The Island Copper Pit Lake

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Acknowledgements

Authors

- Marc Wen, Clem Pelletier, Kelsey Norlund, Gareth Wolff (ERM)
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Outline

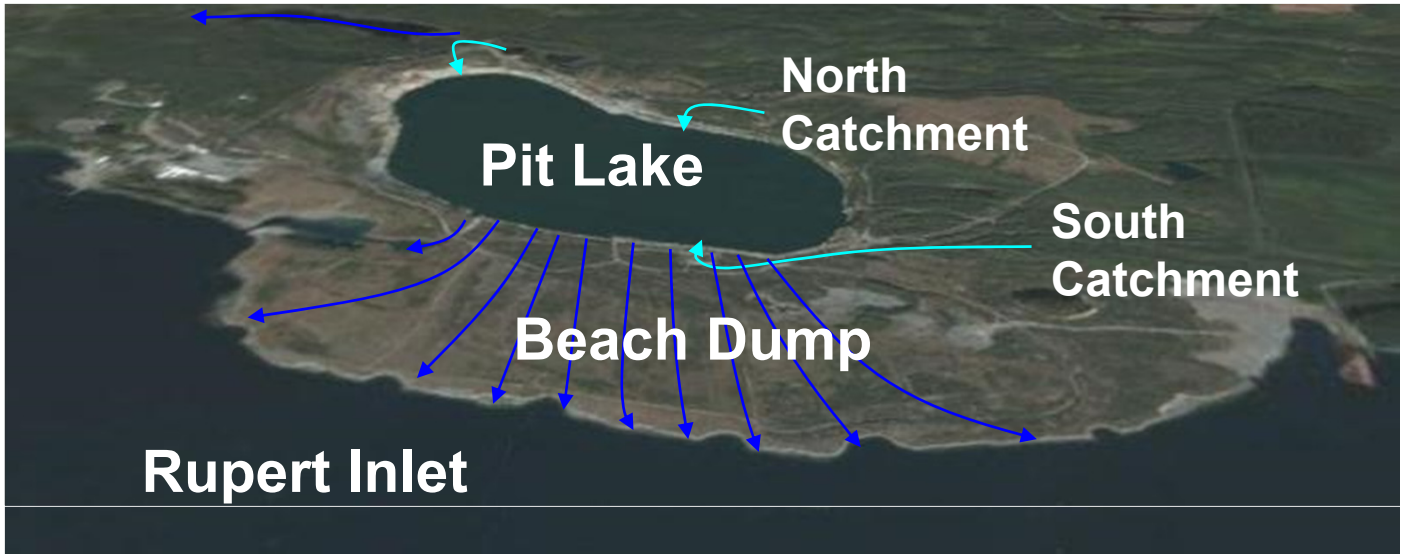
- Island Copper Mine
- Engineered design of the pit lake
- Phytoremediation at the pit lake
  - Biological response
  - Biogeochemical response
- Discussion and conclusion (what did we learn?)

