

10th Annual BC ML/ARD Conference

East Kemptville, Nova Scotia

Prediction versus Observed Drainage Chemistry

Simon Fraser University, Vancouver, Dec 2-3, 2003

Ken Black, Paul Muise and Maxine Wiber



bhpbilliton

Location Map



Background

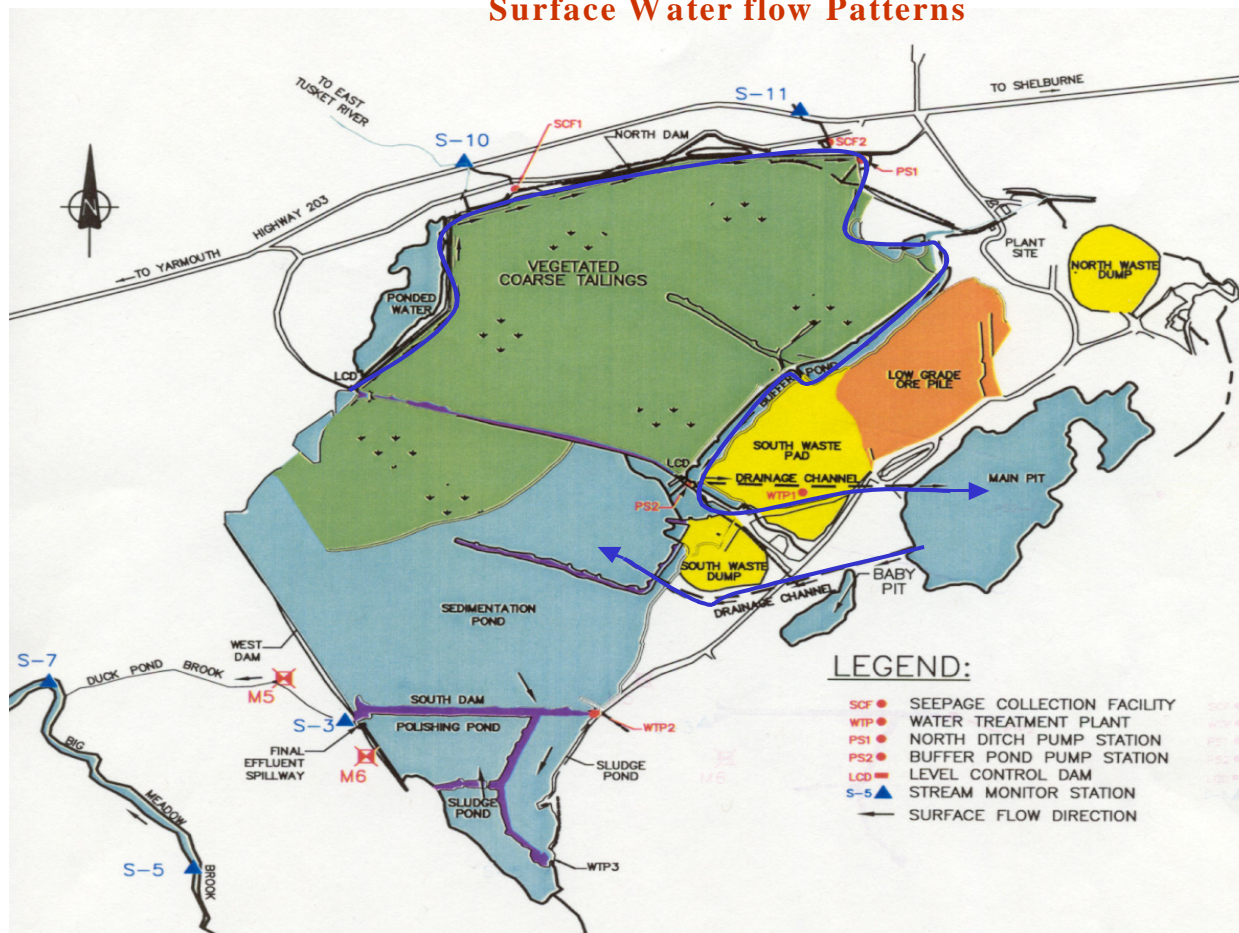
- **Rio Algom operated an open pit tin mine from 1985-1992.**
- **Conventional pit operation; waste rock stored in two dump areas**
- **Produced tin, copper and zinc by flotation and gravity separation**
- **Mill produced two tailings streams; a free-draining coarse fraction and a fine sand fraction that remained saturated**
- **Tailings deposited in 250 ha. basin with engineered dams constructed on two sides**
- **Site operates two- low density hydrated lime treatment plants; one sited at the Pit and the other at the tailings decant structure.**
- **Drainage water from tailings and waste rock dump perimeters are collected and flow to the pit treatment plant**
- **Pit water overflows to main tailings basin where lime is introduced as a polishing step**
- **SCADA monitoring system established for remote operation of the treatment plants**

Closure Planning Objectives

- **Re-grade tailings and waste rock dumps.**
- **Stabilize the tailings with vegetation**
- **Collect and treat ARD waters**
- **Minimize public health and safety hazards by controlling access**
- **Reclaim infrastructures and return land to conditions acceptable to the Province of Nova Scotia**
- **Long term monitoring of system performance**

