

REMEDIATION OF MINE WASTE MANAGEMENT AREAS WITH ECOLOGICAL ENGINEERING



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Overview

(1) Historic reflections on AMD and Sustainability

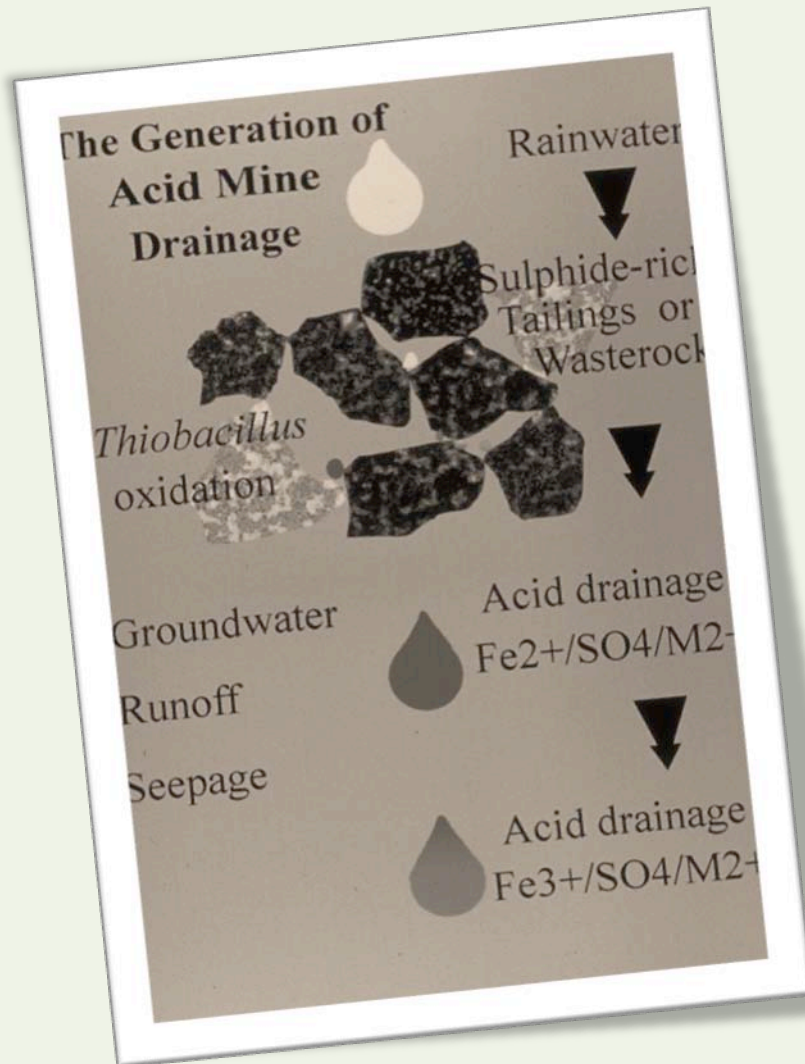
(2) Ecological ingredients:

- **phosphate mining waste**
- **biodegradable carbon for sediments**
- **renewable surfaces for adsorption – algae**

(3) Demonstration projects

- **Applications in decommissioning**

What is Acid Mine Drainage?



Year 1556

"...further, when the ores are washed, the water used poisons the brooks and streams, and either destroys the fish or drives them away..."

thus it is said, it is clear to all that there is greater detriment from mining than the values of the metals which the mining produces."

Agricola

De Re Metallica 1st Edition, 1556

Chemical treatment



- Secondary waste generation
- Unstable metals in long term
- Further consumption of finite resource –lime / carbonate
- Effluent high TDS/ gypsum
- Non-sustainable

Sustainability



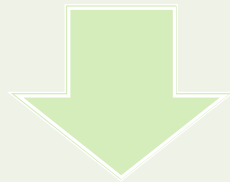
The German 'Nachhaltigkeit' first used in 1713 by Hans Carl von Carlowitz in "Sylvicultura Oeconomica" (Forestry Economics)

Carlowitz found that the wood needed for mines was becoming scarce and prices were rising making the mines 'uneconomic'

What is Ecological Engineering?