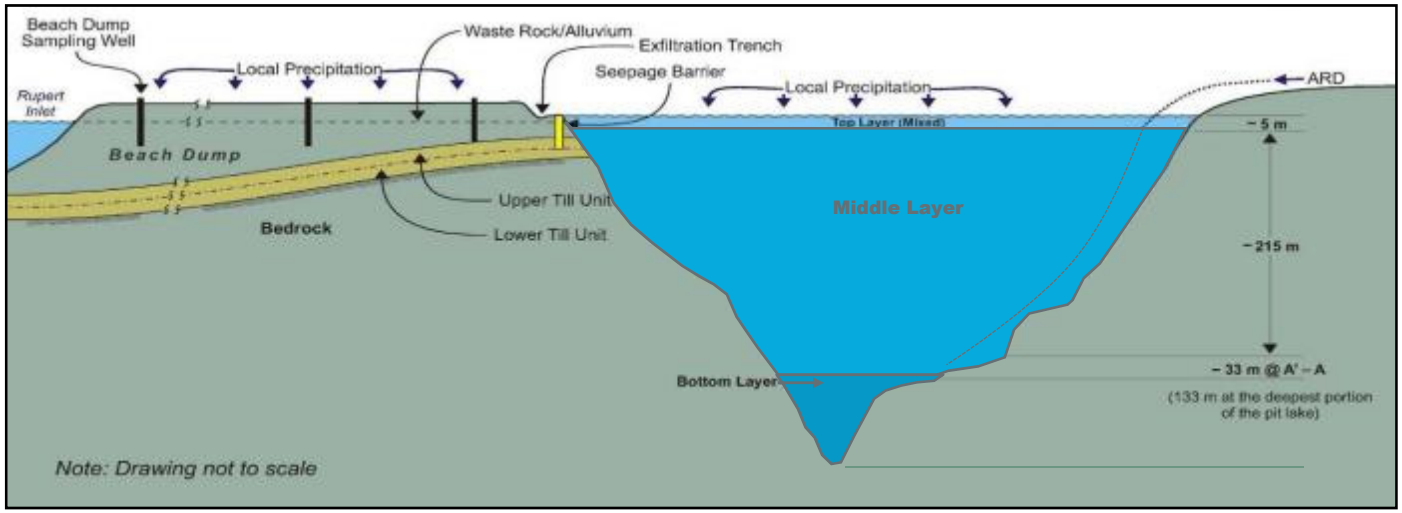
Island Copper Mine

Operated from 1971 to 1995

Design of Island Copper Pit Lake

Pit Flooding



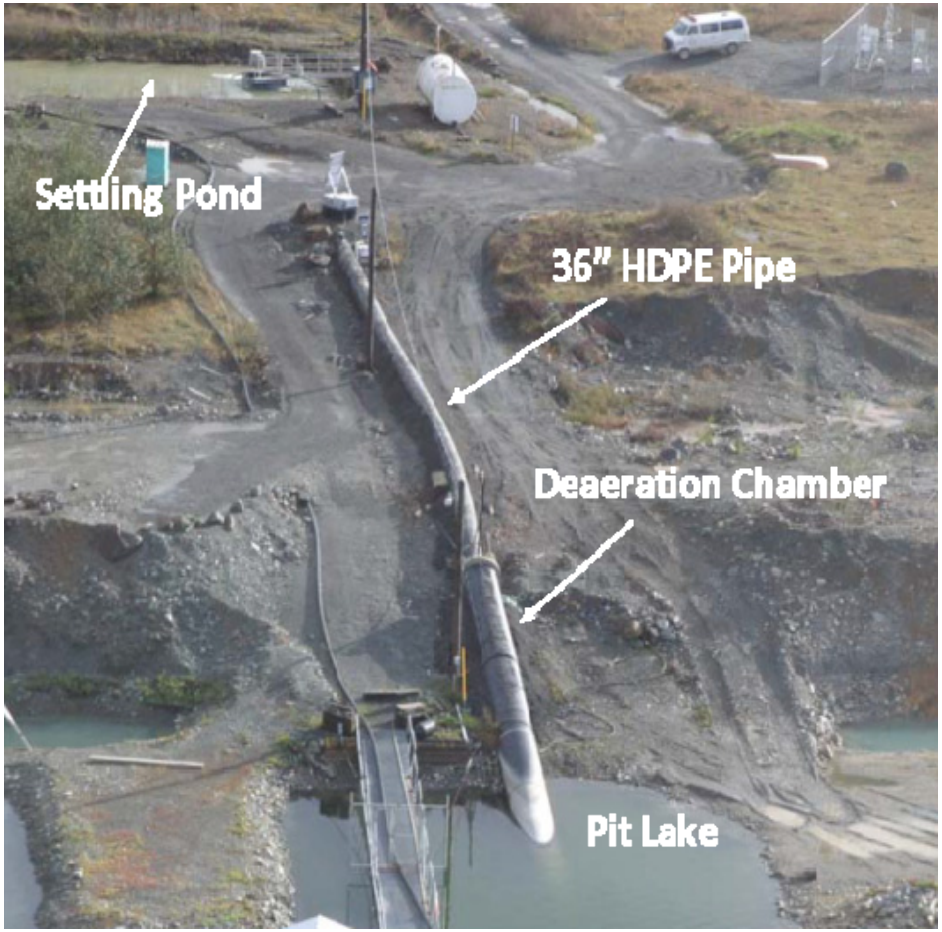


ML/ARD Inputs to Pit Lake

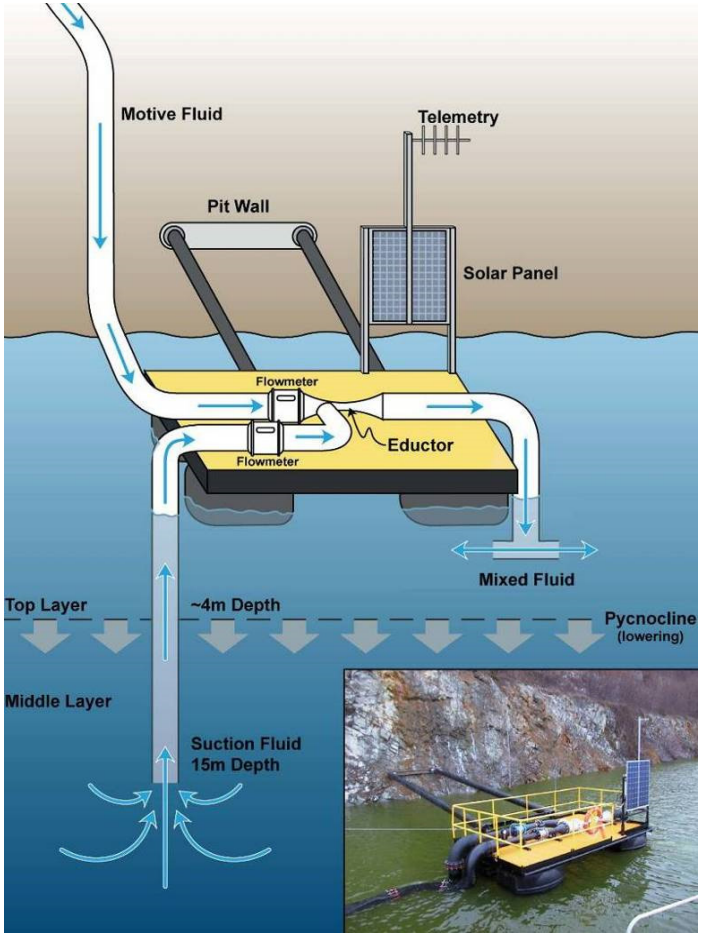
Variable	To surface		To middle layer
	North Catchment	Other	Southeast Catchment
Total annual flow (5-yr average; million m^3)	2.0	0.8	1.5
pH	6.64 - 8.08	3.69 - 8.32	4.30 - 7.83
Conductivity (µs/cm)	726 - 1,220	187 - 2,840	1,210 - 2,302
Sulphate (mg/L)	293 - 638	44.0 - 1,960	653 - 1,621
Dissolved zinc (mg/L)	0.646 - 4.22	0.191 - 23.2	0.564 - 11.1
Dissolved copper (mg/L)	0.0107 - 0.201	0.00823 - 3.78	0.00323 - 2.52
Dissolved cadmium (mg/L)	0.00396 - 0.0234	0.00085 - 0.120	0.0027 - 0.0541