Site Schematic

East Kemptville Tailings Management Facility Surface Water flow Patterns



Prior to Closure



East Kemptville – Post Reclamation –2001



Site Conditions

Existing Conditions

- **Climate**

- modified marine environment,
- annual precipitation - 1200-1400 mm/year

- **Topography**

- low lying swampy areas with little local relief
- bedrock mantle overlain by sand/ till of variable thickness

Site Conditions

Hydrology and Hydrogeology

- Facilities located in a 7.8 km² watershed; drainage to the 35 km² - Big Meadow Brook watershed
- 250-hectare tailings basin located in Duck Pond Brook watershed which drains into Big Meadow Brook
- N/W groundwater flow regime
- Nested groundwater wells drilled around perimeter of the tailings basin
- Mean annual flow of treated water is 0.2 m³/sec
- 100 year storm event is about 110 mm over a 24-hour period

Site Conditions

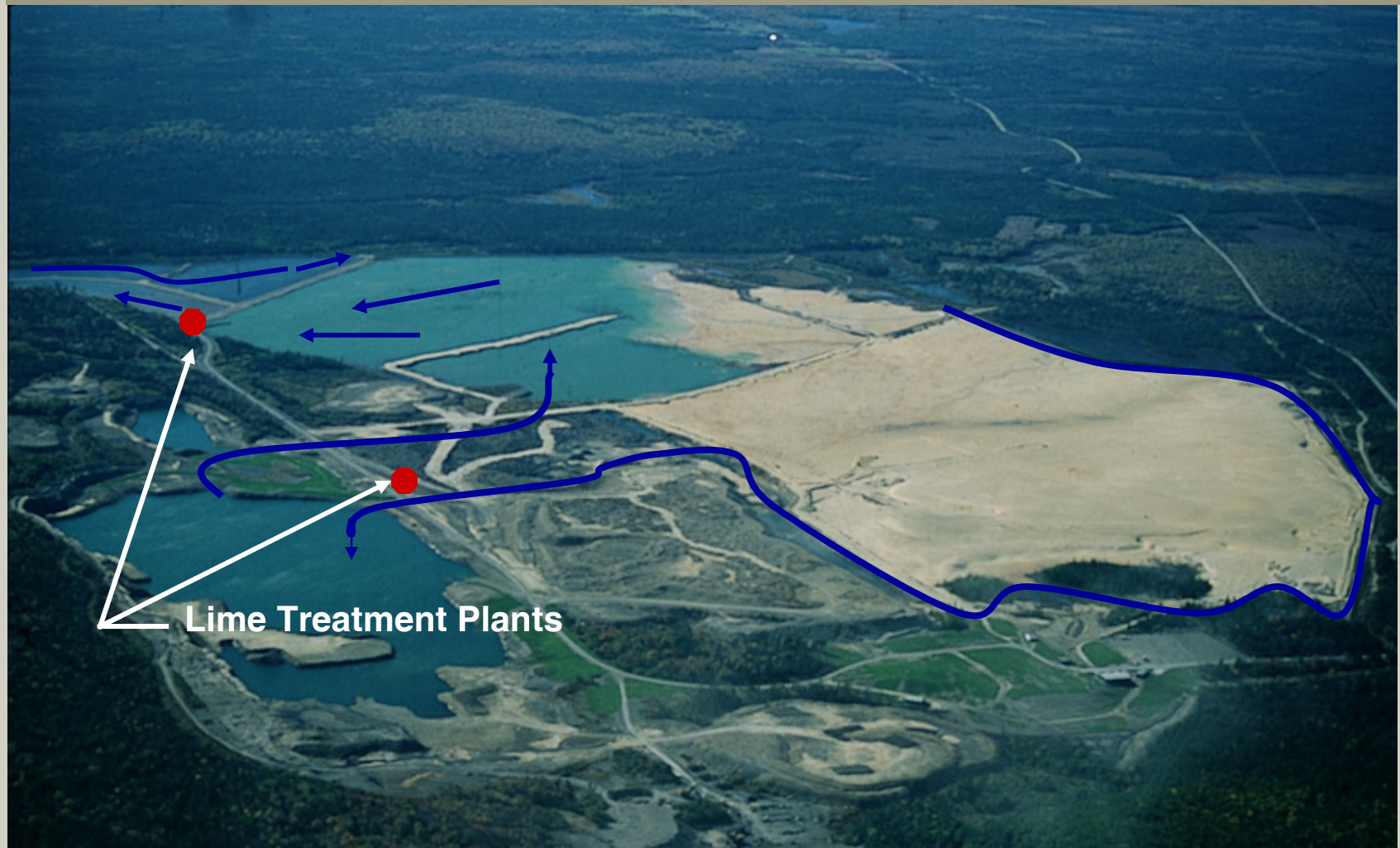
Geochemical Characteristics

- Mineralized zone is a volcanic intrusion
- Dominant minerals: Quartz, plagioclase, muscovite, sericite, feldspar
- Minor minerals:
 - sphalerite
 - chalcopyrite
 - pyrite, arsenopyrite and
 - **pyrrhotite**
- Pre-mining ABA analyses indicated low sulfide content typically less than <0.5% S

