

Note

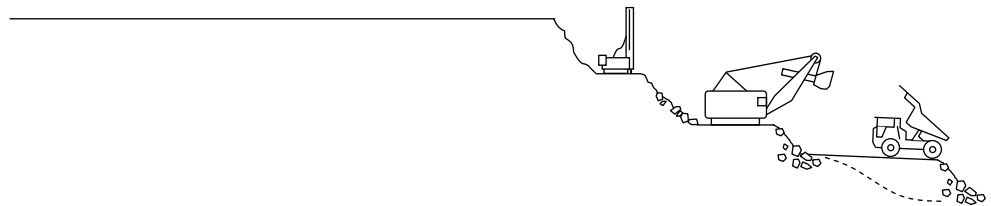
The dilemma of waste management in the mining industry – criteria for sea disposal

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To avoid that tailings disposal will be a stopper of planned mining projects; a roadmap for waste management should be discussed and agreed upon in a preliminary phase of every mine project. Disposal of mine tailings in the sea is considered by many as not appropriate due to the potential environmental risk. However, little focus has been on the difference between acceptable and non-acceptable risk. To improve the roadmap for waste management, more attention should be paid to criteria for suitable disposal sites and acceptance criteria for environmental impact and communication of these criteria to all stakeholders. These criteria should be scientifically based.



I. INTRODUCTION

Mineral production generates tailings in large quantities and due to lack of beneficial use, the tailings are up to now considered as waste material which has to be disposed (Klif, 2010). Management of large amounts of solid waste is an environmental challenge (Apte and Kwong, 2004) and the permits for mining are to a large extent dependent on what is considered as environmentally acceptable. So far the definition of what is environmentally acceptable has been unclear and the consequence is that the mining companies experience a considerable unpredictability in terms of waste handling and permissions. What is needed is a set of acceptance criteria to be used when waste handling, and particularly tailing management, is to be decided. Acceptance criteria represent a specific and defined list of conditions that must be met before a project will be accepted by the assigning parties.

Risk acceptance is the environmental effects which are considered acceptable for the environment and stakeholders. Environmental impact from tailings disposal is unavoidable. It is important that stakeholders take part in the process of developing acceptance criteria to ensure that the disposal is conducted with minimum negative impacts in both short term and long term.

As a majority of the mineral resources in Norway are located near the coastline it is necessary to evaluate the feasibility of sea tailings disposal (STD). This is a sensitive issue due to the fact that sea disposal of waste material is considered non-acceptable per se, but based on little scientific documentation. A way to proceed is to consider criteria for site suitability, where site specific conditions are carefully evaluated, and to establish acceptance criteria for environmental impact and risk.

2. SUITABLE SITES FOR SEA DISPOSAL OF MINE TAILINGS

The ideal situation for a mining company is to dispose the waste as close to the mine site as possible to avoid long distance piping of tailings. In cases where the mine site is located close to a deep fjord, a nearby fjord basin may be an attractive disposal site. However, the environmental setting or the ecological conditions may not necessarily allow disposal. Similarly, the selected site may not be suitable due to potential conflicts with other user interests. Consequently, a comprehensive investigation of the planned disposal site should be made prior to the environmental impact assessments study (EIA) or as a preliminary study linked to the EIA. This will be a screening of suitable sites to avoid spending large economic resources on comprehensive baseline studies and assessments on a site which quite obviously is not suitable as disposal site for mine tailings. A set of suitability criteria should be established, similar to suitability criteria used for the location of aquaculture industry in Norway (Ervik, 2003). The main difference between aquaculture industry and mining industry is that the mine site has to be in the vicinity of the ore, while an aquaculture infrastructure could be located anywhere, only restricted by the suitability criteria.

A sea disposal site for mine waste should ideally be deep (> 100m), flat or slightly sloping bottom and surrounded by sills to make an enclosed basin where sedimentation is prominent. An unsuitable site would be shallow (< 20 m), steep bottom topography and where erosion exceeds sedimentation. A pre-investigation of the sediment characteristics and bottom morphology would indicate if the site is a sedimentation area or an erosional location. By considering the present current regime in the area and seasonal variability, a good prediction of the dispersal of fine (< 20 µm) tailing particles may be done.

In addition to physical condition at the sea floor and the hydrographical regime, attention should be paid to marine resources and ecological properties. If the site is a valuable spawning ground or the ecosystem is unique, the site may be considered as unsuitable.

It should be emphasised that tailings vary dependent on minerals or metals being mined and the pre-concentration process. Tailings vary in grain size between coarse sand and clay and some tailings may contain metals present in sulphide ores, while industrial minerals in oxic ores may contain background levels of metals. This implies that the suitability principle must take into account the composition of the tailings, their physical appearance and the annual volume of tailings to be disposed.

The take home message is that an evaluation of the planned disposal site and its suitability should be made early in the planning stage to avoid waste of money. If the conclusion is that the site may be suitable the next step would be to establish acceptance criteria and to come to an agreement with stake holders what may be accepted environmental impact from sea tailings placement.

3. ACCEPTANCE CRITERIA FOR ENVIRONMENTAL IMPACT

Based on a common agreement that mining will have a negative effect on the environment related to tailings disposal, the next relevant question is whether the negative impact can be accepted or not. The modern society has a certain impact on both the quality of air, land and sea. It is therefore important to put things in perspective. Bottom trawling by fishermen have a significant negative effect on the benthic ecosystem and areas impacted are enormous. In the North Sea 56 % of the benthic biomass is reduced (based on modelling) due to bottom trawling (Hiddink et al., 2006). In areas where cold - water corals exists large damages have been done for many years due to trawling (Hall-Spencer et al., 2002). When the impact from tailing disposal is assessed it is important to consider the magnitude of bottom areas being influenced by tailings and for how long. Furthermore, the volumes of water being affected by reduced water quality should be assessed, including both surface water as well as bottom water. In other words; more quantitative assessments.

As soon as the disposal is terminated a recovery of the sea bed fauna starts, and within a 10 years period a new fauna is established, but not necessarily the same species. This implies that the impact is temporarily and limited to a restricted area. Techniques are now evaluated to improve the disposal site to shorten the rehabilitation time (Kvassnes et al., 2012).

When considering impact and environmental risk it is important to focus on degree of impact (concentrations, areas impacted etc.). The discussion about sea disposal of tailing has come out of proportions due to the fact that scaling and quantification of effects have been absent in the discussion. This suggests that acceptance criteria are needed to distinguish between anticipated effects based on assumptions and real effects based on scientific documentation. One obstacle which will appear when acceptance criteria is discussed is the question of gaps of knowledge and lack of scientific documentation. A new research program about mineral industry and R&D in Norway, where environmental issues should be one of the high priority subjects, has still not been launched after more than 2 years of planning. The lack of research results may slow down the initiation of new mining projects in Norway, even after the submission of a national strategy for the mineral industry which recently has taken place. It is expected that a discussion will appear between scientists about what is critical knowledge and how much can we base the acceptance criteria on existing documentation and what is needed of new knowledge generated through new research. It is therefore important to start the discussion on acceptance criteria on a scientific level as soon as possible. It should also be discussed how acceptance criteria for waste handling should be integrated into the EIA.

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