ML/ARD Delivery Systems

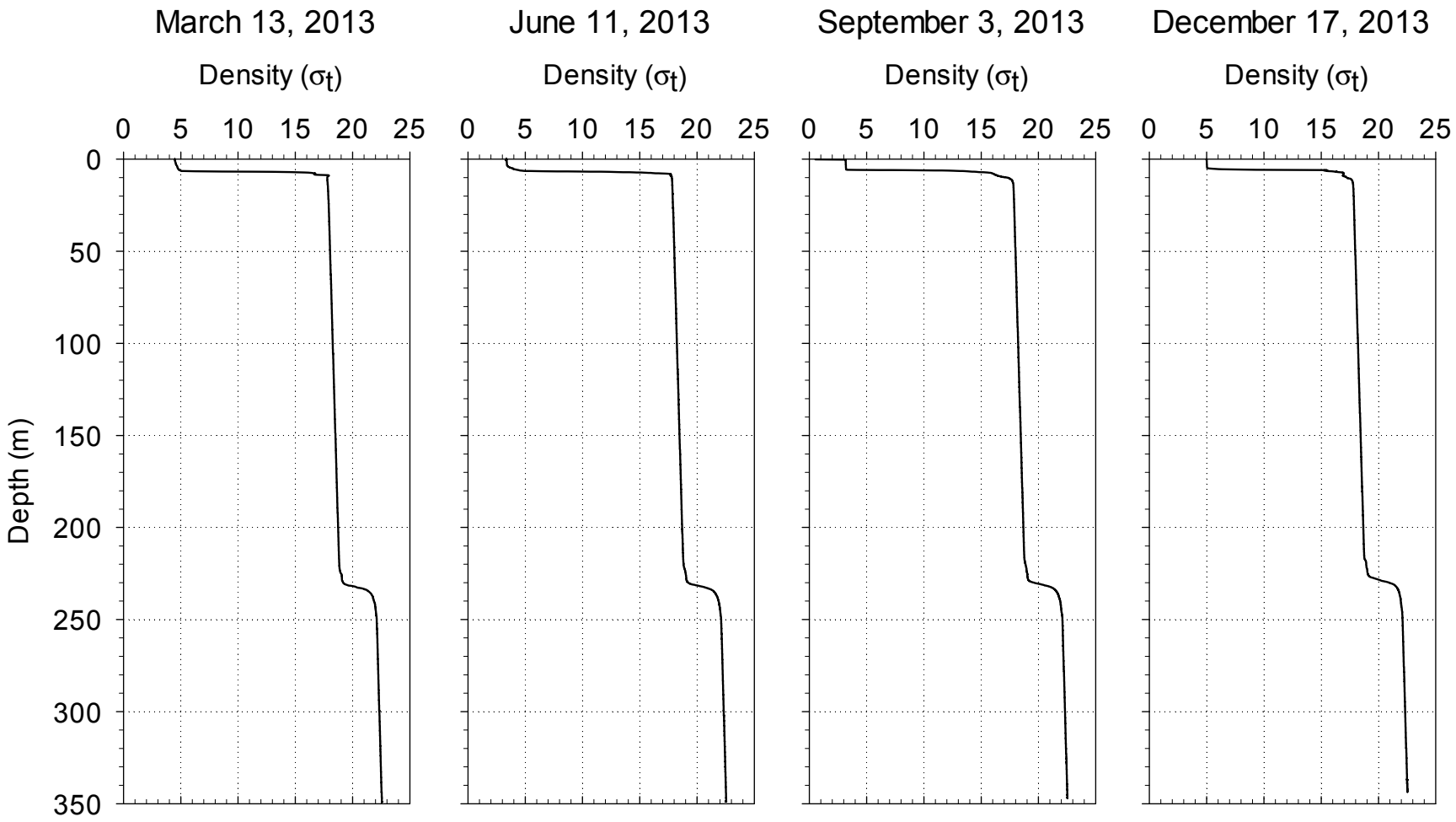
South Injector System (to 220 m depth)



