Mine Water Liability: Evaluating the Risks and Potential Costs

Stephen Day, Geochemist
Tom Sharp, Environmental Engineer

PDAC 2017: March 5 - 8

srk consulting

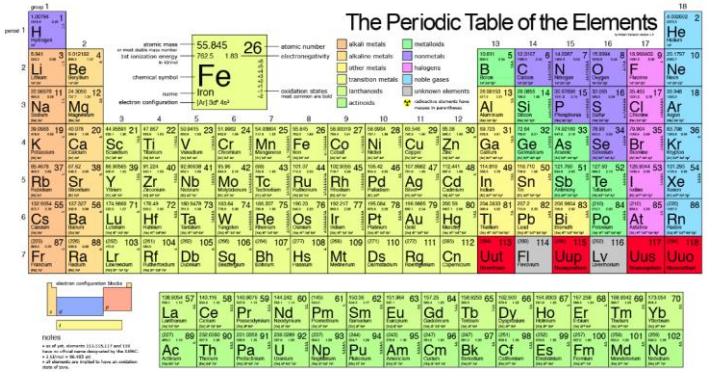
Outline

01

A (Very) Brief History of Water Quality Concerns at Mine Sites

First Came Acidity and Metals……

- 16th Century – De Re Metallica
- Late 20th Century – Metals (copper, zinc etc), metalloids (arsenic), cyanide, radioactivity.
- 21st Century – More metals (e.g, cobalt), non-metals (selenium, sulphate), blasting residues (nitrate), greater stringency (mercury).
- What's coming?
  - More regulated elements (rare earths).
  - Improved understanding of toxicology.



Discharge Objectives vs Receiving Water Quality

Discharges

- Considerations for “acute toxicity” (short term exposure limits)
  - In Canada, “deleterious” according to the Fisheries Act
  - Higher allowable concentrations (e.g. copper 0.3 to 0.6 mg/L)
  - http://laws-lois.justice.gc.ca/eng/regulations/SOR-2002-222/page-10.html#h-51

Receiving Water Quality

- Chronic toxicity
- Lower allowable concentrations (e.g. copper 0.002 to 0.04 mg/L)
- http://www.ccme.ca/en/resources/canadian_environmental_quality_guidelines/

Convergence of discharge standards and receiving water quality guidelines is a concern

02

Predicting Water Quality

Water Quality Predictions

Underpin decisions on water quality management technologies.

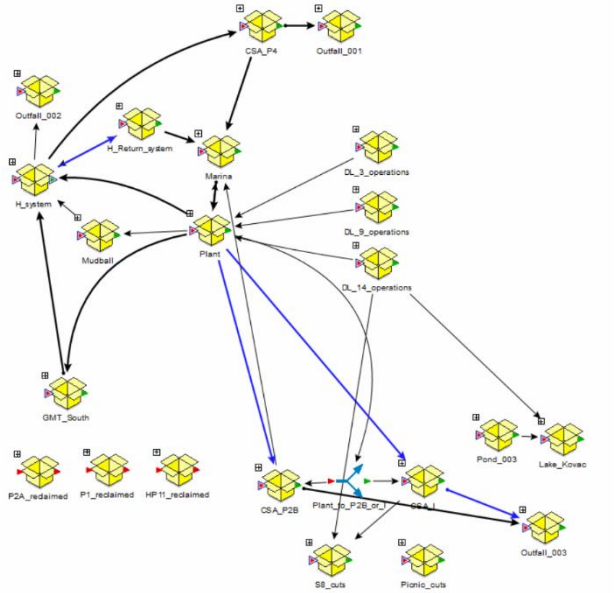
Important elements

- Supported by data collection at all stages of project development (including early exploration and metallurgical testing).
- Appropriate at all stages of economic evaluation (including scoping and PEAs).
- Less complex in early stages (e.g. screening level for scoping studies).
- Relies on strong conceptualization of mine facilities (sources) and pathways (surface water and groundwater).
- Reality checks against analogous operations.