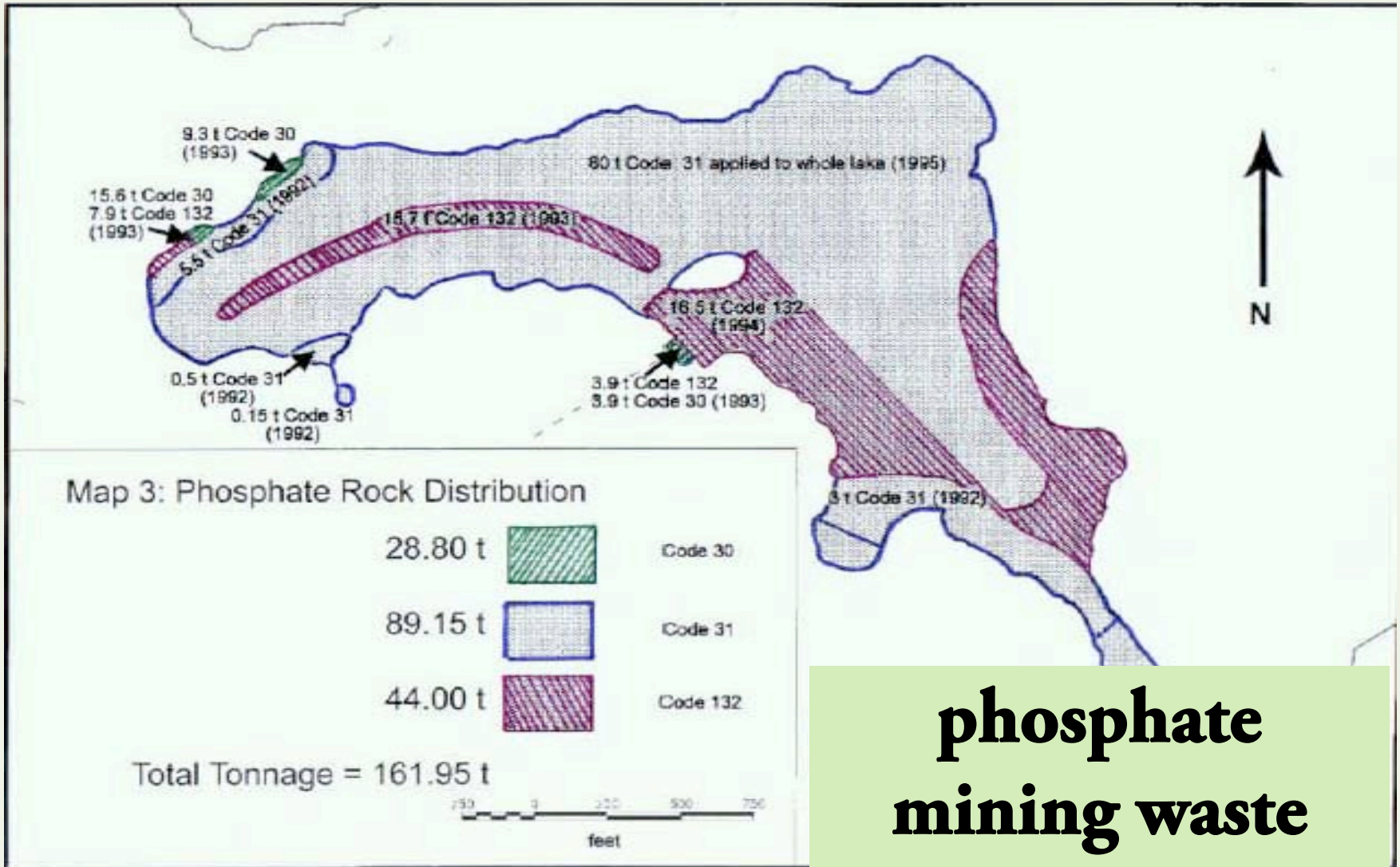
Promotion of natural cleansing processes in the ecosystem

These natural processes are known from disciplines such as ecology, hydrology, geochemistry, limnology, microbiology, geo-microbiology and others.