Middle Layer Lifting System



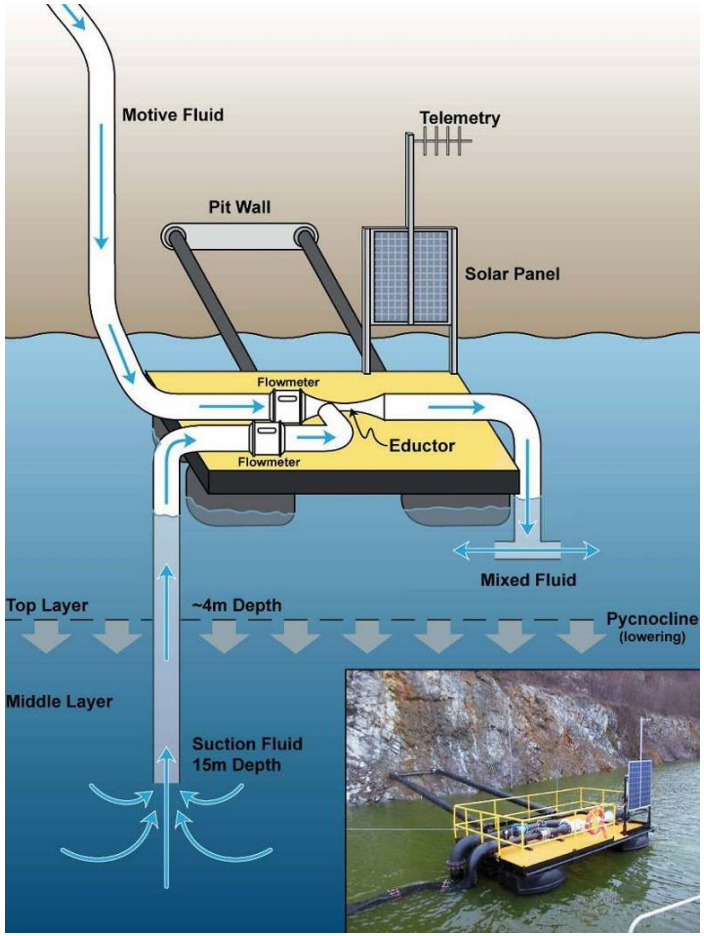
Three-layer Meromictic Lake



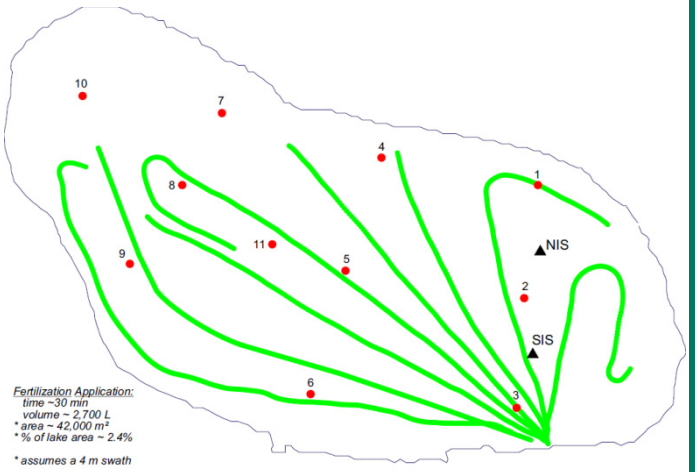
Phytoremediation of the Pit Lake

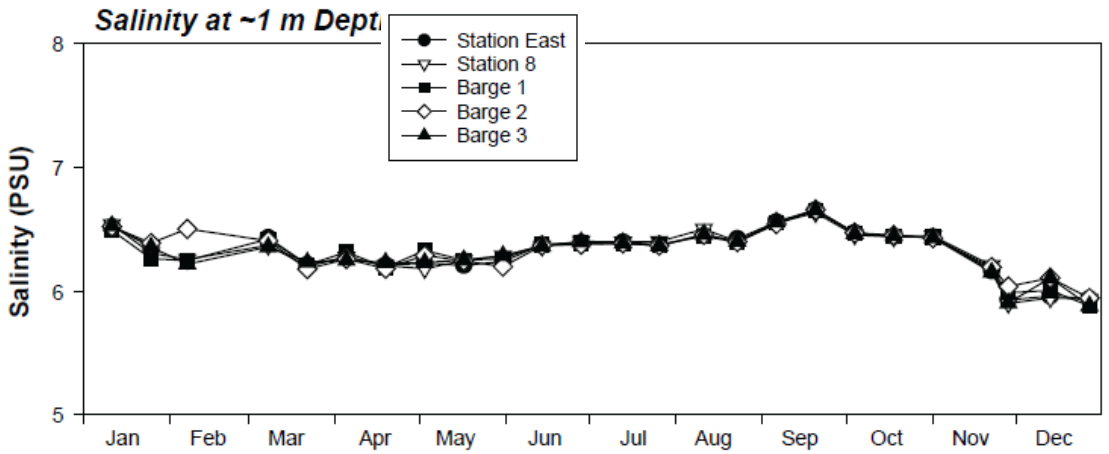
- Treatment required on the surface and at depth
- Nutrient amendments from September to June
- Commercial-grade liquid fertilizer
- N:P ratio of 6:1 by weight
- Weekly application of 383 mg N/m^2 and 63 mg P/m^2
- Boat as backup for fertilizer addition