Two General Groups

1. Waste weathering and leaching processes

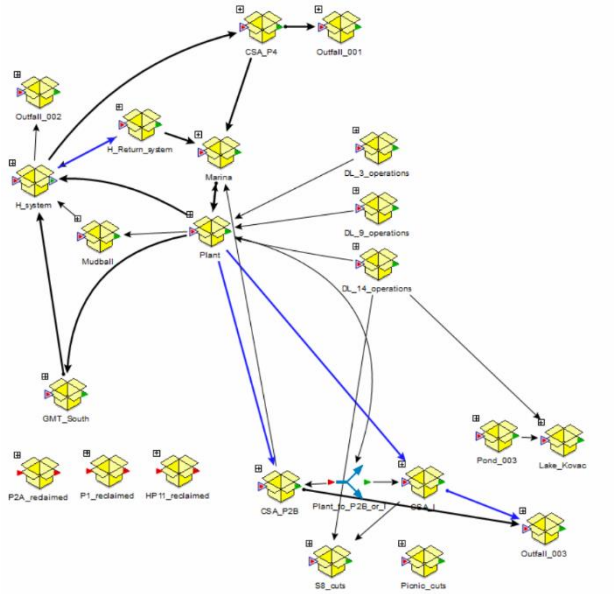
- Physical breakdown (suspended solids)
- Metal leaching (ML).
  - Leaching of soluble minerals
  - Leaching of soluble weathering products
- More specifically, acid rock (mine) drainage (ARD).
  - Oxidation of sulphide minerals, acid generation, acid neutralization.



Two General Groups

2. Residual reagent leaching

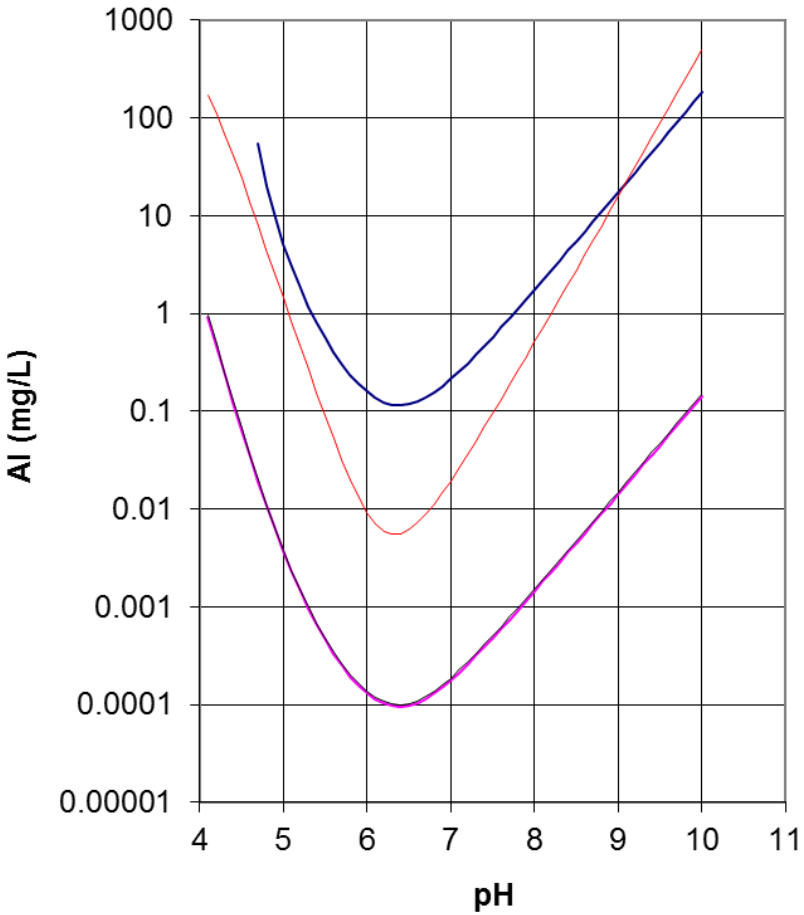
- Explosives residues
- Heap leaching solutions (cyanide, acid)
- Process residues (cyanide, flotation reagents, acid, hydromet)



Prediction Issues

Causes of Uncertainty

- Incomplete conceptualization of site.
- Predictions of waste weathering rates are commonly based on interpretation of laboratory or pilot scale field tests (scaling issues).
- Understanding of underlying controls remains weak.
- Background water quality and flow poorly characterized
- Need for and use of predictions is not well-defined
  - Different methods serve different purposes.
  - Outputs incorrectly viewed as absolute.
  - Excessive conservatism for regulatory purposes.

