Case Study
Kidston Gold Mine Waste Rock Dump Closure Strategy

Introduction

The Kidston Gold Mine operated in North Queensland between 1985 to July 2001. During this period the mine produced over 3.5 million ounces of gold from two open cut pits. The mine used standard drill and blast practices with a truck and shovel operation to remove ore and overburden/waste rock from the pit to either the mill (for processing), or placement of waste rock into engineered dumps. Engineered waste rock dumps were made by end dumping the rock from the dump crest to an average height of between 24-36m high.

Waste Rock Types

Waste rock was identified in the feasibility planning and a segregation management plan was implemented in 1985. Rock was segregated according to the gold grade, which also correlated to the sulphide content and the potential to generate poor quality water from the oxidation of the sulphides. The rock was segregated as: ore, low-grade ore, mineralized waste (sub economic low grade ore) and barren waste (benign material). The ore and low grade ore was processed through the mill and the gold extracted with residual ground up material stored in the tailing storage facilities.

Mineralised waste rock was identified as being the potential problematic waste rock material. Monitoring of the material showed the lag time to produce poor quality water was about 5-6 years after placement within a dump. The water released had a pH of 5, elevated sulphate and some metals such as cadmium, copper and zinc. The water did not meet the target water quality criteria (target water quality criteria was the ANZECC Cattle Watering Guidelines – the land use prior to mining and target land use post mining). Mineralised waste rock comprised about 10% of the total waste rock mined (i.e. about 20 million tons, with about 200 million tons of barren waste rock. The management plan for this material was to isolate it into two discrete areas within the waste dumps. Mineralised waste rock was placed on a base layer of barren waste, and then fully encapsulated around the perimeter with barren waste.

Waste Dump Closure Research

Research into decommissioning of the waste dumps commenced in 1996. The aim was to identify suitable waste dump cover designs that would minimize the amount of water (from wet season rains) that could penetrate into the tops of the waste rock dump and flush out the oxidation products, generating poor quality water.

The research designed and built a cover system known as a 'Store and Release Cover'. The principle was that a densely compacted soil layer was constructed on top of the mineralized waste. This engineered cover had a low permeability of 10^{-8} to 10^{-10} m/s hydraulic conductivity. On top of this was placed a loose soil layer of nominal thickness of 1.5m. This loose soil layer was designed to trap and hold the annual wet season rainfall and then through natural cycling, release the stored water via evaporation and evapotranspiration from a good vegetation cover consisting of grasses and native trees.

Precautionary Approach to design

The cover design was conservative and precautionary. The storage capacity was modeled on a 1:140 year wet season (experienced in 1991), for not one year but 2 subsequent years, i.e. 3 years in a row of 1: 140 year wet seasons back to back.

A trial cover was built on the southern dump complex (26 hectare, containing about 2 million tonne of mineralized material and fully encapsulated with about 18 million tonne of barren waste). The water quality emanating from the toe of the dump did not meet cattle watering guidelines, and was harvested each year and recycled through the milling plant. The trial cover was instrumented to evaluate the covers actual performance against that predicted by the modeling. Modeling indicated that the cover should allow less than 2% of incident rainfall pass through it in the initial years and when the vegetation became established the rate of infiltration should be close to zero.

Monitoring of the cover performance over 5 wet seasons indicated that the design performed better than predicted with less than 1% of incident rainfall passing through the cover in the first year and negligible water passing through in following years.

During the period and prior to developing the final closure plan in late 2000, it was decided that instead of using this cover system only on the mineralised waste rock (20 million tones) section of the waste dumps, it would be prudent to apply the cover system to all of the waste dumps (some 330 hectares). This conservative approach was taken, even though the laboratory testing of the barren waste rock indicated it would not be an acid producer. However, there was a risk that waste rock segregation quality control in the early mine development was not as rigorous as it could have been. This uncertainty and observations of minor oxidation on the surface of some older (15 year old) barren waste, could lead in the long term, to poor quality water generation.

Summary

The decision was made to cap all of the waste dumps, both mineralized and barren waste using the Soil Cover System. This decision was based on a risk based approach for the issue, due to the inability to resolve what material had been placed in the earlier dumps and quality control applied to material segregation during this period. The incremental cost to undertake capping the dumps, over and above the previous plan was $2.5 million. Kidston Gold Mines intention was to use best practice technology to decommission the mine, and to minimise the risk of failure and hence reduce the potential liability to future generations.

By applying a precautionary approach to the Store and Release Cover design, and then by applying the proven design to all of the waste dumps, Kidston believes it has put in place the most appropriate sustainable option for the waste rock dumps.