Fertilizer Injection



Nutrient Amendments and Mixing





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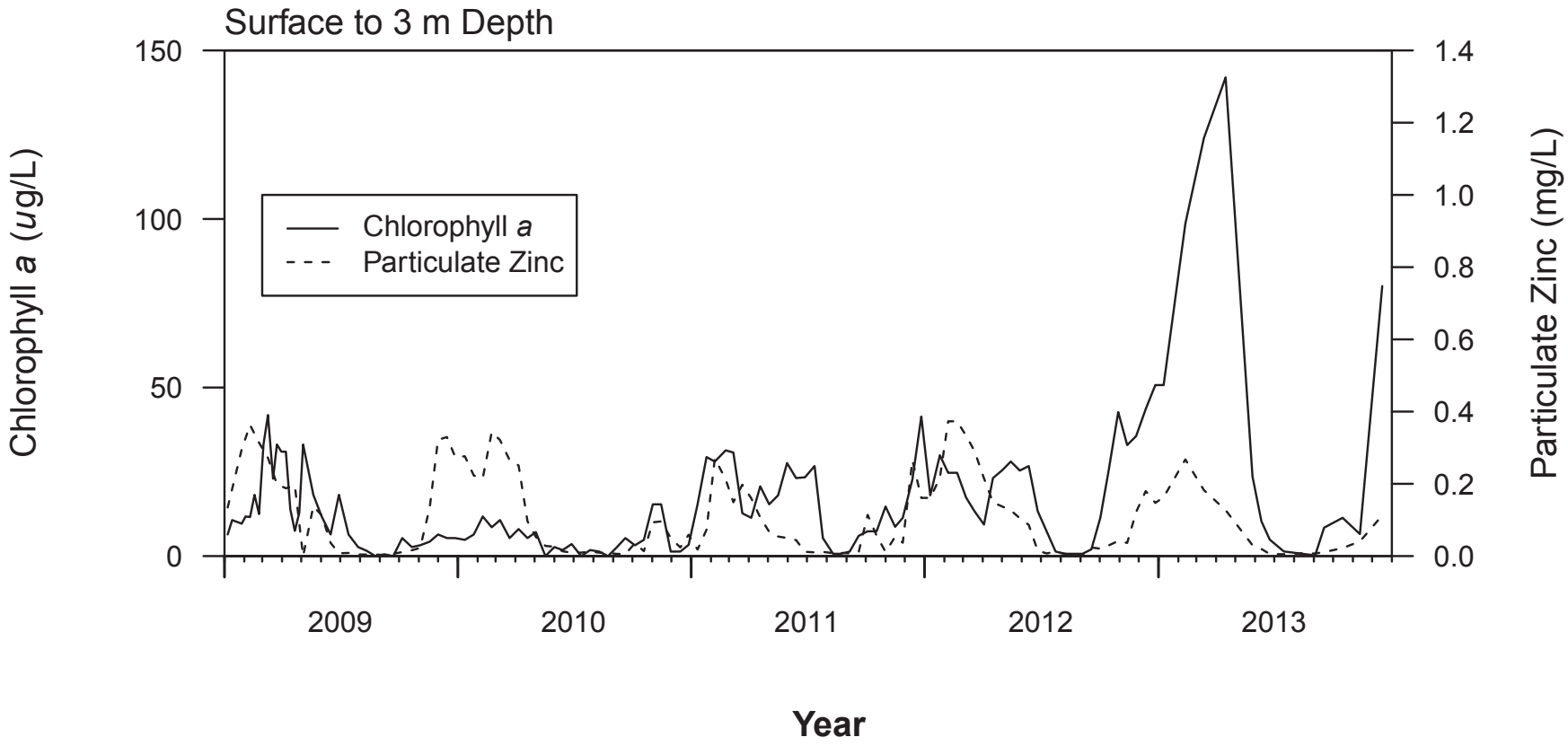
Pit Lake Monitoring Program

- Water quality (nutrients, metals)
- Primary production (chl. a)
- CTD casts
- ML/ARD quality and input flows

