

PACIFIC ECONOMIC COOPERATION COUNCIL Mineral Network
Community Integration in Mining and Mine Site Rehabilitation
17-19 November 2003
The Auditorium, 111 George Street
Brisbane, Queensland

ISSUES SURROUNDING “DEEPSEA” TAILINGS DEPOSITION: Cases studies of the Misima and Lihir Gold Mines in Papua New Guinea from a regulatory perspective

by
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Abstract

Tailings are the final product after processing of the mineral containing ore¹. Tailings disposal has long been an environmental concern. The challenge for developing nations such as PNG is selecting appropriate tailings disposal methods that take account of factors such as geography, geology, rainfall and other competing land usages as opposed to storage of tailings and community acceptance using the triple bottom line (economics, environmental and social) implications of such disposal. Deep sea tailings disposal (DSTD) is one such option and is currently used in two gold mining projects in PNG namely the Lihir Gold Mine and the Misima Gold Mine.

Some of the issues associated with DSTD can be categorised under technical, environmental, regulatory, economic and social. For example, the integrity of the tailings pipeline, impacts on benthic communities and their recolonisation, government approvals, costs and benefits of DSTD as an alternative to a land based containment facility, and community and stakeholder participation and acceptance in the decision to invoke utilisation of DSTD are some of the issues being considered. This presentation draws from the PNG Governments experiences with DSTD at Lihir and Misima Gold Mines and highlights some of the major issues faced thus far. Some suggestions on how best to move forward are also discussed.

PNG is a country with rugged terrain, high rainfall, high incidence of volcanic activities and earth tremors, and with limited arable land for agriculture. Being a tropical country PNG also has many rivers, lakes, and a vast area of ocean space with many scattered islands. Sitting on the Pacific Rim of Fire, PNG also boasts geological endowment with proven mineral resources such as copper, gold, silver and nickel. It also has significant amount of oil and gas resources most of which are yet to be discovered or proven up to extract economically.

¹ MCMPR and MCA , 2003, *Strategic Framework for Tailings Management*, National Capital Printing, Canberra

Given the physical characteristics of the country coupled with other factors such as lack of or run down public infrastructure in many rural areas where mines are located, or mineral resources are found, the choice of tailings management method is an important issue for all stakeholders in a mining project.

Pictures on right- top right is from Abelle on Hidden Valley Prospect in Morobe Province. It gives an example of the kind of country PNG is. Bottom right is a picture of recent land slip at Freeport mine in the Papua Province of Indonesia which PNG shares similar physical conditions including geology.

There are a number of laws governing mining but for purposes of this presentation we will limit ourselves to laws applicable to DSTD. Mining Act is the principle law under which a mining licence is granted for development of a project. One of the key considerations is that any development licence such as Special Mining Lease under which Misima and Lihir operate for instance is subject to compliance with environment law. The Mining Safety Act deals with engineering and safety issues.

The environmental laws envisage an EIA process culminating in approval of an E.P and grant of various WUPs including those for DSTD. An Environment Management and Monitoring Programme (EMMP) is an essential component of the E.P approval and WUPs.

One issue this meeting may note is that so far the DSTD in PNG is permitted within its internal waters. Whilst science may refer to it as sea or deepsea for that matter strictly legally speaking certain conventions like the London Dumping Convention does not apply. However, PNG as a responsible member of the international community has followed the EIA process to ensure her moral obligations are adhered to.

Misima is located in the Milne Bay Province east of Port Moresby. The Misima project is a gold and silver mine and is operated by Misima Mines Ltd (MML). The mine commenced construction in January 1988 and operations in June 1989. It is now due to cease production on the 8th January 2004. MML was the first project to be permitted to use DSTD hence we could say Misima set the precedent for the DSTD system in Papua New Guinea.

As you can see from the slides on right the mine is very close to the sea with maximum water depths in the vicinity of 1500m.

As mentioned the DSTD operates under its WUP discharging after treatment in the deaeration tank at a depth of 112 m with a horizontal mixing zone of 1200 m from the shore. Under the new water quality regulations to be effective January 2004, "**Mixing Zone** means a discrete body of water into which waste is discharged and where the prescribed water quality criteria are not required to be met and the protection of aquatic life may not be guaranteed."

Explain process: the tailings are the result of Carbon in pulp processing where the ore is ground and leached with cyanide to recover gold and silver. The tailings containing residual process reagents are then diluted with seawater and discharged in much of the same way that natural sediments are transported to the deep ocean floor. At the end of 2002, MML approximately 75Mt of tailings had resulted.