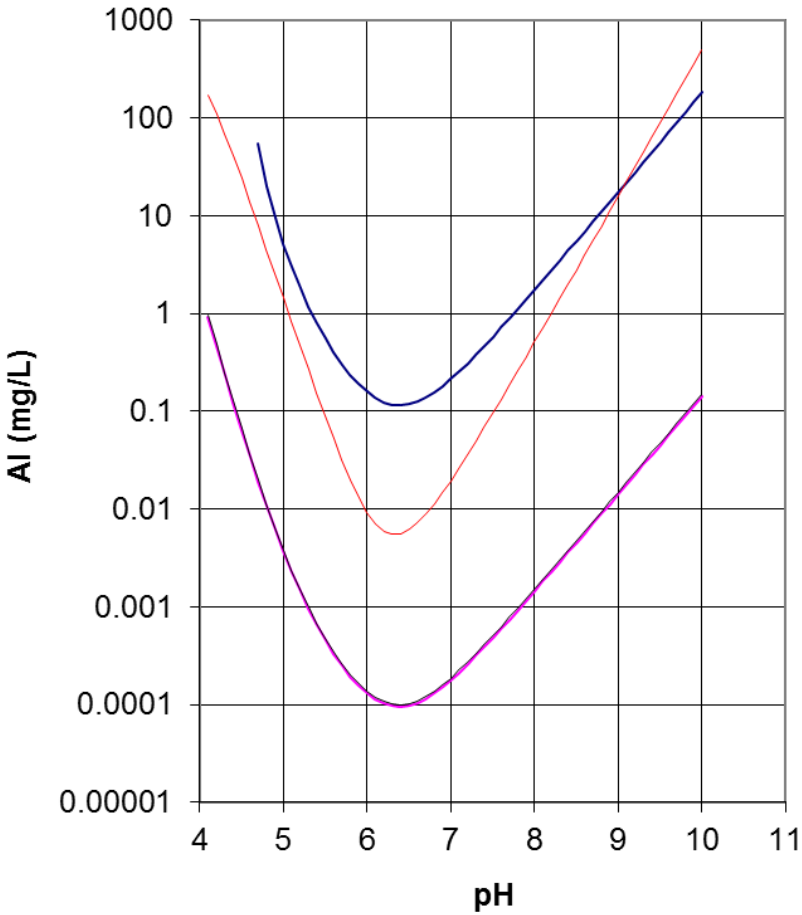


Prediction Issues

Narrowing Uncertainty

- Thorough initial conceptualization.
- Ground-truthing to full-scale analogs.
- Recognition that different models and methods serve different purposes.
- Appropriate modelling detail for each stage of project evaluation (economic and permitting).
  - Avoid excessive complexity.
  - Pick the right tool for the job.

GoldSim



03

Management Technologies

Selection of Management Technologies

Technical requirements

Target water quality objectives (generic or site specific

Maturity of technology

Performance certainty

Regulatory acceptance

Operational vs future costs (bonding)

Types of Technologies

Prevent

- Underwater disposal (ML/ARD)
- Alkali blending (ML/ARD)
- Cooling (ML/ARD)
- Reagent selection (processing)
- Explosives management (blasting)

Control

- Natural covers (soils)
- Artificial covers (membranes)
- Liners
- Water diversions

Treat

- Passive treatment
- Semi-passive treatment.
- Active treatment

Underwater Disposal

- Underwater disposal (ML/ARD)
- Alkali blending (ML/ARD)
- Cooling (ML/ARD)
- Reagent selection (processing)
- Explosives management (blasting)

- Strong technical solution for ARD potential.
- Yields very good water quality.
- Very mature technology.
- Accepted as proven by regulators.
- Can have very low long term costs.
- Can be a permanent solution.

- May be unsuitable for oxidized wastes.
- Places burden on permanent geotechnical containment and maintenance of water covers when implemented as artificial impoundments.
- Concerns about permanent water covers.
- Off-limits for natural water bodies.
- Climate change uncertainties for water covers.

