2nd Annual OAM Workshop

CLEAN-UP, REMEDIATION AND RESTORATION OF MINE SITES

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Outline

1. Conceptual Environmental Risk Profile
2. Site-scale-uniqueness
3. Knowledge Gaps 1: Data quality and quantity
4. Devil is in the detail (unknown unknowns)
5. Knowledge Gaps 2: General
6. A few comments about regulations

Conceptual Environmental Risk Profile

In general: there are diverse and well-established techniques for CRR – the trick is to identify, apply, and adapt those techniques to each CRR site.

The initial questions I have for a site are an attempt to frame the Clean-up; Remediation; Restoration (CRR) needs of a site.

Conceptual Risk Profile:
What is the contaminant source?
What is the contaminant pathway (mine source to environmental receptor)?
What are the Ecosystem Risks?
What are the Human Health Risks?
What gaps need plugging: Timing, Data, Knowledge?
Is there an anticipated CRR approach and thus Team requirements?

Site-Scale: Identifying Uniqueness

Iterative: defines CRR aims, scope and methods

Site characterisation:
(4-D space/time, soil, hydrology, microbio, geology, logistics, etc)
Environments/ecosystems: Does it fit known CRR tech?
Source-Receptor connectivity: Definition of the contaminant flux?
Contamination: Is the contaminant threat and remediation tech known?
What roadblocks to deploying CRR tech?
Team requirements: What skills does the team need?
Actions/Timing – how/when/where: Defined by the CRR needs.

Knowledge gap 1: Data and data quality

CRR success requires **sufficient quantities of good quality, relevant data**.

Virtually all CRR sites have missing and/or poor quality data problems. Identifying and correcting data quantity and quality gaps is often the most difficult and time-consuming component of any CRR effort; eg:

- What are the data gaps (e.g. groundwater; contaminant profile)?
- How important are those data problems?
  - OAM – historical data recovery/loss – fit for purpose?
- Effectively, efficiently eliminating critical data gaps is essential
  - physico-chemistry; modelling?

Communicating critical data needs across different teams is essential.

Devil is in the detail: Unknown, unknowns

Most CRR sites yield unknown unknowns: unexpected surprises requiring solutions:

Unexpected contaminant issues
Complicated site conditions
Difficult-to-overcome data problems

Communicating these issues across different teams is essential

In general: most of the techniques for overcoming CRR problems exist – identifying, applying, and adapting CRR to the site is the main game.

Knowledge Gaps 2: General CRR Canadian context

Generic Canadian gaps (IMO) :
"The North" – precious little research on environmental chemical processes in permafrost terrains – this is a roadblock for CRR in the north.

"*The Boreal"* – The high organic contents of boreal environments means CRR techniques will need significant (?generic) adaptations. More could be done.

Climate change – will have a high impact in boreal and permafrost environments – implications for CRR and OAM requires a greater focus.

