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END PIT LAKES: UNRESOLVED ISSUES

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The Hazards of Modeling

- Numerical models need to have a correct conceptual basis
- Numerical models are of very little value if they have not been tested in actual situations
- Uncertainties can be magnified with multiple and sequential models
- At least in Nevada, a mine will not be permitted if a pit lake model indicates poor quality water. Modeling results have been adjusted to meet “good water quality” requirements
- Don’t believe them- they can be useful, but an unverified model is often merely a mathematical exercise

Lone Tree Pit Lake, Nevada

Relief Canyon Heap: Water is draining laterally and vertically. Note salt precipitate

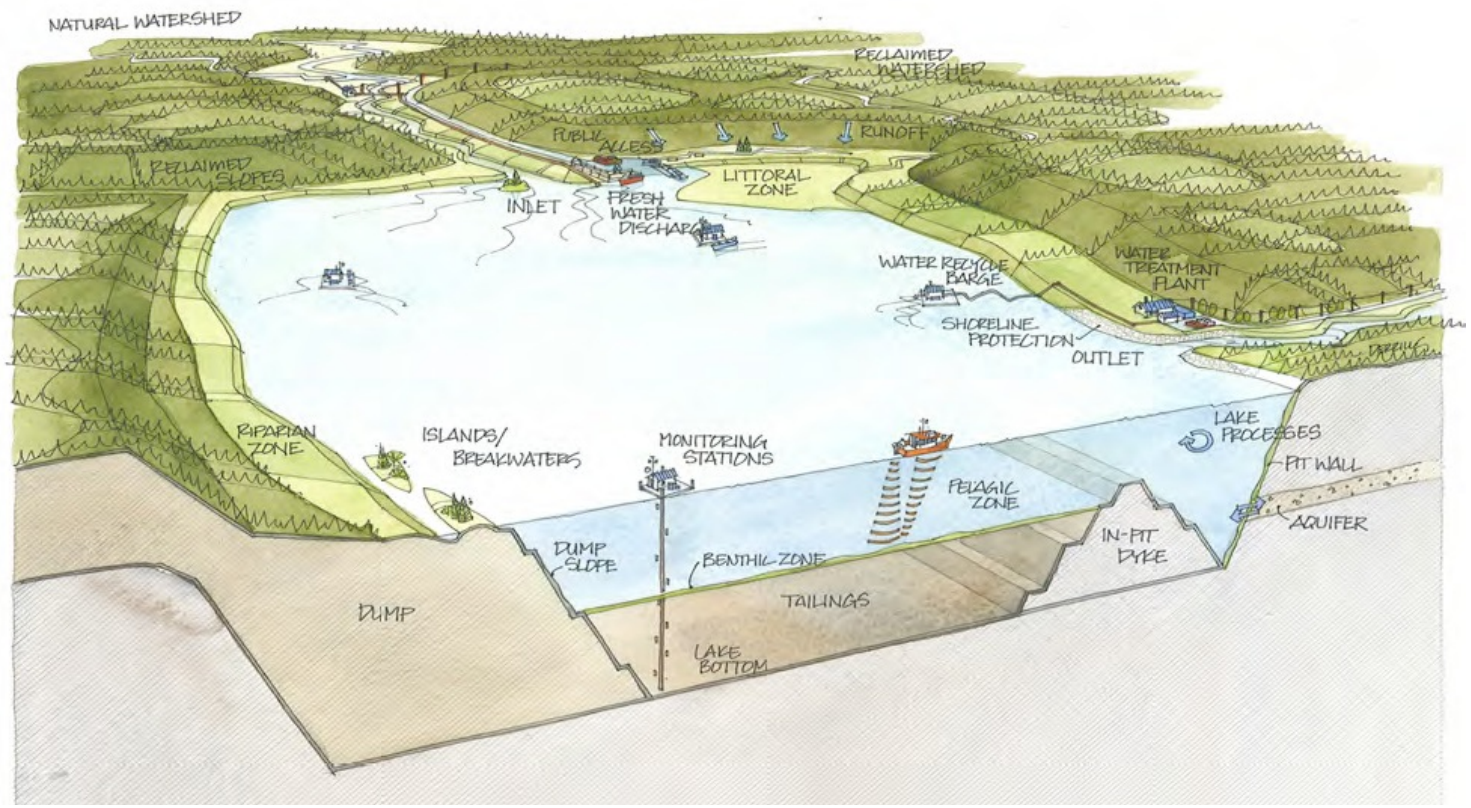
Jerritt Canyon Tailings Pond

End Pit Lake Definition

CEMA defines an oil sands EPL as: “an engineered water body, located *below grade* in an oil sands post-mining pit. It may contain oil sands by-product material and will receive *surface and groundwater* from surrounding reclaimed and undisturbed landscapes. EPLs will be permanent features in the final reclaimed landscape, discharging water to the downstream environment” (emphasis added)

(Westcott and Watson, 2007).

