~~**Adrian Roberts**~~
~~Technical Director – Waste Management~~
Alison Horlyck and Chris Nivison-Smith
Technical Directors – Waste Management

To fill or not to fill?

Are quarry and mine sites the answer to the airspace question

Welcome

Landfill types

- Trench fill
- Valley fill
- Area fill
- **Quarry/mine fill**





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Quarry and mine operations

Typical quarry	Typical mine
Extraction of construction materials (rock, sand, gravel, clay, limestone)	Extraction of valuable minerals or energy resources (coal, iron ore, gold, copper, lithium, etc.)
Generally shallow to moderate depth	Can range from shallow to very deep
Almost exclusively surface excavation	Open-cut or underground
Usually relatively uniform rock or sediment deposits	Often complex ore bodies with variable geology
No processing, to crushing, screening, washing	Beneficiation, concentration, processing plants, tailings management
Generally low to moderate overburden volumes	Often substantial waste rock and tailings volumes
Simple void, pit or excavation	Large pit, underground workings, waste rock dumps and tailings facilities
Often above or intersecting shallow groundwater	Frequently intersects major aquifers and requires significant dewatering
Generally simple rehabilitation	Often higher rehabilitation requirements due to geochemical, stability and water quality issues

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What about the benefits?

- As a nation, we are increasingly challenged/constrained with new landfill locations:
  - Greenfield sites rigorously opposed by activated communities
  - Older sites may not be appropriate to extend / cannot be extended further
  - New remote sites require significant haulage/transport infrastructure considerations
- The reliance on landfill in Australia (at least at this moment) remains high

- Mine/quarry sites are attractive for many reasons:
  - Substantial potential volumetric capacity
  - Existing industrial location/zoning
  - Opportunity for mine/quarry repurposing / integrate landfilling with mine rehabilitation
  - Existing infrastructure that can be repurposed
  - Existing access available for waste haulage and many located in opportune locations

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A match made in heaven??



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Let’s consider the risks…

- Material shortfall
- Steep and uneven walls
- Deep underground infrastructure
- Below-grade operations / spatial constraints
- Operational compatibility
- Residual contamination / mine hazards
- Competing operational priorities
- Increased exposure to geological risks
- Increased exposure to hydrogeological risks
- Final capping limitations
- Shared/deep access challenges
- Increased settlement impacts

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Source: *William Shakespeare's The Tragedy of Hamlet, Prince of Denmark*

Yes, we can!

But we need to acknowledge and address the added complexities:



- Increased importance of a systematic approach
- More intensive operational approach
- Increased redundancy
- Increased cost…but still with a net relative benefit when done properly

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Let’s take a closer look…

Material shortfall	Competing operational priorities
Steep and uneven walls	Increased exposure to geological risks
Deep underground infrastructure	Increased exposure to hydrogeological risks
Predominately below-grade operations	Final capping limitations
Operational compatibility	Shared/deep access challenges
Residual contamination / mine hazards	Increased settlement impacts

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Operational compatibility

Quarry operations	Landfill operations
Steep walls, rough surface finish, local instability	Shallow, smooth walls for lining
Backfill with overburden / spoil material	Stable surfaces for liner placement
No/minimal grading on quarry floor	Fall to cell perimeter for leachate extraction
Single operation traffic management	Landfill and construction traffic
Maximise exported resource	Material for cover and capping



Operational compatibility

Case study:

- Parallel clay extraction and landfilling operations
- Operational site model developed to understand material balance and interdependencies

Compatibility issues identified:

- Overburden had been stockpiled on future landfill area
- Overburden removal + current rate of clay extraction was going to prevent cells being ready in time

Can rate of extraction be increased to meet landfill demand?



Water management

Quarry operations	Landfill operations
Rainfall in the void and surrounding runoff	Clean runoff should be diverted away from waste
Primarily sediment-laden water	Separate clean stormwater, impacted water and leachate
The large void provides storage; reuse or evaporation may be feasible	Contained water may need pumping, tankering, treatment or off-site disposal
Limited controls may be needed beyond the void	Perimeter drains, ponds and discharge points; a detailed water balance is essential
Groundwater flows into void	Groundwater managed behind lining system



Water management

Case study:

- Basalt quarry planning future landfill operations
- All surface water currently managed in the void
- Existing quarry rehabilitation plan provides a final landform which includes surface water flow over the backfilled material

Compatibility issues identified:

- Existing approved extraction boundary doesn't allow perimeter surface water drainage or ponds at site low point

Can extraction/landfill boundaries be adjusted (alignment and/or levels)?



Post-closure management

Quarry operations	Landfill operations
Backfilling/buttressing may be required	Capping limitations incl. material availability
Post-closure use limitations	Post-closure use limitations
	Ongoing environmental monitoring
	Ongoing leachate management
	Settlement impacts





To fill or not to fill?

Mine conversion can provide a sustainable waste management solution where site conditions support it.

The assessment must balance capacity and rehabilitation benefits against the costs of mitigation and acknowledge and address the complexity of these operations.

For some sites, those additional costs may outweigh the commercial benefits.

A site-specific decision

Can the site manage its technical and environmental risks?

Can design and operations meet approval requirements and inherent complexity?

Do the benefits justify the full cost of conversion and long-term care?

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