A sustainable alternative

The engine – nutrient balance - phosphate



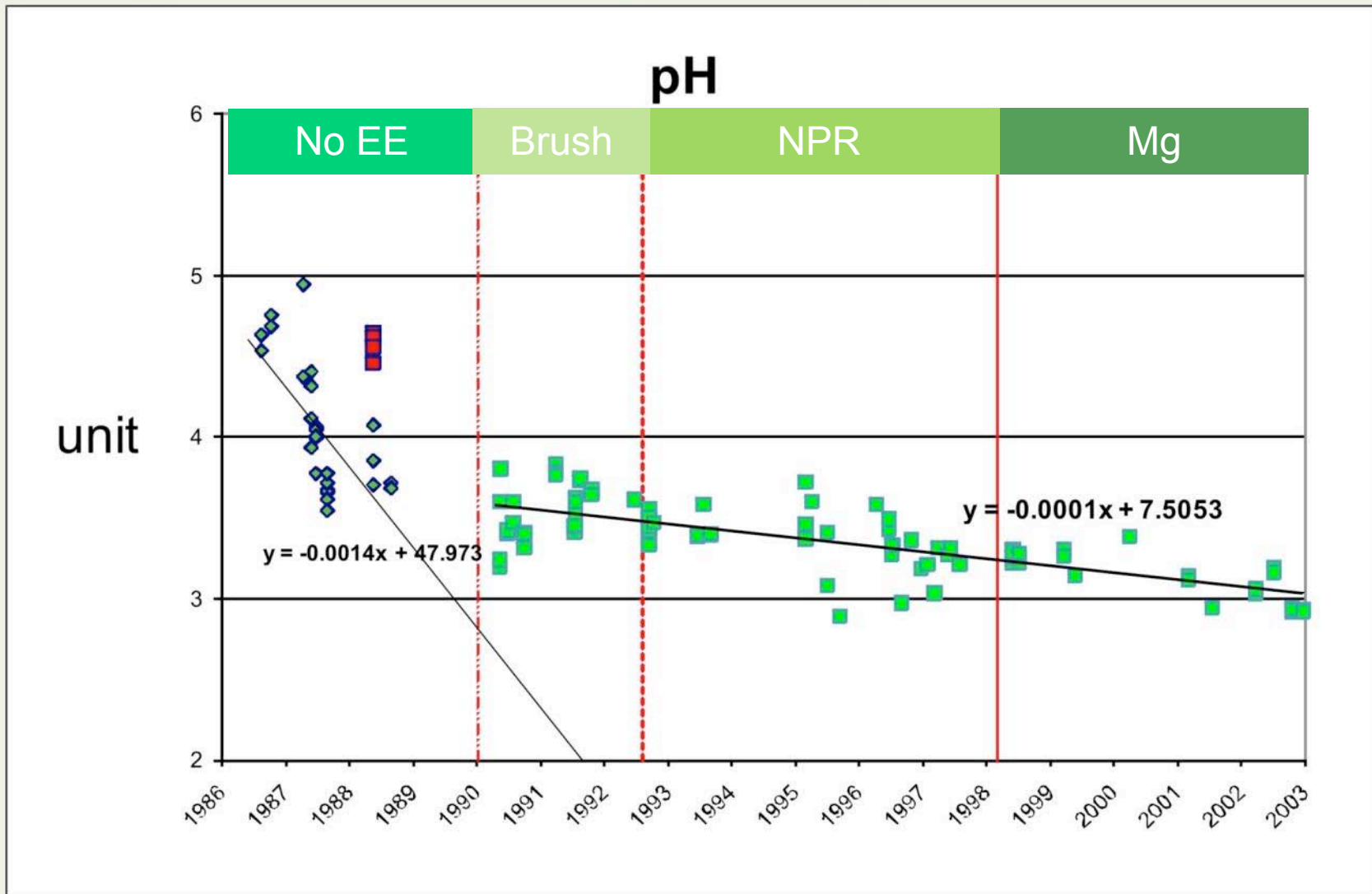
PWP Process- application vessel



pH = 3.5
Max. Depth: 5m

1993

Brush – NPR - Magnesium



Biodegradable Carbon for sediments



Moss Cover
reaching surface

Result underwater meadow over sediment

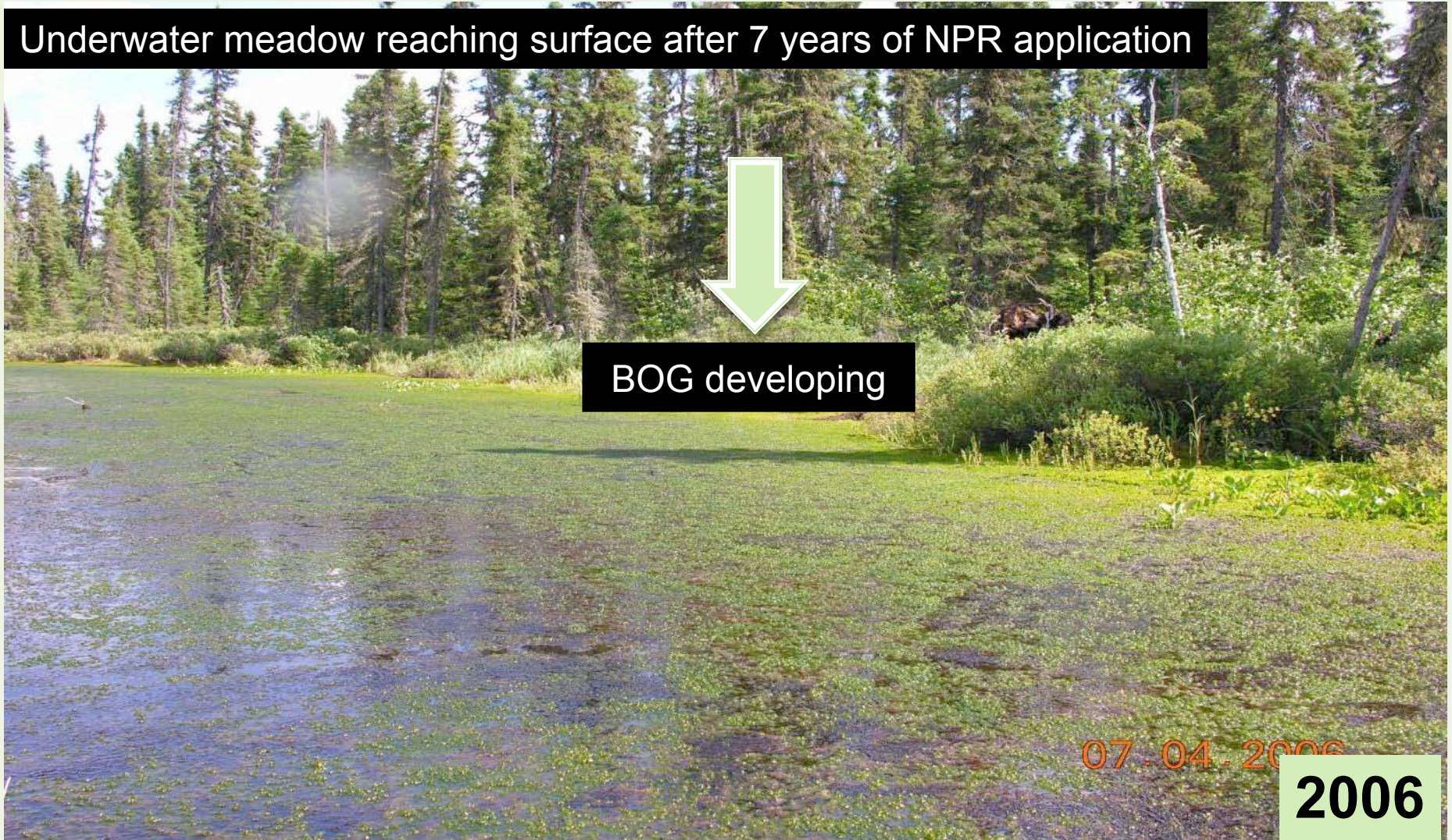
1994-98

Phytoplankton in lakes

Boomerang Lake			Confederation Lake		
No.	Frequency	%Genera/taxa	No.	Frequency	%Genera/taxa
1	65	<i>Ochromonas</i>	1	0	<i>Dinob ryon</i>
2	62	<i>Chlamydomonas</i>	2	0	<i>Unidentified chlorophyceae</i>
3	58	<i>Staurastrum</i>	3	0	<i>Unidentified Chrysophyceae</i>