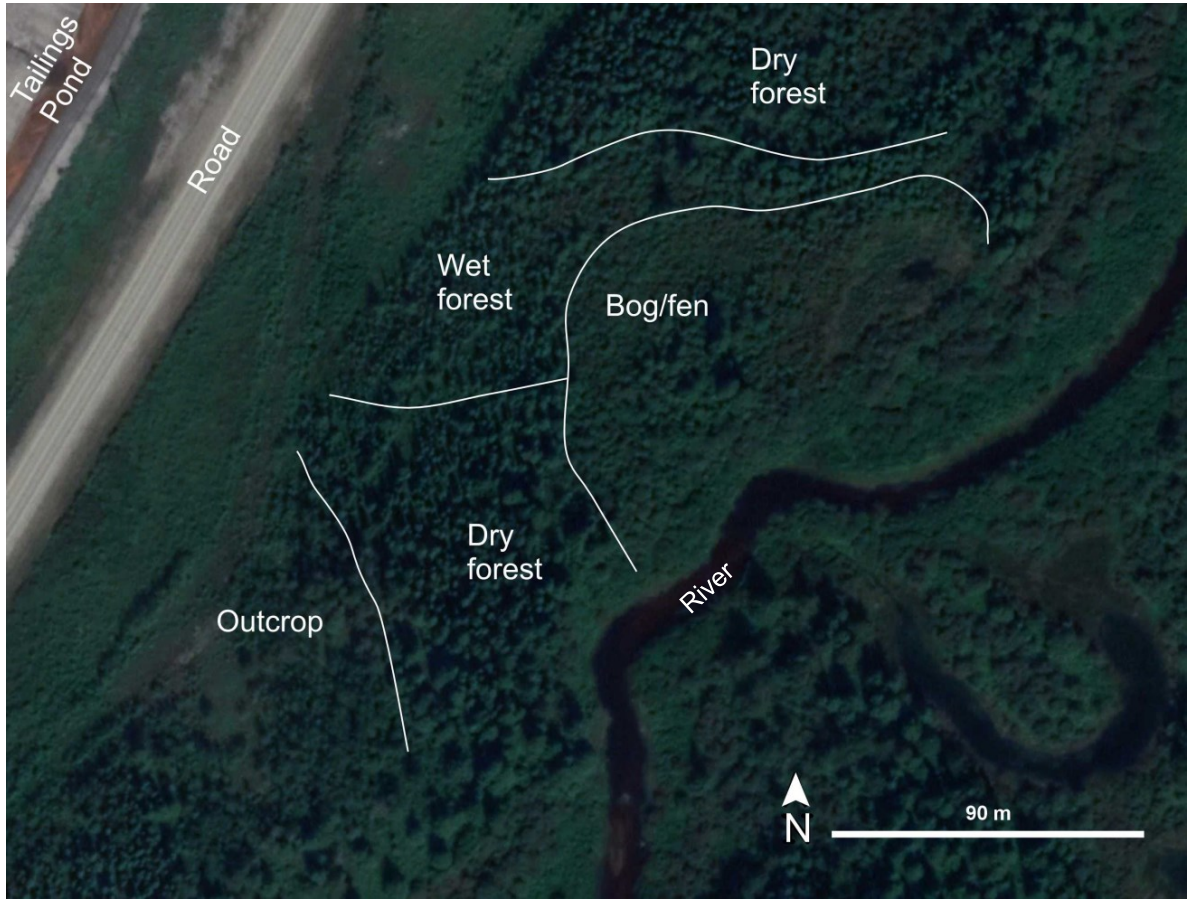
HR – To me it seems that Canada isn't training sufficient highly-skilled CRR people.

Regulations – a perspective

Regulations generalise and distill the state-of-the-art knowledge-experience-best practice in a field. But environments are highly diverse and heterogeneous; ie. complex:

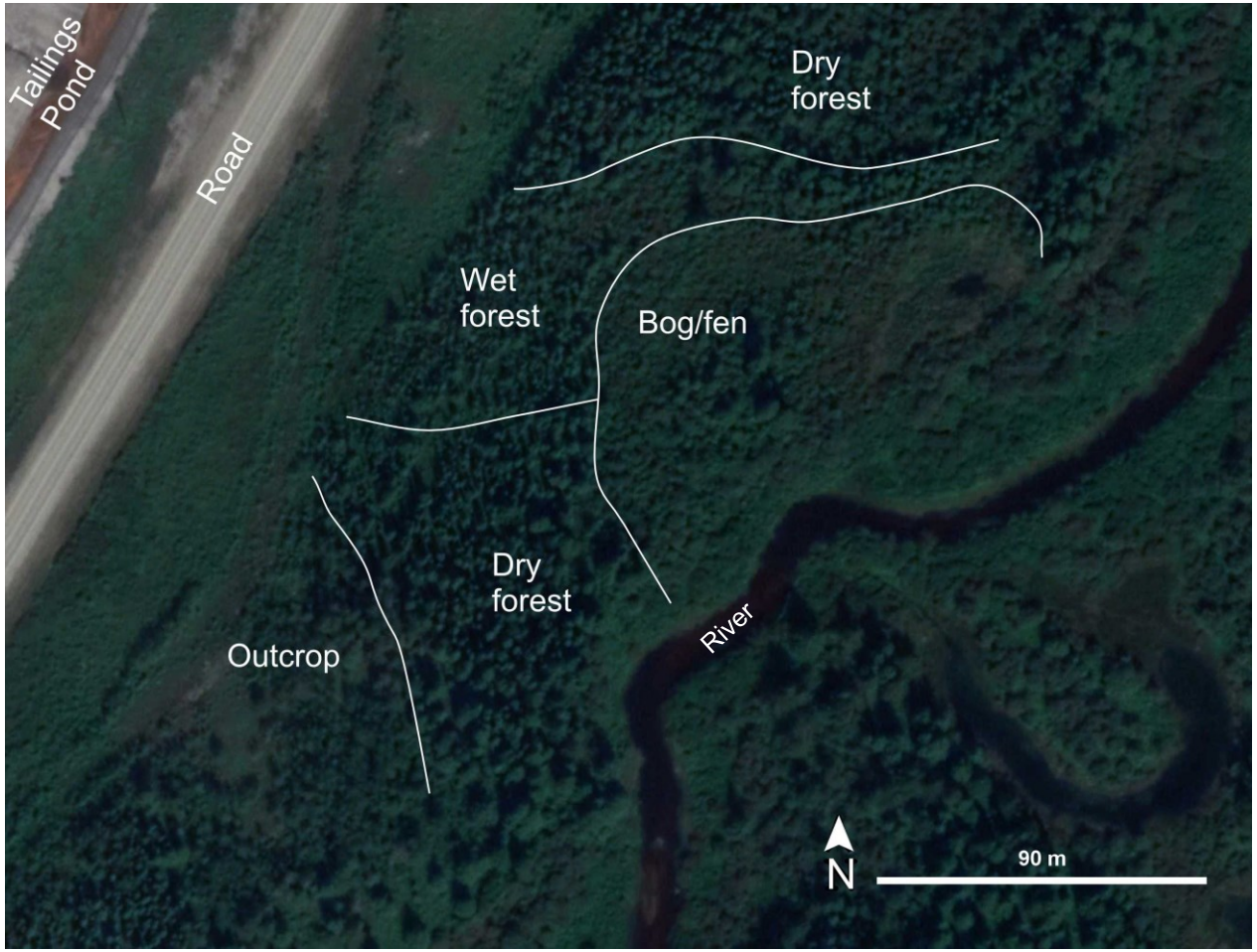
- Regulations cannot (currently) cover all potential eventualities
- Iteratively improve regulations where possible (e.g. monitoring data)
- Prevention is better than CRR - how far should EIS and mining permit regulations and requirements go?

