Keynote Panel

Mining, Sustainability, Durability and innovation

Day 3 (Thursday 9 June)

Professor David Williams, UQ
(email: D.Williams@uq.edu.au)

Evolution of liners beneath stored mine wastes

- Early mine waste storages had no designed liner
- This evolved to:
  - Selecting waste storage sites with natural clays (deep, uncracked)
  - Compacted clay liners (desiccation must be allowed for)
  - HDPE, GCL and bituminous geomembrane liners (under limited head, and exposure to UV and harsh chemistry/biology must be allowed for)
- Composite and leachate collection liners:
  - Combining benefits of clay and geosynthetics, and added safety of leachate collection and reduction of hydraulic gradient

Purpose of liners on mine wastes

- Stored mine wastes add to natural recharge, and have the potential to contaminate the receiving environment
- Liner systems have evolved from a desire to limit potential environmental impacts from stored mine wastes
- Key means by which liners may limit potential environmental impacts:
  - Limiting transport of any contaminants by reducing seepage; and/or
  - Enabling leachate collection of any contaminants or oxidation product; and/or
  - Maintaining saturated conditions within the mine wastes to limit oxidation

Determinants of liner performance

- Climate
- Nature and reactivity of mine wastes
- Topography, surrounding landforms and land uses
- Proposed final land use and water resources at risk
- Appropriate liner selection and design
- Controlled liner material selection and construction
- Limiting exposure of liner to environmental degradation
- Required liner design life and liner longevity

How effective are liners generally?

- Poorly-compacted clayey soils
- Compacted clayey soils
- Natural clayey soils and weathered rock
- HDPE, GCL and bituminous geomembrane liners
- Composite soil and geomembrane liners

Potential leakage rates through liners

LINER	POTENTIAL LEAKAGE RATE			
	Under unit hydraulic gradient		Under 3 m head	
	(m/s)	(mm/year)	(m/s)	(mm/year)
Natural clay/weathered rock (>3 m)	10^{-9}	32	10^{-9}	32
Well-compacted clay (0.5 m) **Will pass ~3 times rainfall!**	10^{-8}	315	6×10^{-8}	1,890
Poorly-compacted clay (0.5 m) **Will pass all stored water!**	10^{-7}	3,150	6×10^{-7}	18,900
HDPE geomembrane (1.5 mm):				
• Intact	10^{-15}	0.0003	2×10^{-12}	0.6
• In practice **Will pass most rainfall!**	10^{-11}	0.3	2×10^{-8}	600

Some observations of geosynthetic use

- Geosynthetics are more likely to be used in tailings dam construction in wetter regions of Australia, particularly on Tasmania’s West Coast:
    - ~2,000 mmpa rainfall – Evenly spread persistent “drizzle”
    - On existing tailings dams, liners will be restricted to the slopes of upper raises
    - Bituminous geomembranes and GCLs are preferred over HDPE because they are easier to install in the cool, wet climate
    - GCLs are typically laid on a geotextile for protection and may be overlain by compacted “clay” – A composite liner
    - Compacted tailings may be used in the upstream zone, with a geotextile separator, and rock in the downstream zone to lower the phreatic surface

Evolution of covers on mine wastes

- Early mine waste covers were intended to support revegetation
- This evolved to:
  - Rainfall-shedding (mounded) covers, comprising a sealing layer (compacted clay and/or geosynthetic), and a growth medium
  - Non-shedding covers to store rainfall infiltration and release it through evapotranspiration, known as:
    - Store and release (for use on mine wastes in dry climates) – Williams *et al.* (1997)
    - Evapotranspirative (ET), Phytocap, etc. (for use on municipal wastes in dry climates) – ACAP Benson and Albright (1998)
  - Capillary break layers to limit uptake of contaminants (difficult to get right!)

Purpose of covers on mine wastes

- Cover systems have evolved from a desire to limit potential environmental impacts from stored mine wastes
- Key means by which covers may limit potential environmental impacts are:
  - Limiting potential oxidation of stored mine wastes by restricting oxygen ingress (best achieved by storage below water, in wet climates), and/or
  - Limiting transport of any contaminants or oxidation products to the environment via rainfall runoff or seepage, or wind (applicable in dry climates)

Determinants of mine waste cover performance

- Climate
- Nature and reactivity of the mine wastes
- Topography, surrounding landforms and land uses
- Proposed final land use or ecological function
- Appropriate cover selection and design
- Controlled cover material selection and cover construction
- Cover maintenance and sustainability

Questions

- What can geosythetics offer to reduce seepage from stored mine wastes?
- How effective are geosythetics, and how can their effectiveness be optimised?
- How long-lived are geosynthetics?
- What can geosythetics offer to reduce oxygen ingress into sulfidic stored mine wastes?
- What can geosythetics offer to reduce net percolation of rainfall into stored mine wastes?

GEOANZ #1

ADVANCES IN GEOSYNTHETICS

7–9 JUNE 2022 | BRISBANE CONVENTION & EXHIBITION CENTRE

Questions

- Dimensional stability?
- How to evaluate service life? 50% of specified property? Discoloration?
- Should sacrificial coupons be included?
- What is expected exposed v. unexposed service life?
- What Operation and Maintenance is needed to prolong service life?
- Should warranties be included? For how long?
- or Evaporation Mining - Stark