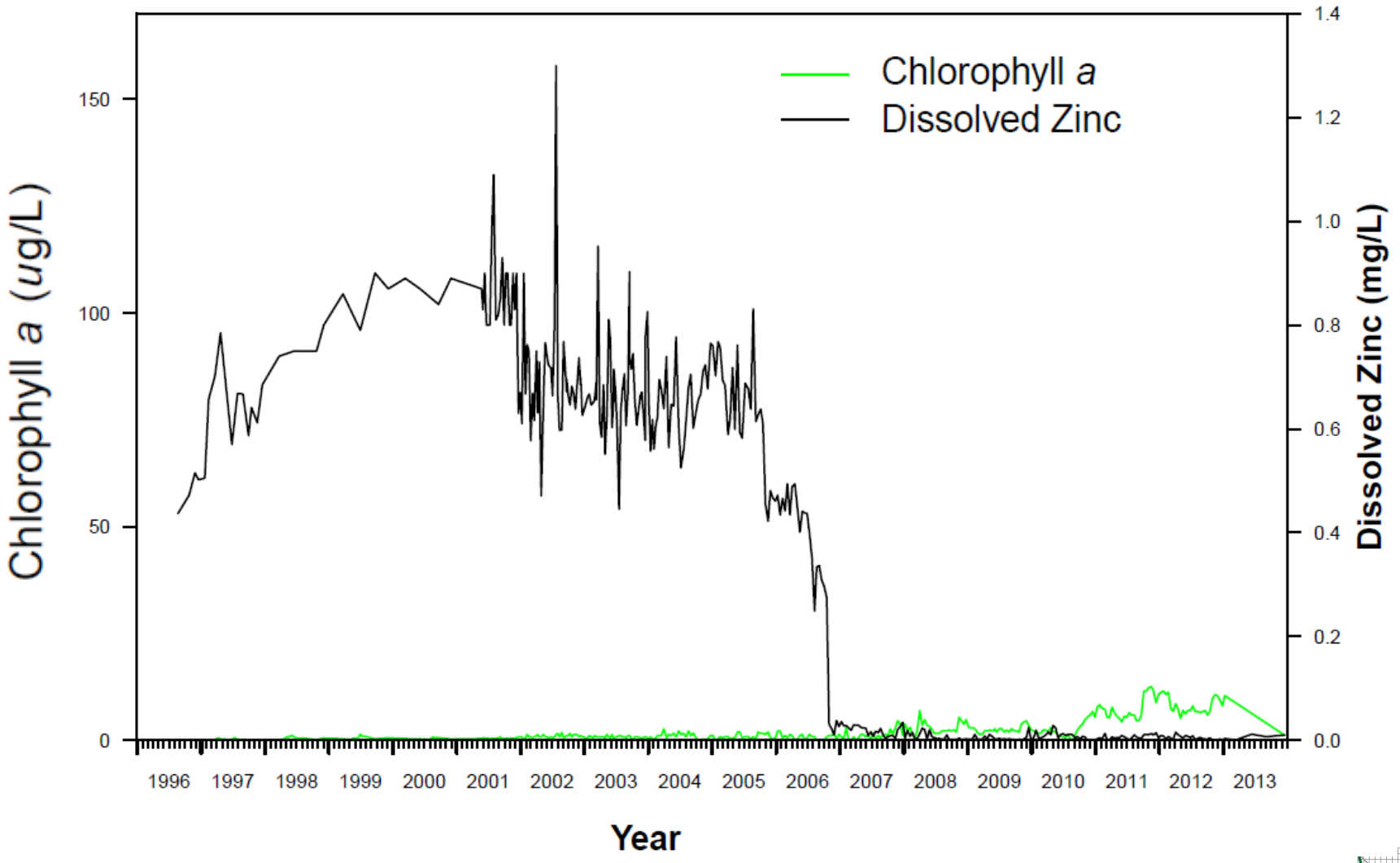
Biological Response



Geochemical Response

- Metal removal at surface is by adsorption onto organic matter
- Export of organic matter from surface to depth
- Oxidation by bacteria of organic matter drives redox potential
- Three zones
  - Oxic
  - Transition
  - Sulphidic
- Metal-sulphide precipitation at depth

Middle Layer Zinc Removal



Conclusions

- Designed to be strongly meromictic
- Engineered manipulation of upper pycnocline elevation
- Three geochemical zones
- Two metal attenuation mechanisms:
  - Metal adsorption in oxic zone
  - Metal-sulphide precipitation in sulphidic zone

Conclusion

1. Integrated physical biological pit lake design can provide long-lasting and effective treatment system for ML/ARD
2. Site-specific conditions can be challenging, but same conditions can create opportunities for innovation
3. Ignoring the inter-relation between the physical and biological characteristics of a pit lake or future pit lake may lead to non-optimal or unintended results

THANK YOU
QUESTIONS?

2009 BC Mine Closure Site Tour