AUSTRALIAN EARTH SCIENCE EDUCATION

Waste Rock and Tailings at Cadia Waste Management Case Study

Case Study – managing waste rock and tailings at Cadia Valley Operations gold mines

The ore

Mineral deposits in the Cadia Valley are the result of Ordovician volcanic activity in the Lachlan Orogen. These deposits formed in an oceanic subduction environment, creating gold-copper porphyry deposits. Volcanic porphyry deposits contain a variety of sulfide minerals.

The Cadia Valley deposits have been mined since 1851. The area was originally mined for copper, then iron and now is one of Australia's largest gold mines. In the 2019 financial year, Cadia Valley Operations (Figure 1) produced 913,000 ounces of gold and 91,000 tonnes of copper. Future plans include extraction of molybdenum.

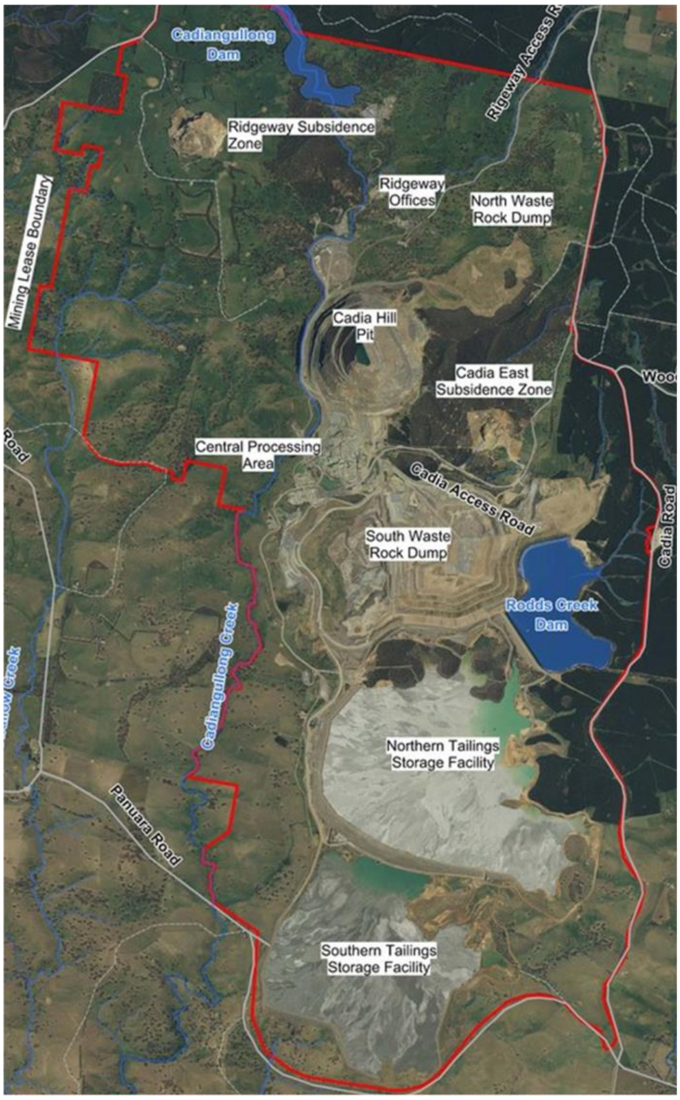

Figure 1: Cadia Valley Operations
(from http://www.cadiavalley.com.au/site/about)

Waste to be managed

The Cadia deposit contains approximately 1.31 billion tonnes of ore at 0.31% copper and 0.74 grams per tonne of gold. This ore body is profitable when mined on a large scale, producing a correspondingly large amount of waste rock and tailings. Ore is processed on site and mineral concentrate is shipped off site for smelting. Coarse waste rock is produced when accessing ore bodies. Very fine tailings are produced in ore processing.

There are several challenges in managing the mine waste:

- Large amount of waste – millions of tonnes must be managed
- High likelihood of erosion if waste rock is piled steeply and/or unsecure
- Tailings are very fine, loosely placed sediments with high potential for ponding
- Sulfide minerals in waste could result in acid production, dissolving and mobilising toxic elements, such as arsenic
- Habitat loss due to construction of the Cadia East open pit, processing facilities and physical plant

Summary of waste management challenges and solutions

Challenge	Management strategy	Rationale
Large volume of waste rock and tailings	Manage waste on site	The large volume of waste requires management on site.
Erosion of steep rock piles	Contour waste piles (Figure 2a)	Gentle slopes are less susceptible to erosion.
Acid drainage	Seal rock dumps with high density polyethylene (HDPE) liner material topped with 0.5 m of clay (Figure 2b)	Sulfuric acid is produced when sulfide ores react with water and oxygen. Two layers of sealant provides extra protection to ensure that waste does not react with water and oxygen.
Habitat loss	**Waste Rock** Top clay-capped dumps with 2 m of inert waste rock and 0.2 m of topsoil (Figure 2c); plant with native seeds; construct artificial wetlands	A thick layer of inert rock and soil on top of the capped dump allows growth of trees without root systems damaging the integrity of sealant materials. Native seeds from the area are planted to restore an appropriate ecosystem. Artificial wetlands provide habitat and treat water containing residual mineral waste.
	Tailings Treat tailings with topsoil and/or biosolids, then plant with native and pasture species; create rock-lined drainage channels; artificial wetlands in drainage area	Tailings are depleted of nutrients. Experiments on site showed that 20 cm of topsoil and/or incorporating biosolids promoted growth of native vegetation, even during drought. Drainage channels prevent tailings from becoming waterlogged after heavy rain. Artificial wetlands provide habitat and natural water treatment for tailings drainage.