Conceptual Environmental Risk Profile:



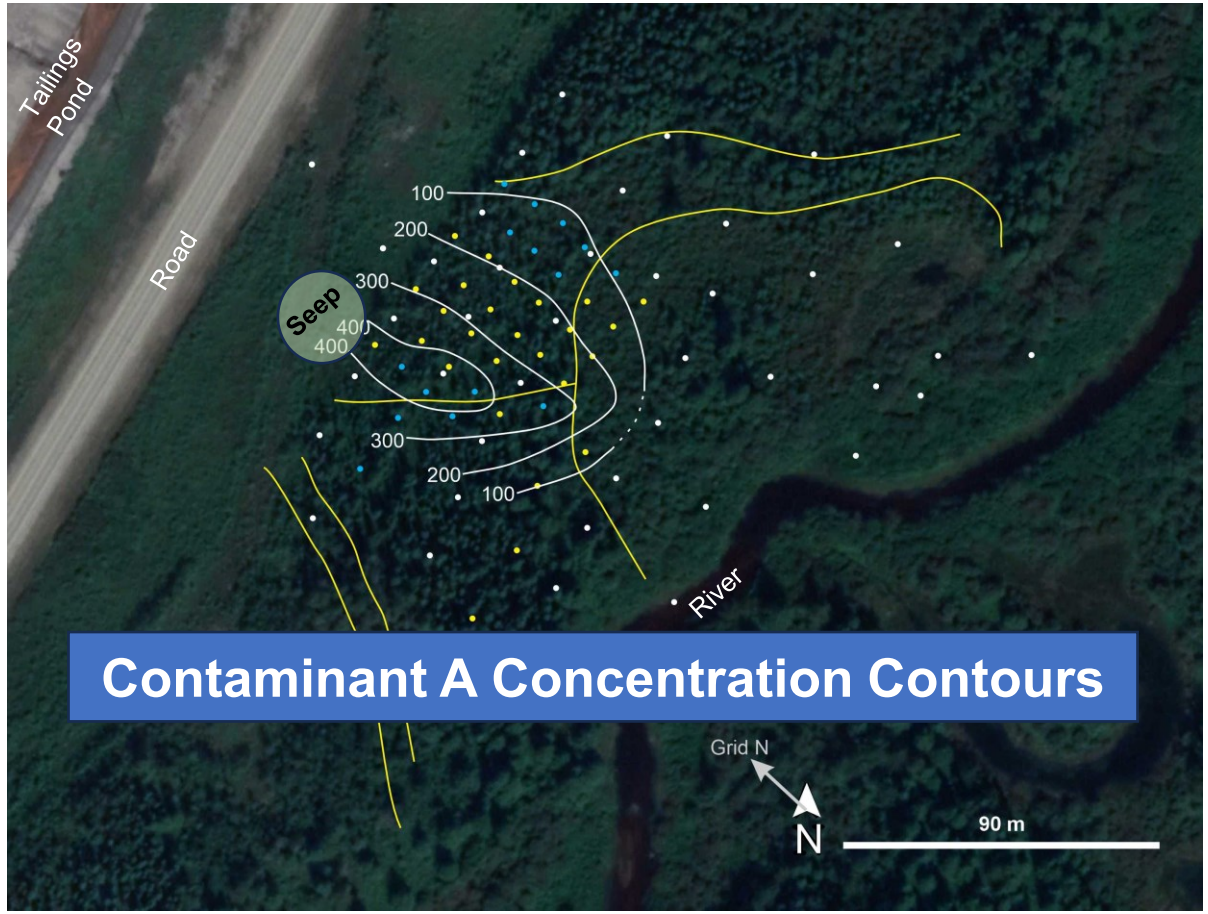
Conceptual Risk Profile: Moderate
Source: Tailings Pond
Pathway: Groundwater
Ecosystem Risk: Fen, river degradation
Human Concern: Uninhabited; some FN fishing
Minimal data; major knowledge gaps
Timing: unknown
CRR: potentially difficult