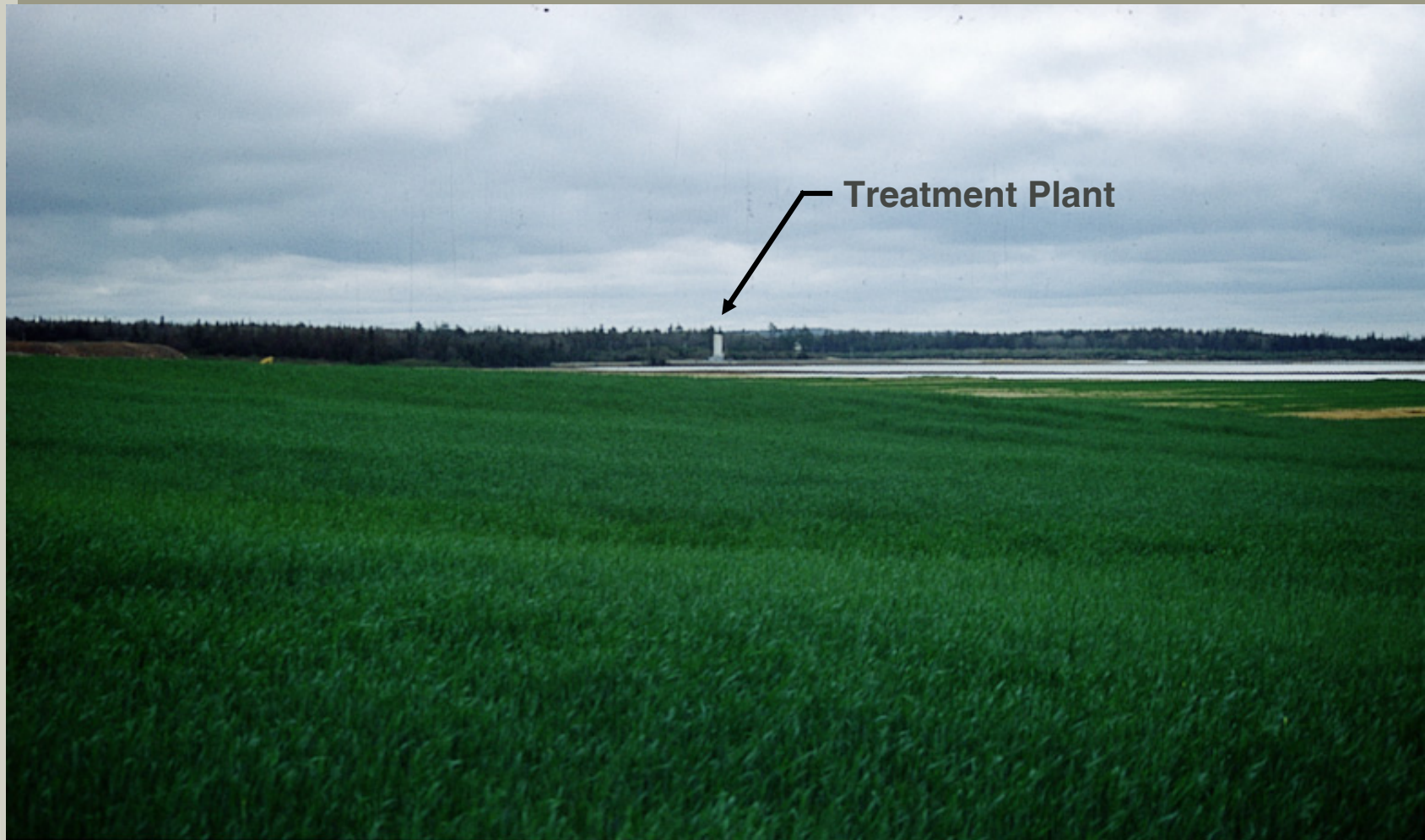
GRADED LOW-GRADE STOCKPILE –1996



DRAINAGE SYSTEM



VEGETATION OF THE COARSE TAILS -1999



VEGETATED COARSE TAILS –1998



ABA Data

Comparison of Average and Ranges from Current and Past ABA Analyses of Tailings				
Coarse Tailings	Total % S	NP	NNP	Ratio NP/AP
Past ABA n=8	0.155 (0.05-.341)	11.9 (10.0-12.8)	7.1 (+1.6 to +10.4)	2.46
Current ABA n=8	0.161 (0.056-0.295)	6 (4-7)	1 (-2 to +5)	1.77
Current ABA n=11	0.166 (0.028-0.548)	6 (6-7)	1 (-10 to +5)	2.0
Fine Tailings				
ABA n=2	3.69 (2.43-4.95)	47 (22.8-71.2)	-68.3 (-53.1 to -83.5)	0.38

Notes:

Data extracted from Geocon Closure Report (Table 6.1, 1995)