4	58	<i>Unidentified Chlorophyceae</i>	4	0	<i>Ochromonas</i>
5	54	<i>Pinnularia</i>	5	0	<i>Asterionella</i>
6	54	<i>Ulothrix</i>	6	0	<i>Cryptomonas</i>
7	50	<i>Eunotia</i>	7	0	<i>Tab ellaria</i>
8	42	<i>Cryptomonas</i>	8	0	<i>Chromulina</i>
9	42	<i>Euglena</i>	9	0	<i>Peridinium</i>
10	42	<i>Sphaerellopsis</i>	10	0	<i>Synedra</i>
11	38	<i>Navicula</i>	11	0	<i>Unid-Cyano</i>
12	38	<i>Nitzschia</i>	12	0	<i>Chlamydomonas</i>
13	38	<i>Peridinium</i>	13	0	<i>Moegeotia</i>
14	35	<i>Chromulina</i>	14	0	<i>Melosira</i>
15	35	<i>Euglena</i>	15	0	<i>Staurastrum</i>
16	35	<i>Synedra</i>	16	0	<i>Nitzschia</i>
17	31	<i>Lepocinclis</i>	17	0	<i>Unidentified Bacillariophyceae</i>
18	31	<i>Unidentified Chrysophyceae</i>	18	0	<i>Scenedesmus</i>
19	31	<i>Unidentified Bacillariophyceae</i>	19	0	<i>Anab aena</i>
20	27	<i>Fragilaria</i>	20	0	<i>Oscillatoria</i>
21	27	<i>Melosira</i>	21	0	<i>Navicula</i>
22	27	<i>Tab ellaria</i>	22	0	<i>Euglena</i>
23	23	<i>Chlorella</i>	23	0	<i>Cosmarium</i>
24	23	<i>Mougeotia</i>	24	0	<i>Botryococcus</i>
25	19	<i>unid-Chrys-1</i>	25	0	<i>Rhodomonas</i>
26	15	<i>Asterionella</i>	26	0	<i>Gymnodinium</i>
27	15	<i>Unidentified Chryptophyceae</i>	27	0	<i>Ulothrix</i>
28	15	<i>Unidentified Chrysophyceae</i>	28	0	<i>Ank istrodesmus</i>
29	12	<i>Dinob ryon</i>	29	0	<i>Chlorella</i>
30	12	<i>Euglena</i>	30	0	<i>Spondylosium</i>