Site-Scale: Defining Uniqueness



Small scale, standard soils/aquifers
Boreal environment (high organics)*
Fen sensitivity*
Leakage from large tailings pond*
Difficult contaminant profile*
Good collaborative team
Easy logistics

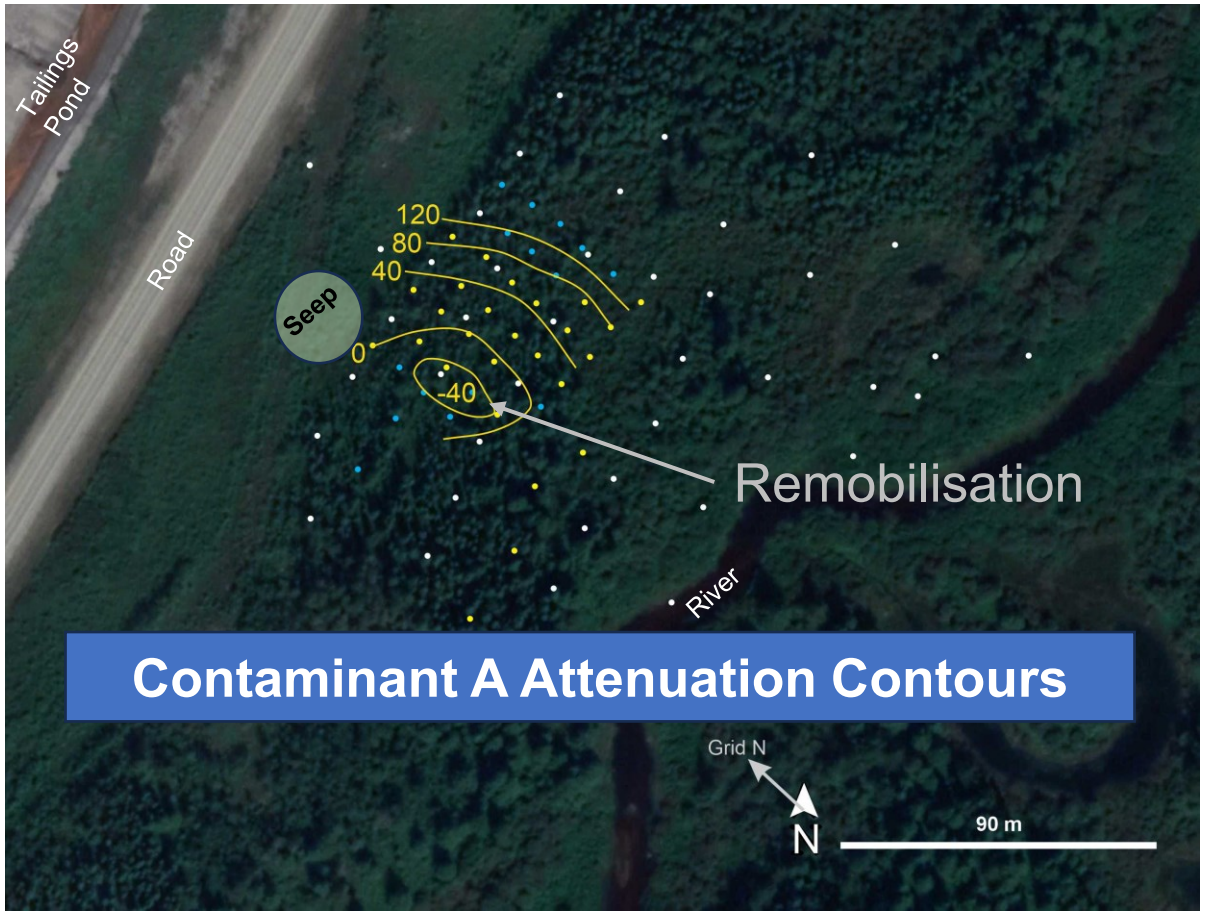
Knowledge Gap 1: Contaminant A



Initially – virtually no data

Collected comprehensive data mesh
Bullseye distribution downstream of seep
- TP source (via groundwater)
- Rapid natural attenuation
- Not an environmental concern?