1) Coarse Tailings Volume is 11.29 m tonnes

2) Fine Tailings Volume is 7.47 m tonnes

3) NP and NNP expressed as in tones of CaCO₃ equivalent /1000 tonnes of tailings

Estimates of Acidity Loadings

Estimated Acidity (tonnes)	Geocon/ Morwijk	SENES
Unsaturated Coarse Tailings	60,900	53,000
Waste Rock Dumps	17,500	17,500
Soluble Acidity in Inventory	-	3,000
Total Available Inventory	78,500	73,500

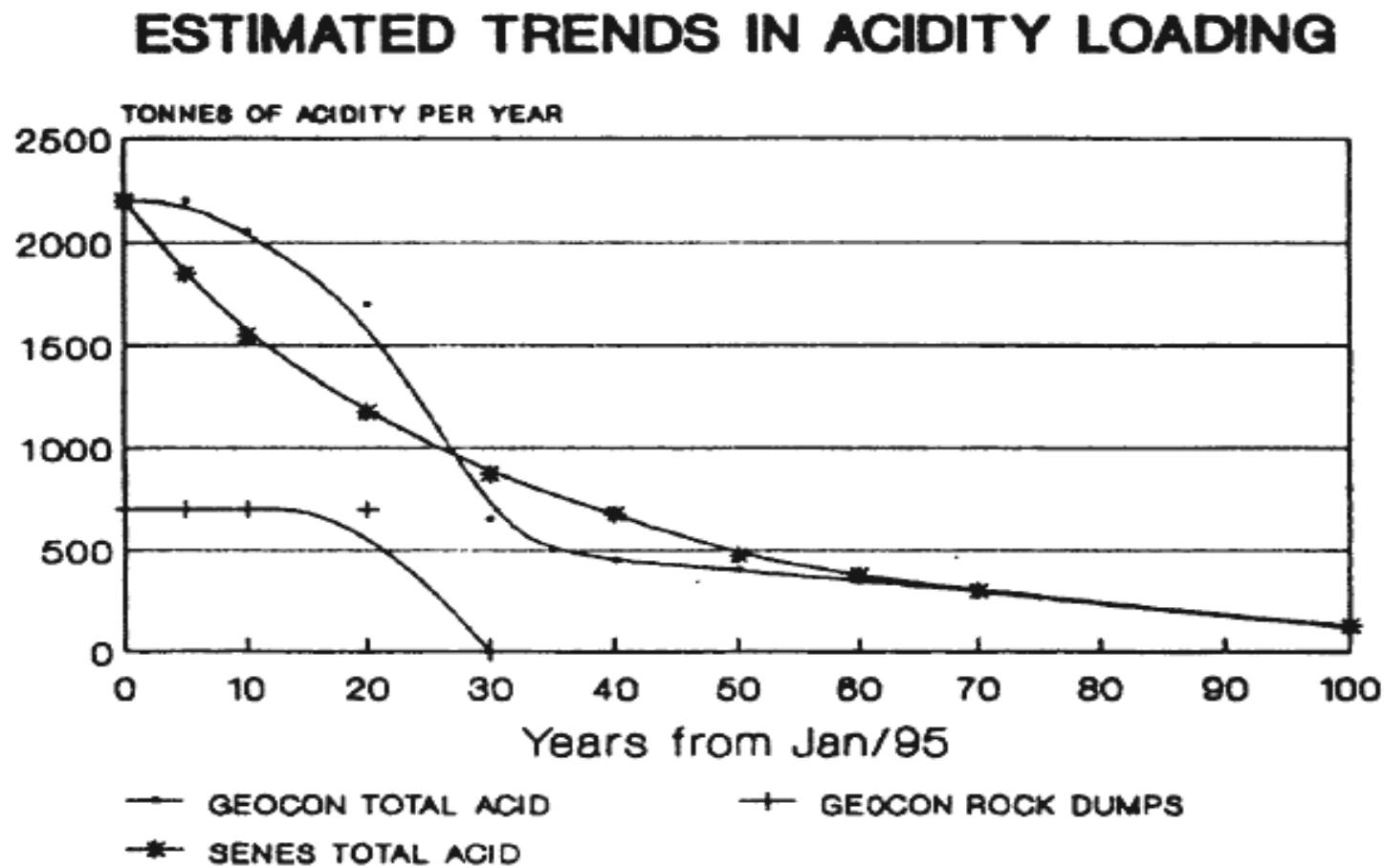
Notes:

Upper limit estimates of available acidity; projections within 9 %

No credit taken for the neutralization potential

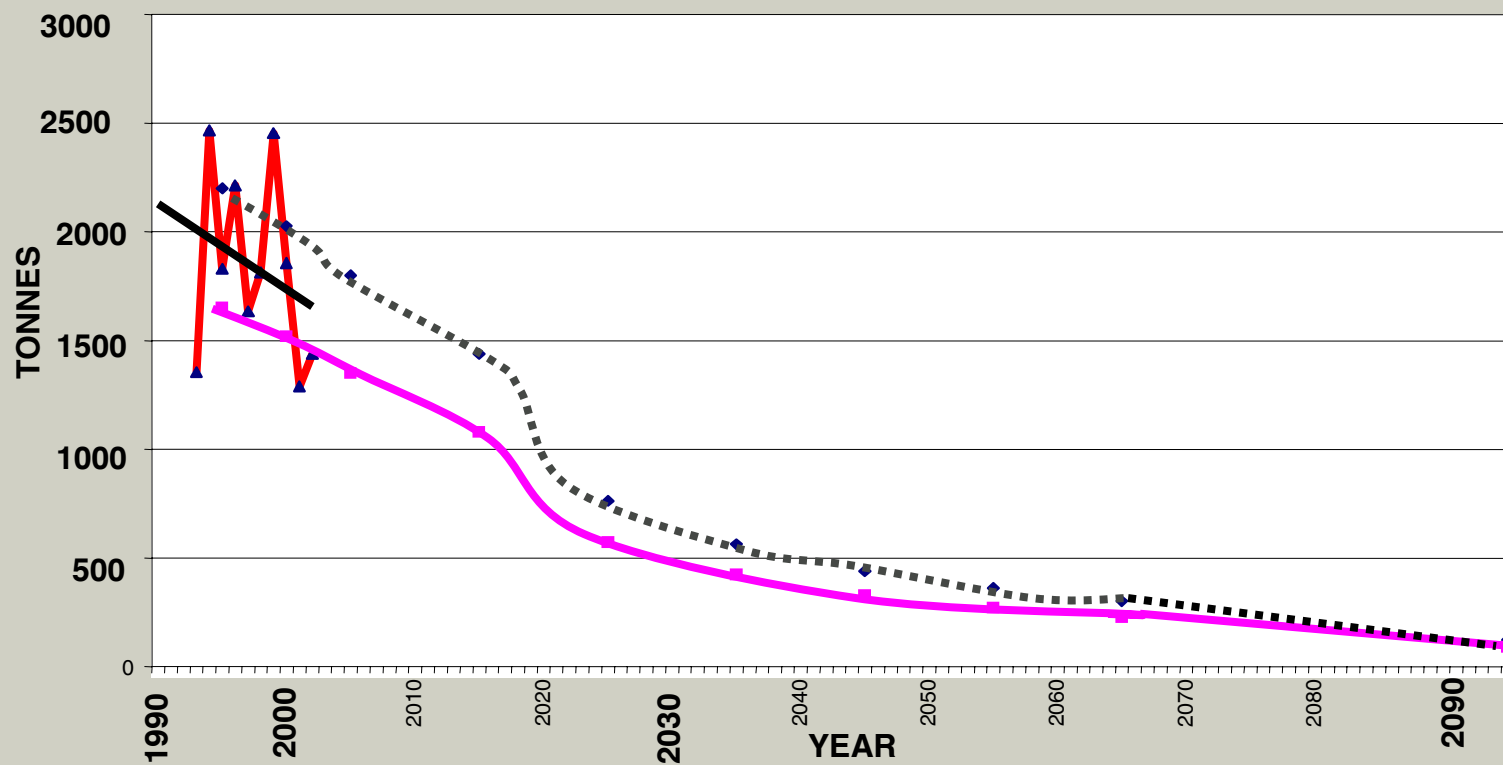
Depletion of acidity would occur within 80 years