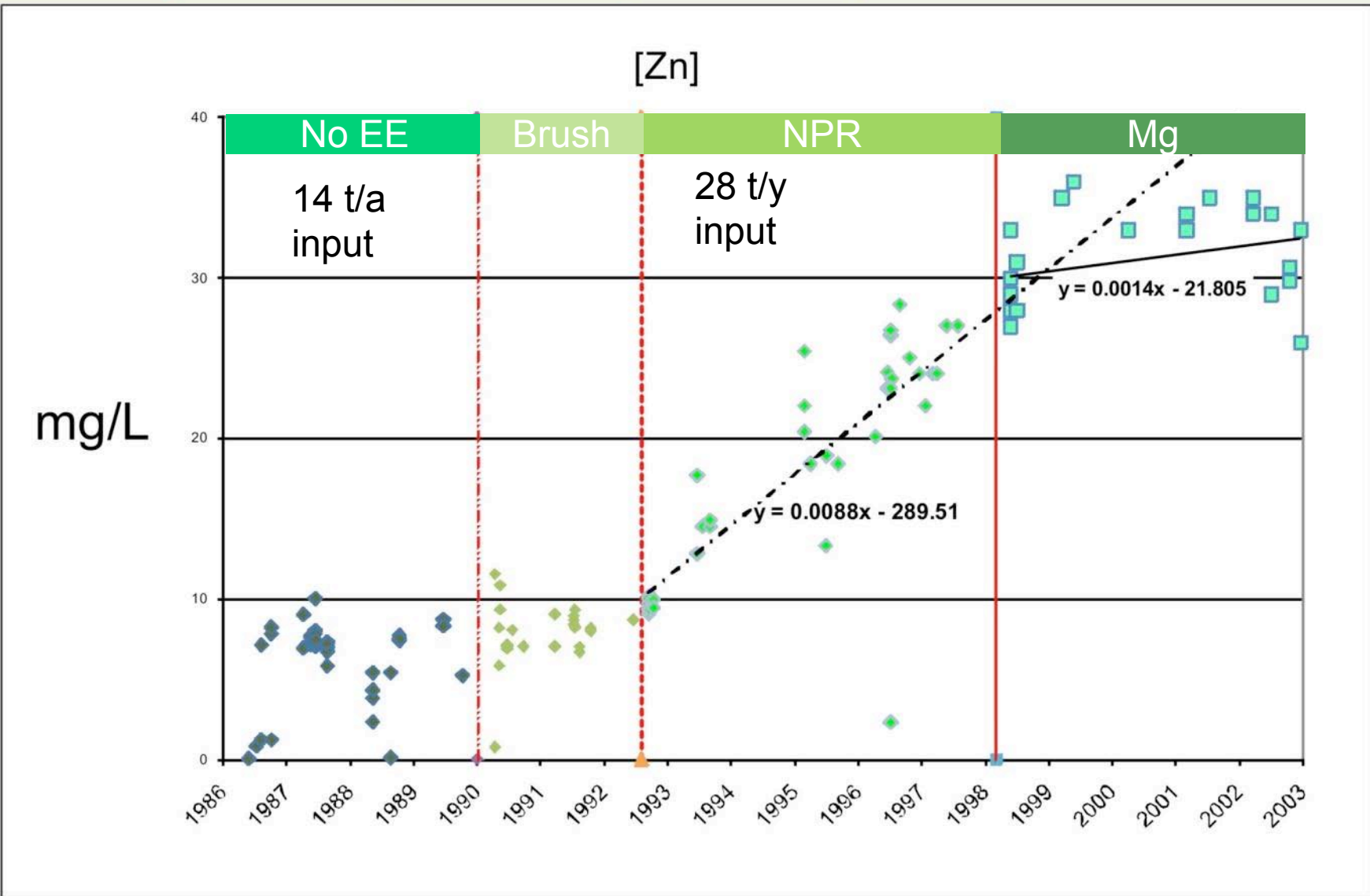
Boomerang Lake

Underwater meadow reaching surface after 7 years of NPR application

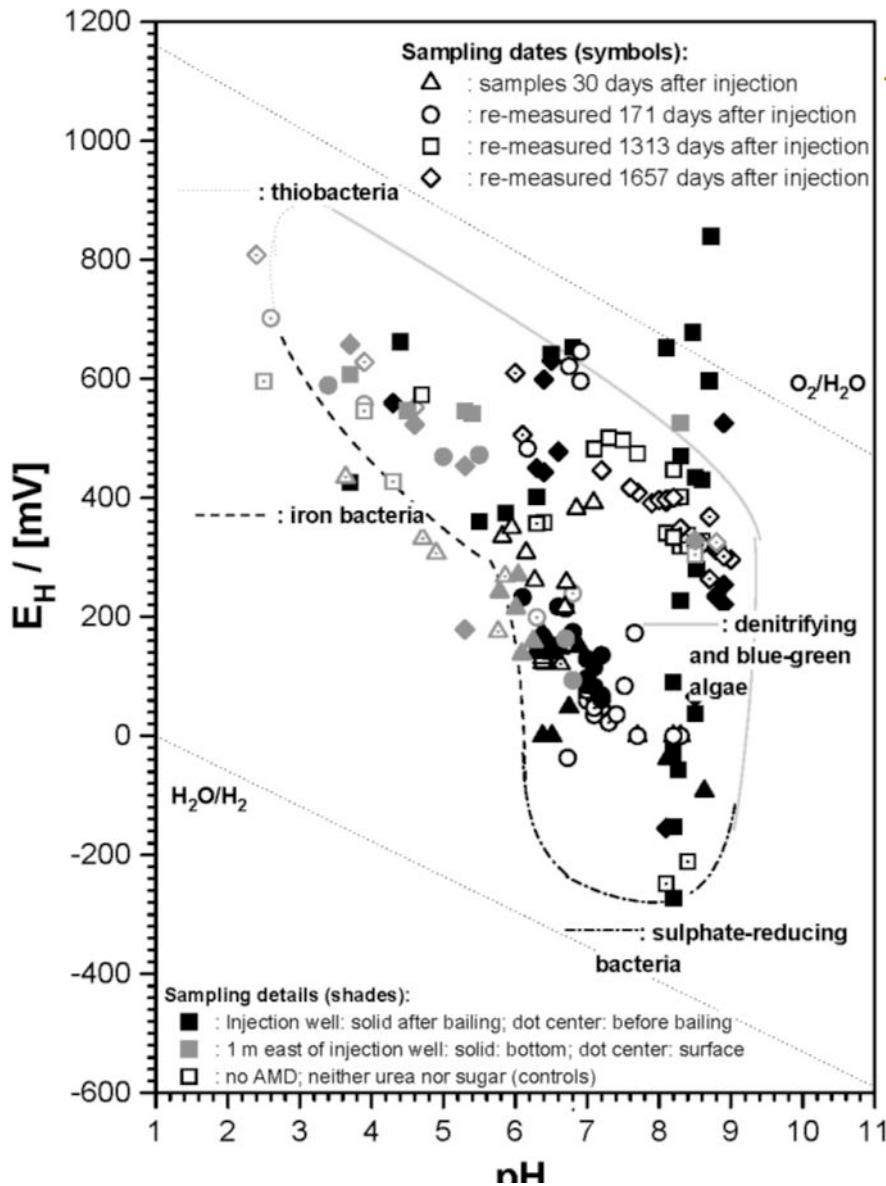


2006

Brush – NPR - Magnesium

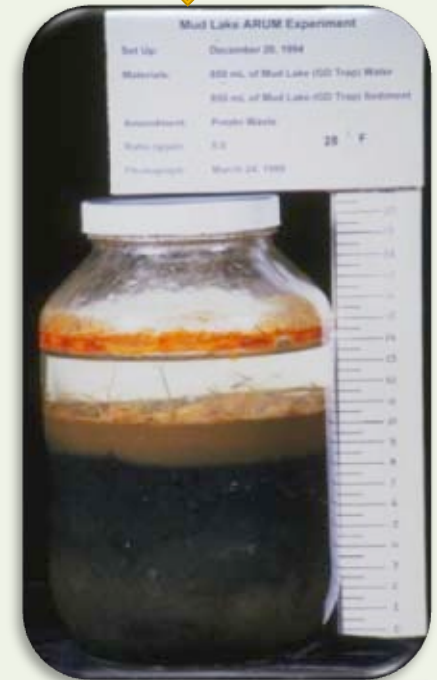


Do we need microbes?



In sediment
biomineralization
takes place

An example of in-situ groundwater treatment of the plume from the tailings at the same site.



Buchans Polishing Ponds - Full Scale



Summary

- Contaminant generation is a natural process therefore natural processes can be used to counteract its release
- Demonstrations exist in Germany, Brazil and Canada which provide the foundation on which we can build
- My dream is to show regulatory authorities, universities and industry a sustainable approach is possible .
- Please take the time to have a look and learn - Thanks.

Boojum Research Virtual Library

The screenshot shows the website for Boojum Research at Laurentian University. The header includes the university logo and the tagline "Learning. It's in our Nature." Navigation menus are provided for various university departments and research areas. The main content area features the "Boojum Research Virtual Library" title, a logo for "MERLIN", and a detailed description of the