Figure 2 (a) waste piles are contoured to less than a 18° slope, (b) HDPE and compacted clay layers seal the waste, and (c) inert rock and soil are placed on top of compacted clay (from Cadia District Heritage & Recreational Area Guide Book)

Revegetation of waste rock dumps

The North Waste Rock Dump contains more than 30 million tonnes of waste rock covering an area of 66 hectares. It was rehabilitated and seeded in 2013 (Figure 2). Some revegetation can be seen in the overview of the site shown in Figure 1.

The South Waste Rock Dump contains more than 266 million tonnes of waste rock over 442 hectares (Figure 1). The area is being progressively rehabilitated for final use as a native woodland ecosystem.

Revegetation of tailings storage facilities

Mine tailings are very fine sediments that are pumped with water into containment dams. Experiments on site demonstrated that it was possible to grow pasture grass in pure tailings with fertiliser. A much better result was achieved with use of topsoil and/or biosolids. Native vegetation grew through drought conditions and demonstrated seeding in the experimental tailings plots (Figure 3). An important finding was that plant roots penetrated up to 2.5 m into the tailings. This increases stability for the land over time and bodes well for rehabilitation.

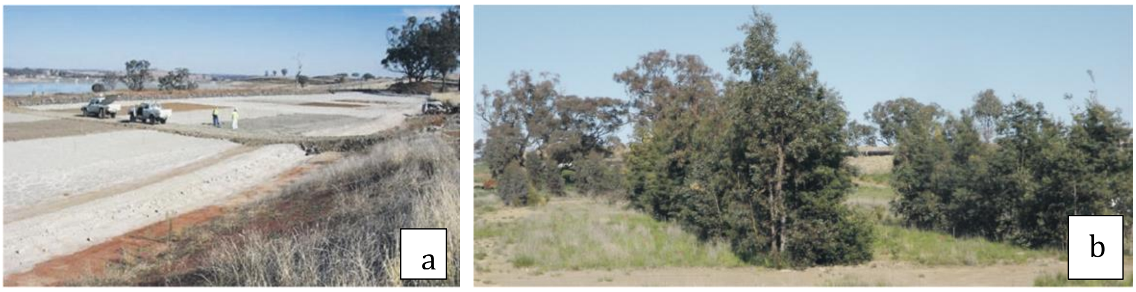

Figure 3: Tailings revegetation trials. (a) Construction of plots for rehabilitation in 2004. (b) Significant growth of vegetation seen in 2010, despite drought. (provided by Newcrest Mining Ltd)

Outcome of waste management

Restoration of a stable ecosystem is a goal that takes many years to achieve. Early results from the North Waste Rock Dump suggest that a productive ecosystem has been established. However, long term monitoring is planned. Monitoring includes flora and fauna studies, as well as water quality monitoring to ensure that run off meets national standards.

Long term vegetation trials suggest that habitat restoration on the tailing's storage facilities should be successful. Progressive rehabilitation of tailings areas cannot begin until the storage is at capacity, followed by a drying period.

Continued monitoring is part of the operating requirements of mines. Revegetated land must closely match local reference areas for closure criteria to be met.

References:

All photos used with permission of Newcrest Mining Limited.

Geoscience Australia (n.d.). 2.2 Prophyry-epithermal mineral system. Accessed 29/5/20 from http://www.ga.gov.au/data-pubs/data-and-publications-search/publications/critical-commodities-for-a-high-tech-world/porphyry-epithermal-mineral-systems

Newcrest Mining (2014). Cadia District Heritage & Recreational Area Guide Book.

Newcrest Mining (2019). Cadia Rehabilitation Strategy. Accessed 29/6/20 from http://www.cadiavalley.com.au/client_images/2152624.pdf

Newcrest Mining (2020). Our assets: Cadia. Accessed 29/5/20 from https://www.newcrest.com/our-assets/cadia

Newcrest Mining (n.d.). Cadia Valley Operations – heritage walking tour. Accessed 29/5/20 from http://www.cadiavalley.com.au/client_images/1071622.pdf

Newcrest Mining – Cadia Valley Operations (2015). The history & archaeology of Cadia Valley. Accessed 29/5/20 from http://www.cadiavalleyheritage.com.au/

Porter Geoconsultancy (n.d.). Cadia Valley Operations – Ridgeway, Cadia Quarry/Extended, Cadia Hill, Cadia East/Far East Big Cadia. Accessed 29/5/20 from http://www.portergeo.com.au/database/mineinfo.asp?mineid=mn228