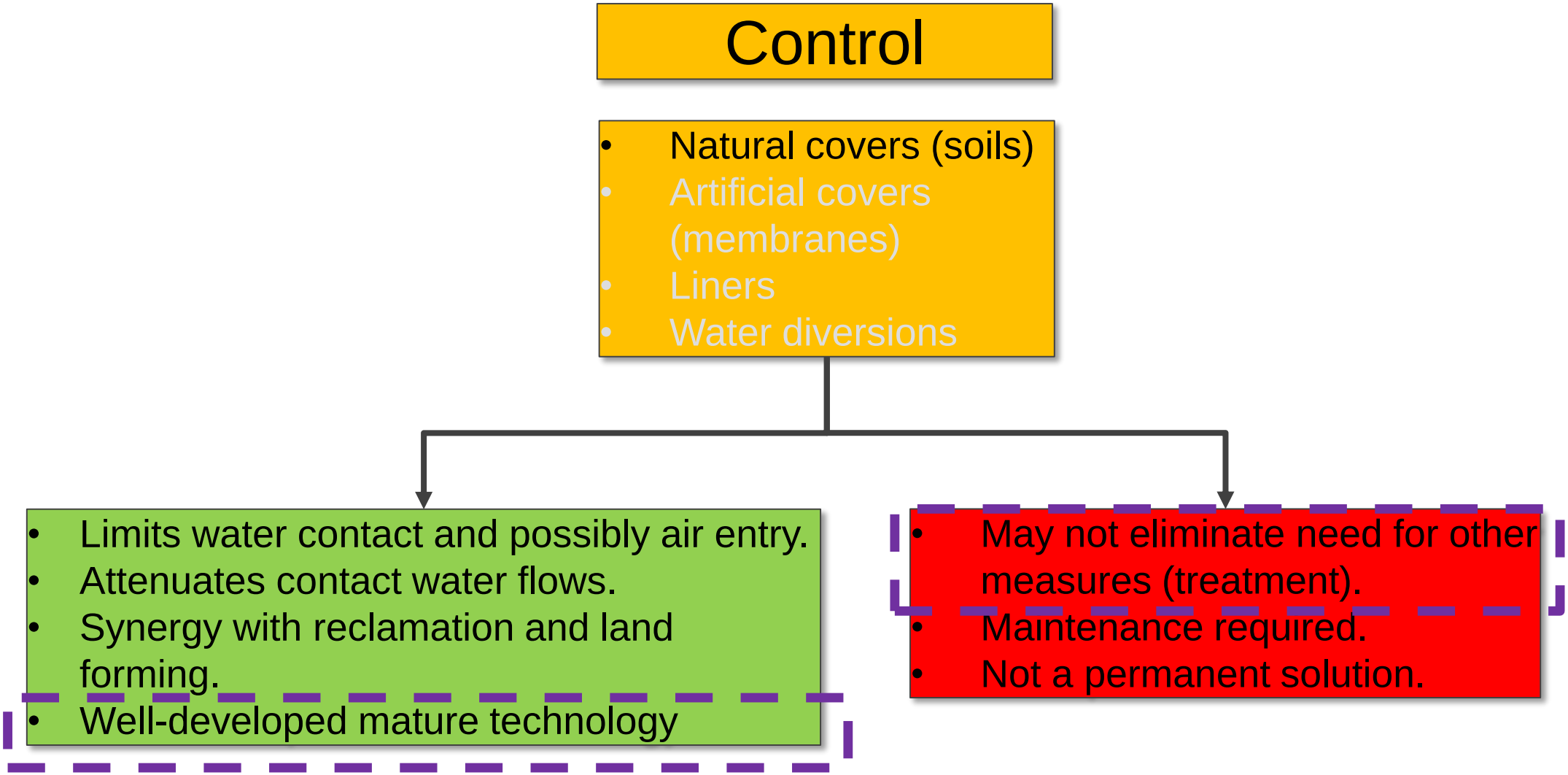
Alkali Blending

- Underwater disposal (ML/ARD)
- Alkali blending (ML/ARD)
- Cooling (ML/ARD)
- Reagent selection (processing)
- Explosives management (blasting)

- Technical solution for ARD potential.
- Can yield very good water quality
- Immature technology
- Can be a permanent solution.

- Not commonly accepted as proven by regulators due to failures.
- Few reliable long term case histories.
- High operational costs for selective handling.
- Can result in double costs due to bonding for ARD uncertainty.

Soil Covers


Control
Natural covers (soils)
Artificial covers (membranes)
Liners
Water diversions
Limits water contact and possibly air entry.
Attenuates contact water flows.
Synergy with reclamation and land forming.
Well-developed mature technology
May not eliminate need for other measures (treatment).
Maintenance required.
Not a permanent solution.

Active Treatment

- Strong technical solution for ARD and conventional metals.
- Can meet discharge standards.
- Mature technologies for some parameters.
- Can have very low long term costs (in NPV terms).