library's mission and services. A sidebar on the left contains navigation links such as "Project Summary", "Project Map / Indexes", and "Project Contributors". A "Links" section provides access to a database search, mining environment database, and MERLIN overview. A "News" section is also visible at the bottom.

Boojum Research Technical Reports : Project Index

The map displays the geographical distribution of Boojum Research projects across North America. Red pins indicate the locations of various sites, with labels for each project. The map includes a scale bar, navigation controls, and map style options (Mapa, Satélite, Híbrido). The project locations are as follows:

- B-Zone, Sask.
- Buchans, Nfld.
- Chicoutimi, Que.
- Cluff Lake, Sask.
- Elliott Lake, Ont.
- Falconbridge, Ont.
- Farley Lake, Man.
- Faro, Yukon
- Hope Brook, Nfld.
- Kam-Kotia, Ont.
- Key Lake, Sask.
- Kidd Creek, Ont.
- Kitimat, B.C.
- Le Mine Doyon, Que.
- Le Mines Selbaie, Que.
- Levack, Ont.
- Link Lake/Rabbit Lake, Sask.
- Makela/ARUM, Sudbury, Ont.
- Mike Horse, MT.
- Port Radium, NWT
- Prince Mine, N.S.
- Red Lake, Ont.
- Salt Lake City, UT
- Selminco Summit, N.S.
- South Bay, Ont.
- Star Lake, Sask.
- Victoria Junction, N.S.

<http://biblio.laurentian.ca/boojum>