Conceptual End Pit Lake



Source: McKenna and Hrynyshyn: EPL Guidance Document, 2012

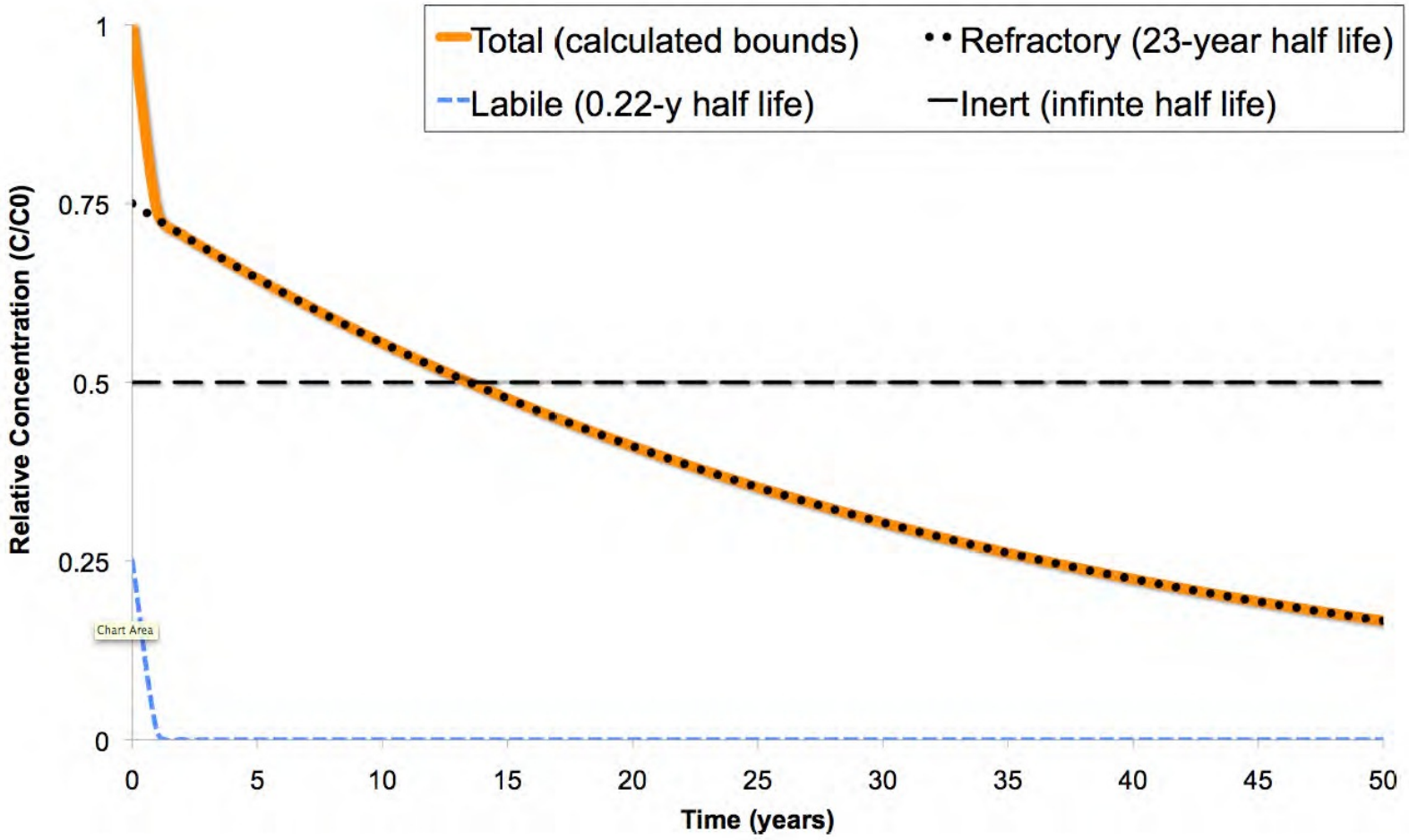
Contaminants in End Pit Lakes

- Salts: can be diluted, but not treated in an EPL, except by very expensive membrane techniques. Dilution with fresh water decreases the concentration, but not the total load into receiving waters
- Naphthenic acids: Continual release over decades and beyond- can be treated, but the cost is very high. Natural degradation is unlikely to be successful
- PAH: Highly variable and low solubility, but several are toxic and phototoxic
- Other contaminants: aluminum, cadmium, iron, mercury, strontium expected to exceed water quality criteria. Difficult to model
- Radioactive substances?