(James acknowledge contributions from MML and LMC by way of slides)

The terminus of the pipeline is located below the maximum thickness of both the euphotic zone and the surface mixed layer confirmed in the early stages of the project.

Conditions specific to Misima:

Limited land for land based waste containment facility as most land is used for subsistence agriculture (mainstay of island population);

Deep water available a short distance from land (approx 5-6 km from shore water depths of 1300m);

Prior to mine, no deep-water subsistence fishery; and

Location of terminus below the depth at which ocean is consistently stratified.

The key impacts from the DSTD are: the potential for rupture of the pipeline and the impacts of the tailings on the seafloor and ocean.

This is a collage showing the entire damaged section of the outfall pipe. In total there are five sections of pipe that are damaged, with two sections having actual holes. The other sections are only deformed.

As mentioned in the video, the split section is located at a depth of approximately 13.6 meters while the deformed sections continue to a depth of about 24 meters. The damaged sections are located about 90 meters from the shoreline.

There have been two such incidents with Misima: one in 1997 where a piece of the pipeline broke off and in 2001 when there was some damage to the pipeline. In both instances the company, government and community were involved in a timely fashion.

MML commissioned a series of investigations during the period 1993-96, one of which was a review of the DSTD system. In summary this slide shows that the tailings are confined to an oceanic basin at a maximum depth of 1500m south of the island. The study concluded that the major environment issue is the recolonisation of tailing material following mine closure. Investigations show that benthic communities are colonising tailings deposits however this can be confirmed by way of long term monitoring.

Like Misima, the Lihir gold mine is located on Lihir island in the New Ireland province about 900km northeast of Port Moresby. The conditions for Lihir are similar to Misima in terms of close to shore deepwaters with the mine nearshore.

The mine produces more than 600,000 oz of gold annually. The sulphide ores processed by pressure oxidation liberates gold by CIL recovery. It is anticipated that mining will cease in 2014 followed by 12 years of processing low grade stockpiles. DSTD was a preferred option after much investigations, review and agreement by government, company and the community before acceptance. It is expected that a total of 89Mt of tailings will be produced over the mine life. The key to the success of the DSTD is the lack of upwelling of deep ocean waters to the surface as this should ensure that the tailings remain submerged. The only way tailings could reach surface waters is if the tailings pipeline ruptured.

The tailings are detoxified by the addition of an iron solution to bind free cyanide and then mixed with seawater for dilution prior to discharge at 128m depth. The depths range from 900-2000m. As the tailings descend small subsurface plumes (on average 1000 times less concentrated than the main turbidity plume) form and spread out over approx. 2-5 km where they dilute and dissipate further until they are not detectable (Leggatt H et al.,2002).

Thus, Lihir Mines undertakes intensive monitoring and research such as tracking the size and location of tailings plumes and materials that deposit on the ocean floor.

As mentioned earlier, the DSTD is regulated under relevant environment regulations and the government through the DEC carries out its validation sampling programs to confirm compliance by the mine.

As shown in the slide, the issues are categorised under the technical, environmental, economic, social and regulatory.

In addition to these issues, the definitions for 'DSTD' and 'deepsea' are still outstanding. Furthermore, good science will assist the formulation of policy and regulations.

DSTD has proven to be a viable alternative to land-based tailings disposal in PNG due ideal conditions such as deeper waters, mining processing infrastructure nearshore, limited land for alternative use, compensation demands, impact of ARD in the long term onland and large volume of seawater for dilution and dispersion at the end of the tailings outfall. However there are still some gaps in knowledge such as benthic ecosystems recovery, impacts of low concentration plumes for DSTD.

Whilst studies are being undertaken largely by those mining companies using DSTD there is need for independent research. But, such research can be cost prohibitive hence, collaborative approach is a way to go. However, as a compromise, these studies should then be subjected to a peer review process.

Periodic Independent Validation studies be undertaken during operations phase consistent with mine life.

Long term validation studies should be undertaken after mine closure.

Common definition and standards needed for DSTD but should take account of unique circumstances e.g. PNG. For instance, the definition of 'deepsea' and DSTD.

It is recommended that those countries or companies planning to use DSTD in conditions similar to PNG may wish to collaborate with PNG entities to study the impacts of DSTD especially in areas where there are gaps in knowledge. Peer Review Process should be undertaken on research including collaborative research. Holistic approach to mine development, operations and closure is a must.