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A framework for a sustainable approach to mine tailings management: disposal strategies

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Abstract

The aim of mine tailings management strategy is to protect the environment and humans from risks associated with mine tailings. It seems inevitable that future production from lower grade ores in mines will increase, generating a higher tonnage of tailings. Approximately 14 billion tonnes of tailings were produced globally by the mining industry in 2010. The need for a comprehensive framework for mine tailings management (including dewatering) that promotes sustainable development is therefore becoming increasingly recognised by the mining industry. In this paper, we review existing frameworks for tailings management and propose an improved framework that considers key sustainable development pillars: technological, economic, environmental, policy, and social aspects. This framework will be able to guide the mining sector to choose its mine tailings management strategy based on sustainable development concepts. It incorporates a range of tools for determining trade-offs inherent in different tailings management methods during operation and throughout the Life of Mine (LOM); these include Life Cycle Assessment (LCA), Net Present Value (NPV), Hierarchy System Model (HSM), and Decision Analysis. In particular, this proposed recognises the highly case-specific of tailings management by explicitly integrating physicochemical characterisation of tailings properties as a first step. In future, the framework could be expanded through integration of reuse/recycle principles of industrial symbiosis.

Keywords: mine tailings management; disposal options; framework; sustainable development

1. Introduction¹

1.1 Background

Mineral processing plants produce two types of products, categorised as either economic or non-economic. The non-economic product, usually known as tailings, consists of waste (by-product), small quantities of valuable minerals or metals, chemicals, organics, and process water (Lottermoser, 2010, TI, 2014). The volume of tailings generated by mines can be almost equal to the volume of raw material processed for example, a mine producing 200,000 tonnes of copper ore per day will also produce nearly the same tonnage of tailings per day (MMSD, 2002). Some mining operational data showed that the volume of tailings generated is around 97-99 percent of total ore processed (NDM, 2005, NNT, 2011). In other words, the amount of concentrate produced is only 1-3 percent.

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¹ TSF: Tailings Storage Facility

MCMPR: Ministerial Council on Mineral and Petroleum Resources

MCA: Minerals Council of Australia

DITR: Department of Industry, Tourism, and Resources

MAC: Mining Association of Canada

RTD: Riverine Tailings Disposal

STD: Submarine Tailings Disposal

LPSDP: Leading Practice Sustainable Development Program

TT : Thickened tailings

TP : Tailings paste

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