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Approach and Benefits of Sustainable Solid Waste Management

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Abstract: ***The current utilization of mineral resources has challenged the earth's capacity to withstand the negative environmental problems and this affects the economy, energy and climate aspects of our future. We need to fulfil our human needs and demands now while making use of limited resources. Historically, mining has affected the environment negatively by causing land degradation, household waste production, land, water & air pollution, species extinction, acid mine drainage and imbalance in biodiversity. This paper reviews sustainability in the context of solid waste management in a mine setup. A conceptual Sustainable Solid Waste Management approach model is devised and applied to sentinel mine in Solwezi, Zambia. Results of this study show that the mine waste material that may be generated throughout a mine process can be reduced; reused; recycled; recovered and or disposed in an environmentally friendly way thereby leading to efficient utilization of mineral resource. The study further highlights some of the benefits that may come with this practice and a conclusion is drawn from the same.***

Keywords: Solid waste management; Mine waste material; Sustainability; Mineral resources; Environment

1. Introduction

The current utilization of mineral resources has challenged the earth's capacity to withstand the negative environmental problems and this affects the economy, energy and climate aspects of our future. We need to fulfil our human needs and demands now while making use of limited resources. Historically, mining has affected the environment negatively by causing land degradation, household waste production, land, water & air pollution, species extinction, acid mine drainage and imbalance in biodiversity. (Frank, Galloway, & Assmus: 2005; Lottermoser, 2010:36)

The geology of Zambia is prospective with diverse kinds of mineral resources which include copper, coal, nickel, gold and zinc among others and the economy is largely dependent on copper mining hence there has been a huge demand for copper production to meet the demands of the growing economy. It is for this reason that the essay will try to discuss the sustainable solid waste management approach, how this initiative can be structured in Zambia and some benefits of such an method using sentinel mine in North Western Province of Zambia, in Solwezi Town as an example (Frank, Galloway, & Assmus: 2005; FQM, 2018; UNEP, 2005)

2. Defining of Terms

2.1 Mine waste material

Mine unwanted products are produced during excavating and can be extremely deadly to living things that is humans, animals and vegetation because they are very combustible, volatile, or acidic in nature. (Fillip, 2013; Lottermoser, 2010:3)

2.2 Minerals

Minerals are treasured attentiveness of non-living similar metals like copper, gold or nonmetallic, like talc. Minerals are inadequate, non-renewable and have a fixed chemical organization and they occur naturally in the earth. The conversion of metals into useful materials is beneficial now and also in the future hence they should be extracted in a responsible way to avoid exhaustion (Frank, Galloway & Assmus (2005:1)

2.3 Sustainability

In 1987, the Brundtland Commission published its report, Our Common Future, in an effort to link the issues of economic development and environmental stability. In doing so, this report provided the off-cited definition of sustainable development as growth that provides the requirementsin the present ensuring that there is enough supply for the forthcoming generations (WCED, 1987:7)

3. Sustainability in Solid Mine Waste Management Approach

Compacted by products from mine processes range in natural and physical arrangementtherefore may affect the environment uniquely. The types of solid mine waste include;

- Waste rock materials containing low mineral concentration and stored in heaps or dumps on the mine site
- Overburden soil or rocks removed during excavation at open pit and pilled, normally reused as revegetation during mine closure
- Nonmetallic by-products from metal smelting known as slag which is a raw material in the construction of roads
- Water treatment sludge which consist of the added chemical to the water and the solids that were removed from the water

- Gaseous waste containing particulate matter (dust) produced during smelting

Solid waste management (SWM) system therefore includes the generation of waste, storage, collection, transportation, processing and final disposal. Therefore a sustainable solid waste management approach tries to reduce these impacts by prevention; reduction; reusing; recycling; recovering and disposing waste in an environmentally friendly way like in landfills.