Estimates of Acidity



Treatment Plant Performance

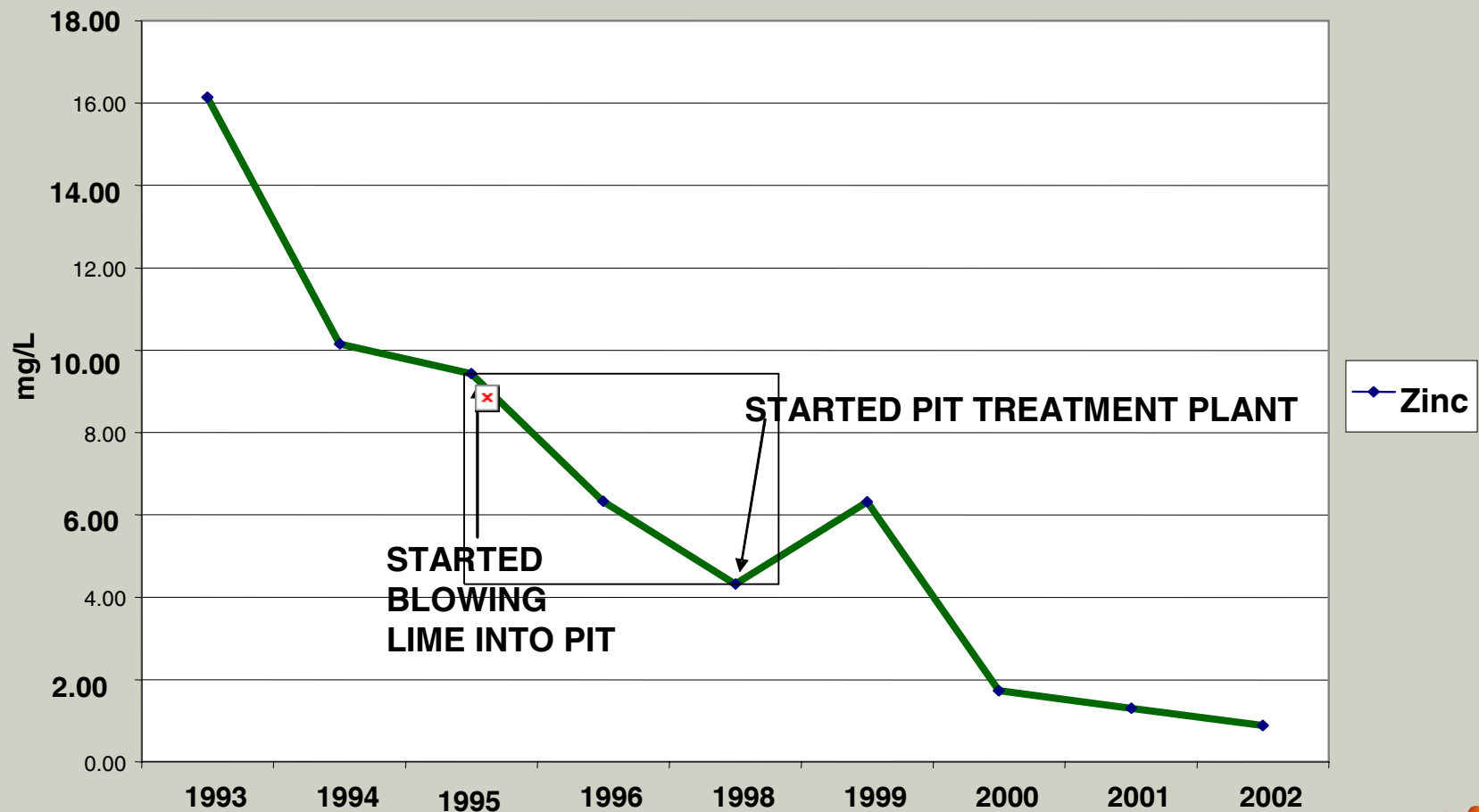
PREDICTED ACIDITY (TONNES) / ACTUAL LIME CONSUMPTION



.....◆..... PREDICTED ACIDITY TONNES — PREDICTED LIME CONSUMPTION —▲— ACTUAL LIME TONNES — BEST FIT (ACTUAL LIME TONNES)