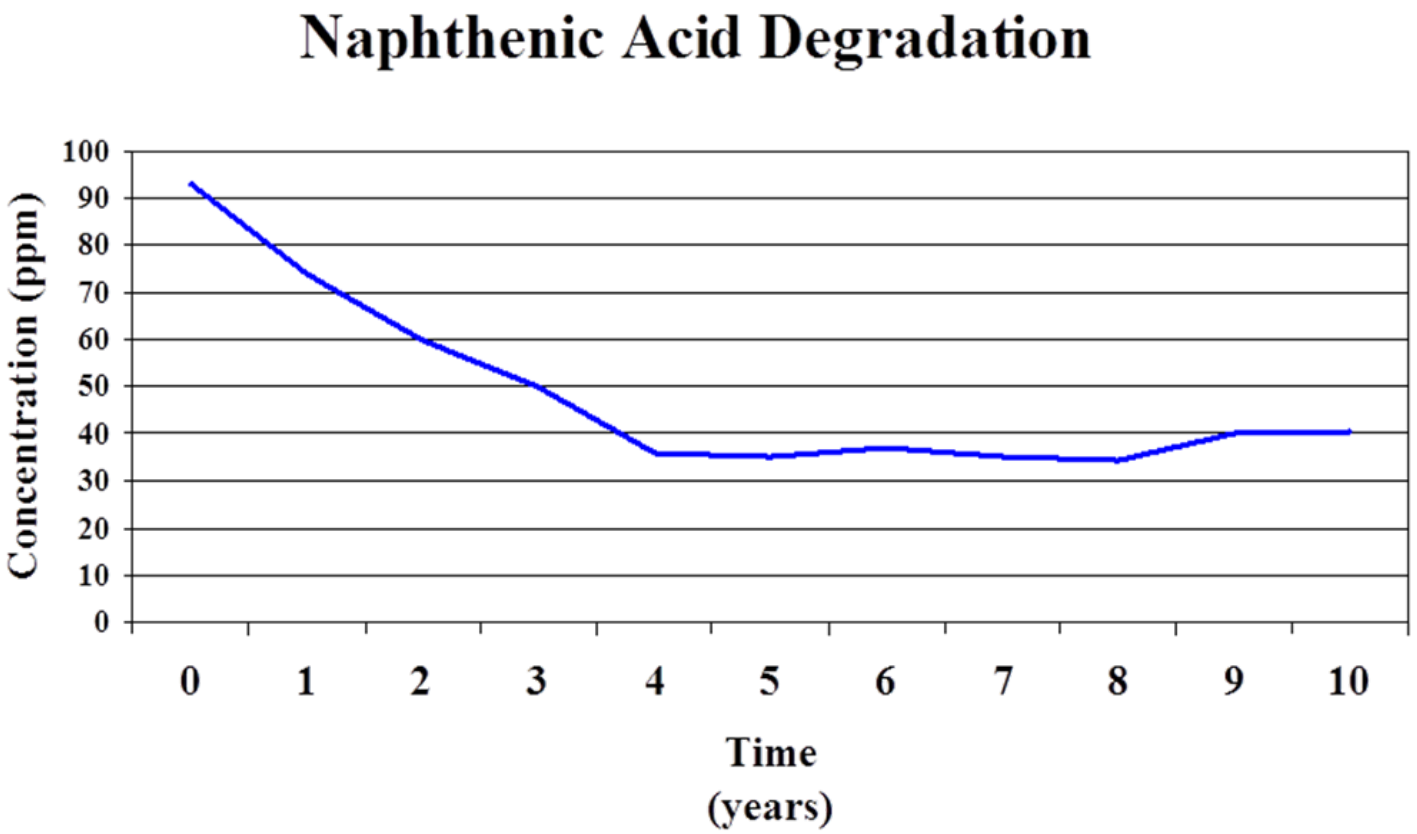
Naphthenic Acids

- Highly complicated array of aliphatic and aromatic carboxylic acids
- Grouping of these compounds as a single analyte ignores specific toxicity differences
- Grouping of these compounds as a single analyte ignores fate and transport differences
- How can a regulation be placed on these compounds when so much data is lacking?

Figure 9–4: Modeled degradation of a single source of naphthenic acids.



McKenna and Vandenberg, EPL Guidance Document, 2012



Source: Zubot, Syncrude Presentation on Base Mine EPL

Uncertainties in Modelling

- Release of contaminants to the EPL is highly variable
  - Dependent on infiltration of water into the tailings and release to the EPL
  - Highly heterogeneous hydraulic conductivities are expected– prediction of seepage is as much guess as quantifiable amounts
  - The time frame for leaching the contaminants from the tailings is on the order of many decades to centuries
  - Concentrations of soluble contaminants may exceed concentrations determined in the process water

Uncertainties, cont.

- Lake dynamics are variable- seasonal stratification may increase discharge of higher concentrations of tailings affected water
- Production of methane and hydrogen sulfide from settled tailings is highly uncertain. Sulfide may prevent sensitive species from colonization of the lake
- Data on the presence or absence of radioactive substances (common in many hydocarbon deposits) were not available

Uncertainties, cont.

- Salts are not biological degraded- the salt release to the receiving waters is a cumulative problem from all of the mines in the region
- Modeling metals is highly complicated, and imprecise.
- Naphthenic acids are known to be toxic and a proportion (25-75%) very stable
  - While naphthenic acids have been studied for several years, the components that contribute toxicity are not well known.
  - Quantitation of naphthenic acids is apparently on a total amount, and does not reflect toxicity

Conclusions

- Creation of EPL's is a grand experiment that is highly uncertain and problematic, based on the information available- modeling is not sufficient
- Alternative management of drainage water from the sites should be investigated, although few water treatment options exist that are economically available
- Although zero-discharge management is promised if water quality is unacceptable for discharge, treatment/management options of the volume of water that will generated are not clearly identified, and may not exist.