This practice has resulted in a more efficient manner of mineral resource utilization and the following benefits can be realized;

- Tailings and slags are used in brick, floor tiles and cement production; backfilling in underground mines; dried and stacked or stored in open pits, thereby avoiding direct contamination into nearby water bodies
- Extraction of minerals and metal from waste rock which can be used in road construction or used in cement & concrete production
- The sulfur oxide emission during copper ore processing at sentinel mine for example may be converted to sulphuric acid which can be reused in the industry or sold
- The high iron content sludge from acid rock drainage treatment can be sold commercially for use in pigments (UNEP,2005 & USGS, 2013)

4. A conceptual Sustainable Solid Waste Management approach model

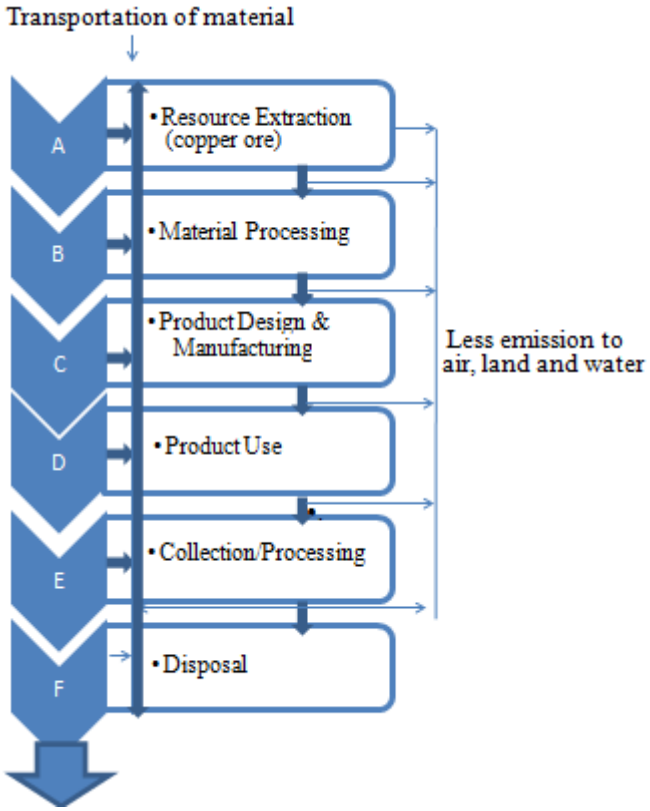

Figure 1: A conceptual sustainable solid waste management model (Adopted from UNEP, 2005:9)

Key

A: Reduce amount of waste that is generated during mineral extraction as prevention may not be possible, hence it is encouraged to extract only what is needed, prioritize the use of renewable materials and those that can be used in closed loop systems

B: Recycle the post-industrial (tailings) or post-consumer waste (Product Stewardship), waste modification through chemical use

C: Remanufacture or redesign industrial processes to reduce toxic pollution, employ cleaner technologies hence reduction in the toxic or hazardous properties of waste streams

D: Materials that are recovered from waste in the current state are reused

E: Reduction of transport in the supply chain, thus reducing fuel and machinery use.

F: Seepage from the waste is controlled and there is an attempt to preventing waste production (of which is almost impossible), Green House Gas (GHG) emissions are reduced associated with the mineral manufacturing process and disposal. Waste disposal is reduced by reusing it in cement, tile, brick manufacturing, landfills and construction

(Frank, Galloway & Assmus 2005:1; Lottermoser, B.G., 2010; UNEP. 2005:9)

5. Declaration

The author declares that every word used in this review has been cited unless otherwise and this review can be published and or referred to for any academic and other purposes. However, B. Thole retains ALL the rights of the writer of this article.

6. Conclusion

There has been a major shift from underground way of extracting mineral resources to open pit mining like in the case of Sentinel open pit mine due to the deterioration in ore grade and this poses a lot of danger to the environment hence with technology advances and changes in management techniques such as the sustainable solid waste management approach, these negative impacts can be reduced or avoided all together in an effort to attain sustainability in mineral processing (Frank, Galloway & Assmus, 2005:1; FQM,2018;UNEP. 2005:9

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