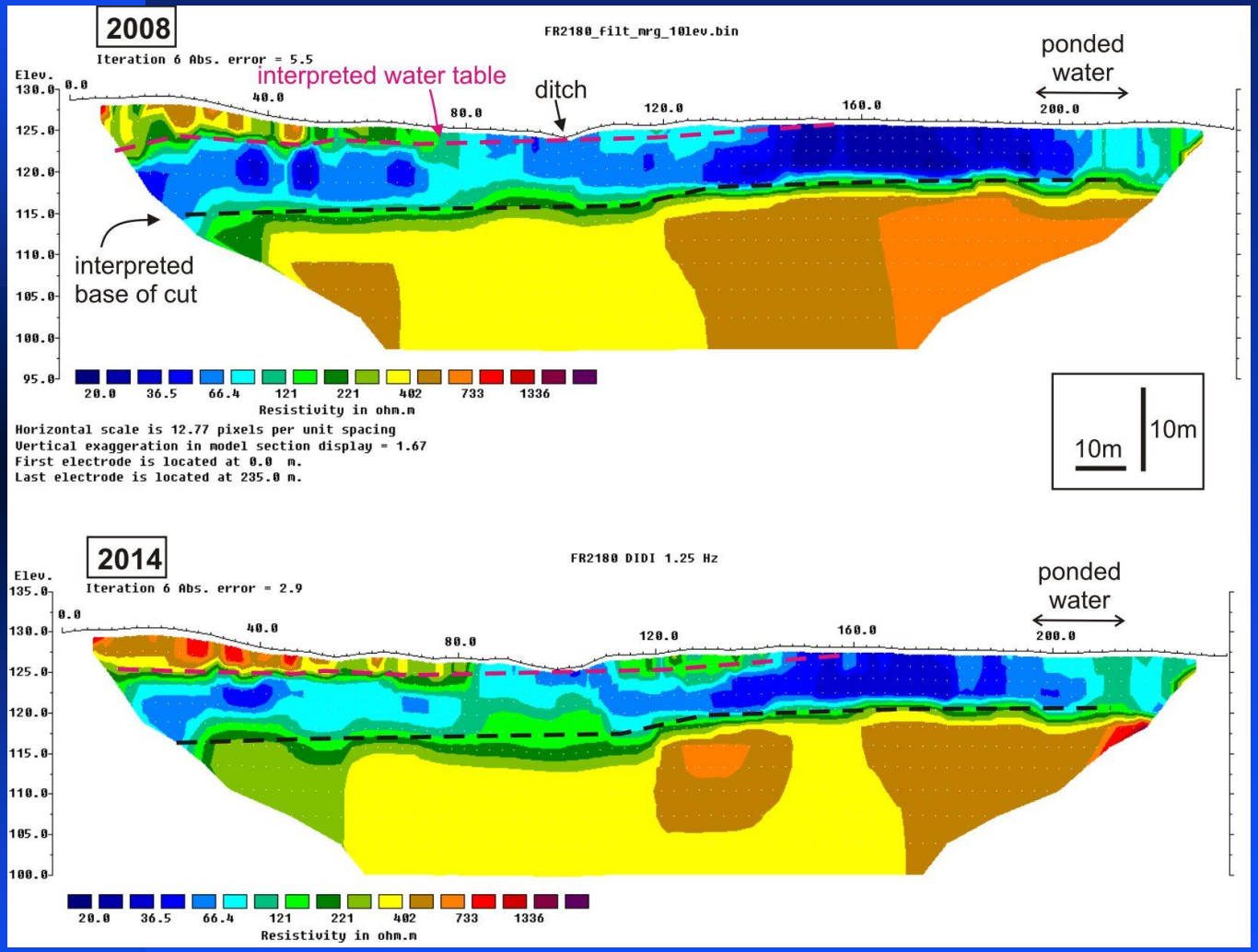
possible effects of annual variability including heavy snow and late snow melt in 2014.

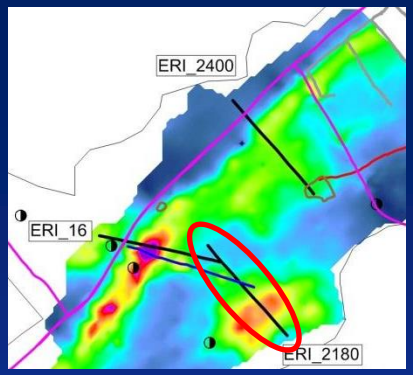
Freeze Thaw Experiments

Sludge conductivity is dependent on sludge moisture content.