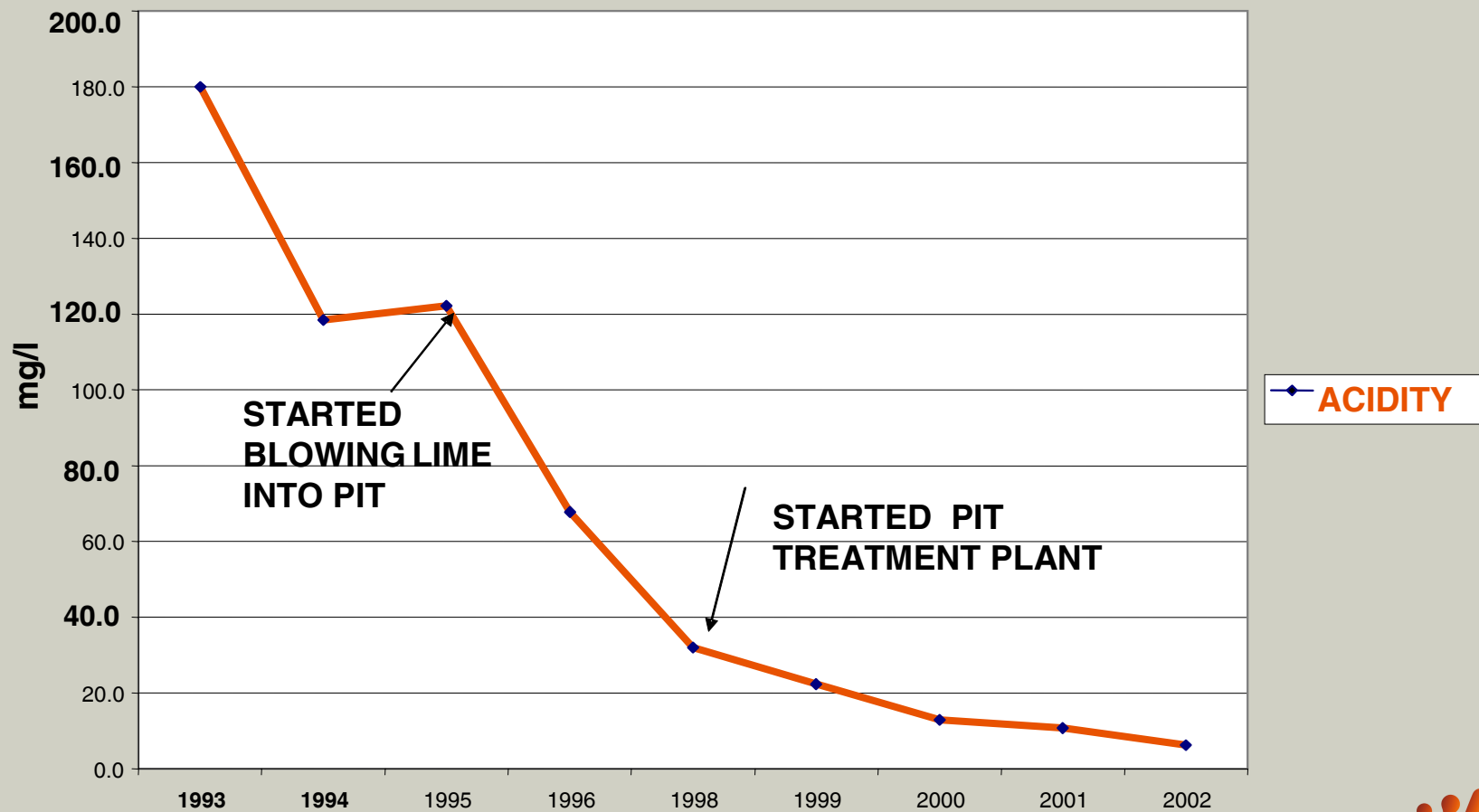
Environmental Performance

MAIN PIT - ZINC



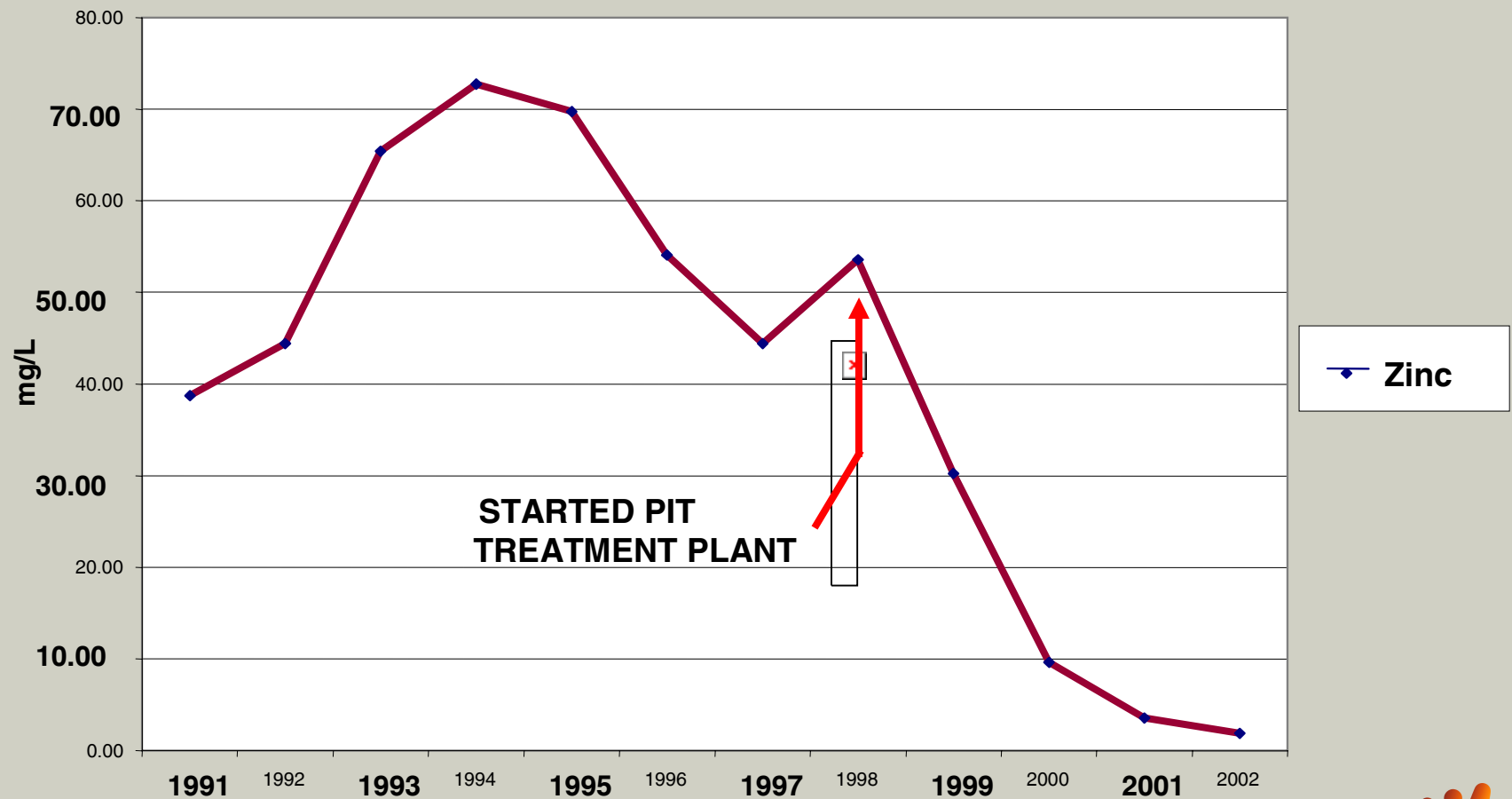
Environmental Performance

MAIN PIT - ACIDITY



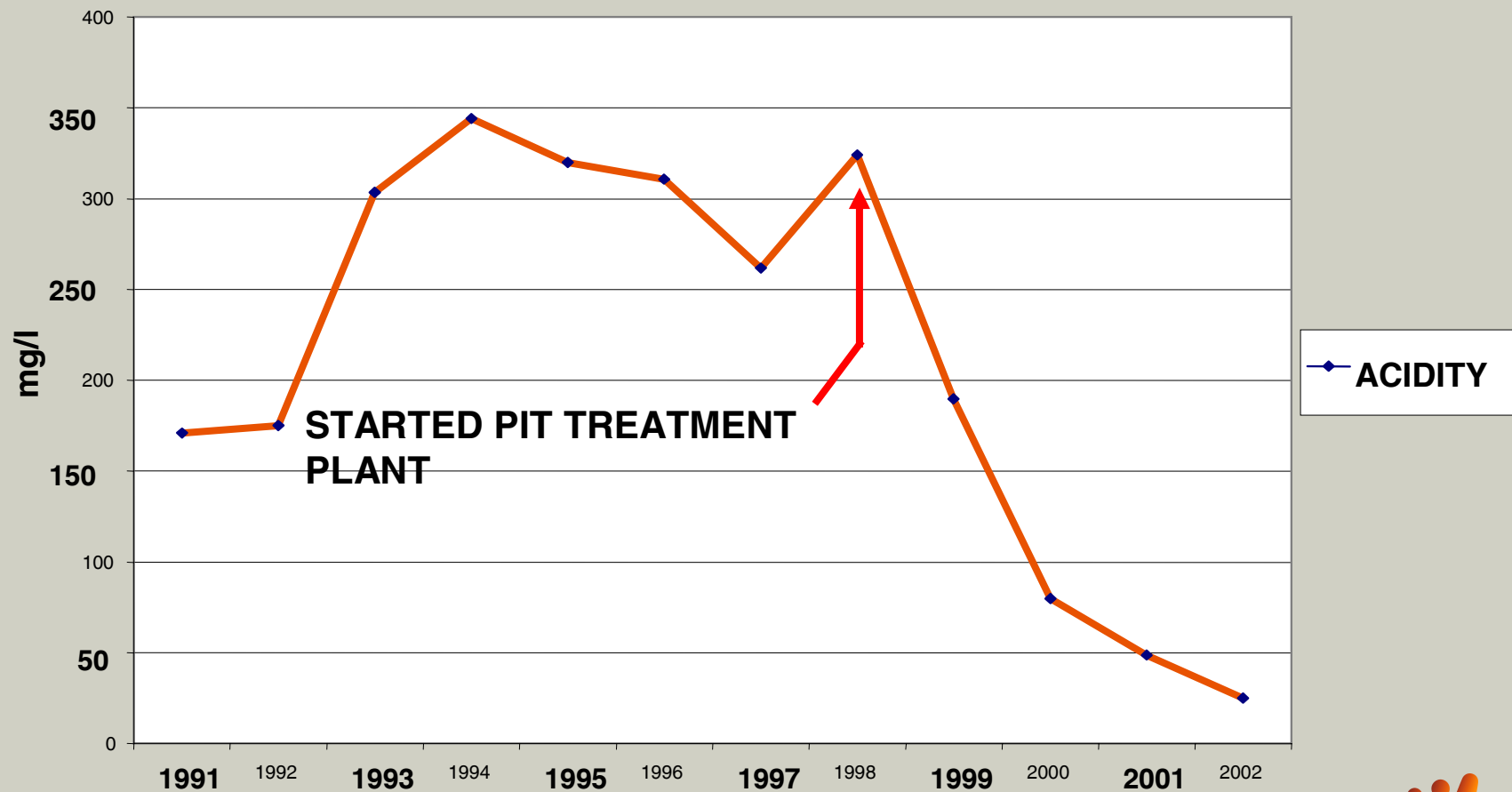
Environmental Performance

MAIN TAILINGS POND - ZINC



Environmental Performance

MAIN TAILINGS POND - ACIDITY



Environmental Performance

Permit and Sample Values at Final Effluent - 2002

Parameter	Permit Limits (in mg/L)	Final Effluent	
		Average	Maximum
pH	5.0-10.5	7.31	8.1
Iron	7	<0.11	0.5
Suspended Solids	50	1.49	2.3
Arsenic	1	<0.002	<0.002
Copper	0.6	0.16	0.021
Lead	0.4	0.004	0.016
Nickel	1	0.009	0.02
Zinc	1	0.19	0.26

Notes:

NS DOE Permit

Mean annual flow is 0.2 m³/s (2002)

Conclusions and Areas of Focus

- Performance as expected or better
 - Lower pit lake acidity & metal levels
 - Tailings pond water quality
 - Expected versus actual trends confirmed to support long term treatment cost estimates
- System designed to manage large storms
- Areas of focus
 - Pit lake sampling
 - Groundwater monitoring to understand early trends & sources