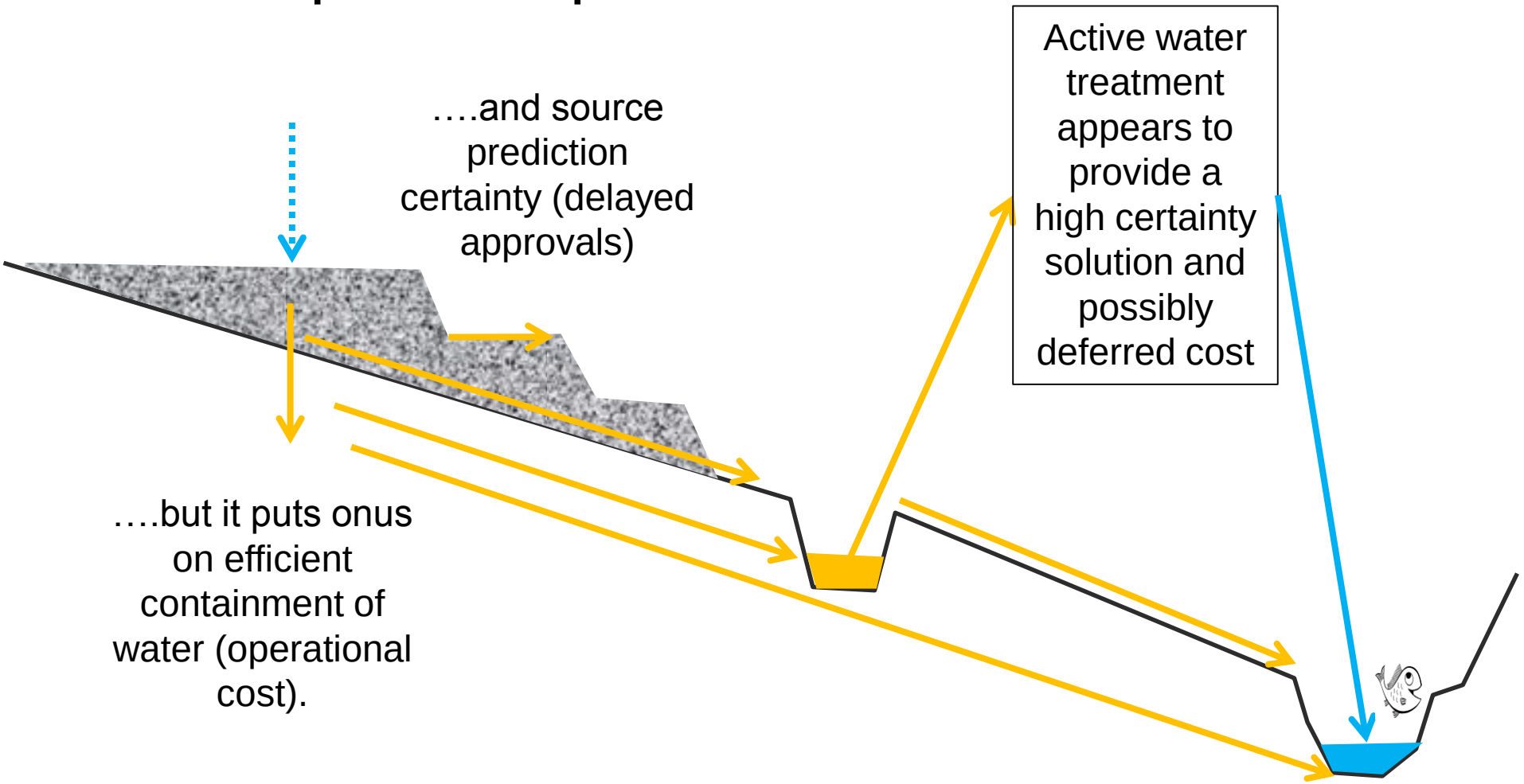
- Passive treatment
- Semi-passive treatment.
- Active treatment

- High costs for some parameters (e.g sulphate).
- Finicky for some parameters using biological processes.
- Requires containment of non-dischargeable waters (surface water and groundwater).
- Disposal of residues (sludges and brines)
- Requires perpetual presence (infrastructure).

04

Implications of Uncertainty

An Example of Implications



05

Concluding Remarks

Concluding Remarks

- Cost and schedule implications of water quality management are very commonly missed (or covered too cursorily) in the early stages of economic assessments.
- Scoping level water quality assessments supported by early data collection during exploration can provide strong early feedback to project designs.
- Technology selections need to consider other consequences to costs and permitting risks.

Thank You

Mine Water Liability: Evaluating the Risks and Potential Costs

Presented by:

Stephen Day, PGeo
Corporate Consultant

Tom Sharp, Peng
Principal Consultant

SRK Vancouver
Oceanic Plaza, 22nd Floor, 1066 West Hastings Street, Vancouver, BC, Canada V6E 3X2

Tel: +1 604 681 4196

srk consulting