- Clockwise from top
  - 2010-2011 35-40% remaining
  - 2006- 2008 40-50% remaining
  - 2002-2004 95% remaining
  - 2012 23-25% remaining

Electrical Resistivity Imaging Line 2180: 2008 – 2014 comparison





- Resistivities are higher (conductivities reduced) throughout the backfill compared to 2008.
- Supports apparent conductivity lateral results.

Note: High conductivities (low resistivities) are deep blue in the ERI sections (i.e. opposite to the apparent conductivity map color scheme)

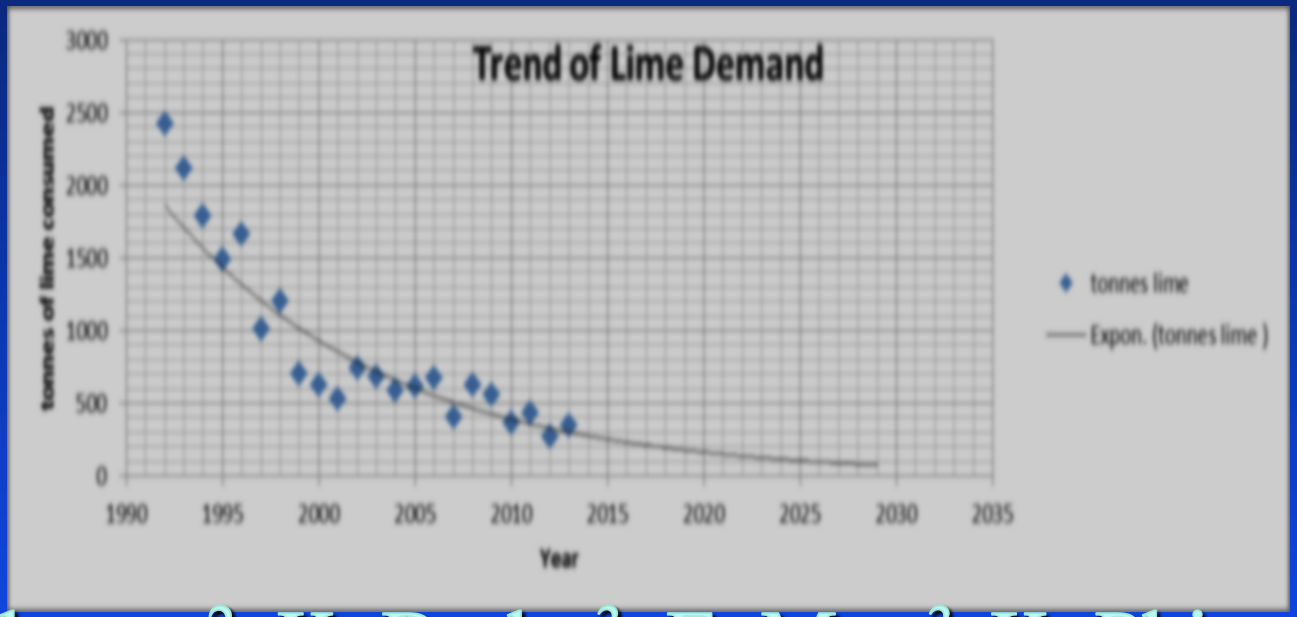
Conclusions

- Acidity decreasing overall (water samples, AC, ERI maps useful for illustrating)
- Concentrated high conductivity areas can be identified (apparent conductivity, groundwater analysis).
- Conductivities are reduced in both the flooded zone (ERI) and in the overlying waste rock
- Sludge deposition- is it helping?
  - Benefits- decreased liability, land use, short term acidity decrease.

Further Research

- Lower acidity means an end or reduction in chemical treatment
  - how do we address these conductive zones so that we can address closure?
- Can we separate sludge versus mine water conductivity?
  - Alkaline vs acidic
  - Especially if there are no groundwater wells in the area
- Should we target sludge disposal for high acidity areas?
  - Or should we be considering options such as SRB or straight lime slurry injection?

Towards Closure of the Fire Road Mine



M. Coleman[2], K. Butler[3], E. Mott[3], K. Phinney[1] and S. Pelkey[4]

[1] Consulting Chemist/ Chemical Engineer

[2] NB Power

[3] University of New Brunswick, Dept. of Earth Scienc

[4] Gemtec Consulting Engineers