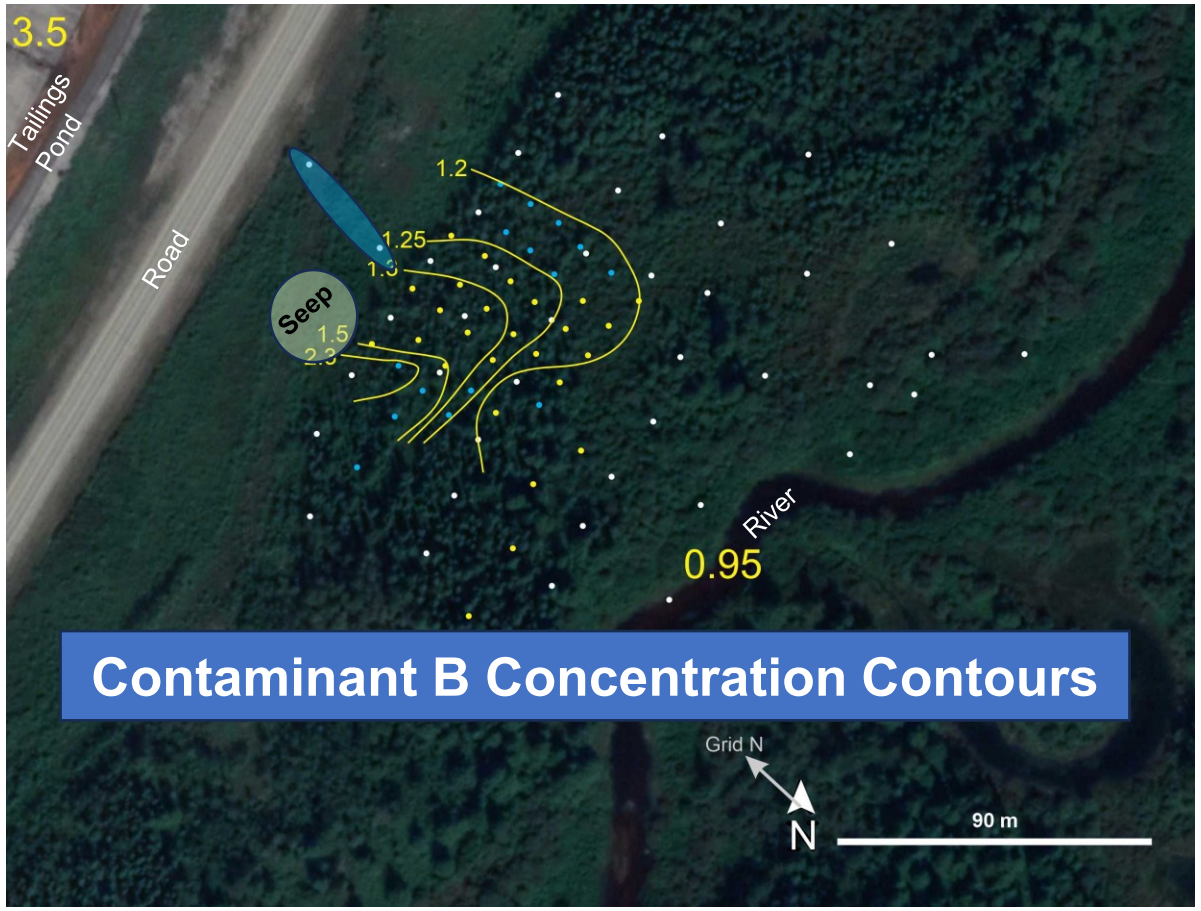
Knowledge Gap 1: Modelling Contaminant A



Numerical modelling demonstrated
- Chemically saturated bullseye
- Remobilisation (unknown, unknown)
- Not an environmental concern?

Modelling a useful tool for complex settings

Knowledge Gap 1: Contaminant B – devil is in the detail



Contaminant B has no easy remediation tech.

- Extremely rapid attenuation (10m scale)
- Natural Bioremediation: phew! new tech
- Not an environmental concern
- CRR needed if no natural attenuation

Overall there is no urgent need for CRR actions:

- Short term: sump/pump the seep
- Long term: plug aquifer

Monitoring: despite their best efforts, the companies monitoring wells were ineffective.

Thanks for Listening