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"Technical Support for Grassroots Public Interest Groups"

OPTIONS FOR DEFINING ENVIRONMENTAL "GO/NO-GO"[1] ZONES FOR MINES

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Introduction

Establishing criteria for guiding Go/No-Go decision making for mines has been applied on a limited basis for land use planning. Examples include the International Union for Conservation of Nature (IUCN), and at a corporate level Rio Tinto in the mining industry.

For the mining industry the advantage of a successful Go/No-Go policy applied to potential mining projects is that the company learns as early as possible in the exploration process whether a mine can be developed in a sustainable manner. Or more appropriately, whether it cannot be developed in a sustainable manner given the technologies available today to mitigate the potentially negative impacts of mining. For communities and governments this is a way of both establishing and asserting priorities between designated land use and mining.

This paper looks primarily at the potential environmental impacts of mining, and how a Go/No-Go policy might be structured to weigh the potential environmental impacts of mining against non-mining natural resources that could be impacted by mining. It should also be stressed that in addition to potential environmental impacts, there are also the social and economic considerations of mining that need to be factored into the Go/No-Go process, and this paper does not address these factors.

In addition to focusing only on potential environmental impacts, it is beyond the scope of this paper to develop measurable criteria, only to establish a framework from which such criteria could be developed.

Background[2]

In the past NGOs have asked mining companies and financial institutions to adopt a set of "No-Go" zones for mining. The mining industry, through its umbrella association the International Council on Mining and Metals (ICMM), has signaled progress in this debate by recognizing that World Heritage Sites constitute "No-Go" zones. However, adoption of a broader set of "No-Go" zones has met with resistance from mining companies and financial institutions for several reasons:[3]

(1) Uncertainty in the mining industry and financial sector regarding criteria for establishing protected areas.
(2) A belief in the mining industry that current best practices would sufficiently minimize negative environmental impacts in sensitive areas.
(3) A need for access to land to fuel growing demands for metals and for poor countries to develop.
(4) Difficulties identifying a broadly applicable set of "No-Go" zones.

Many mining companies, multilateral development banks, export credit agencies, and private banks acknowledge the importance of ensuring that mining does not hinder valuable ecosystems upon which

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[1] Go/No-Go testing refers to a pass/fail test (or check) principle using two boundary conditions
[2] This section is condensed from Miranda et al (2005)
[3] MMSD (2002: 162–66).

societies depend. Most large mining companies address biodiversity issues through site-specific mitigation of impacts at the mine site level.

A few companies have implemented broader policies identifying natural "No-Go" zones,[4] and there is growing recognition of the existence of natural "No-Go" zones. In 2003, ICMM members committed to consider World Heritage Sites off-limits to mineral development. World Heritage Sites are areas nominated by national governments to be considered of global natural or cultural importance. Governments are committed to identifying and protecting these areas through the World Heritage Convention, to which more than 175 countries are signatories. The acknowledgement by the mining industry of World Heritage Sites as "No-Go" zones represents an important step forward and a precedent upon which further action to identify additional "No-Go" zones can be built.

An example of conservation areas where the mining industry has not agreed to universally classify as "No-Go" zones are the IUCN protected areas. The World Conservation Union (IUCN) – a network comprising 82 countries, 112 government agencies, 774 national NGOs, 82 international NGOs, and 34 affiliates – provides guidance to governments on the development and implementation of protected areas and land use policies. The UN maintains a global list of protected areas encompassing six management classes (I–VI).[5]

The classification system does not hold the force of law, but it is designed to reflect the commitments governments make toward conserving their natural heritage. The categories were not designed to be prescriptive, nor to mandate particular uses. Rather they are meant to describe types of protected area management for the purpose of allowing greater global comparison among protected areas. Theoretically, governments indicate the appropriate IUCN category for listing purposes when a protected area is established.

Although industry groups have not explicitly endorsed a "No-Go" zones policy encompassing IUCN protected areas, there is growing recognition of the importance of protecting natural heritage. ICMM's sustainability principles specifically state that members will "respect legally designated protected areas," although further definition on how this principle will be applied or verified is not provided.

Among export credit agencies, the Overseas Private Investment Corporation's (OPIC) environmental handbook states that projects operating in or impacting IUCN I–IV protected areas are categorically excluded from OPIC loans and guarantees. The World Bank does not support projects that would result in degradation or destruction of IUCN I–IV protected areas, and some banks that have signed the "Equator Principles" have adopted similar policies.[6] ABN AMRO includes the IUCN protected area classification system as a filter in its decision-making system for lending in the extractive industry sectors.

National legislation in some countries explicitly prohibits mining in IUCN I–IV protected areas.[7] For example, U.S. policy effectively precludes mining in designated wilderness areas and national parks (categories I and III, respectively), unless a valid claim was established prior to establishment of the

[4] Rio Tinto (2008)
[5] The categories are as follows: I-Strict Nature Reserves and Wilderness Areas; II-Natural Monument; III-National Park; IV-Wildlife Refuge; V-Protected Landscape/Seascape; VI-Managed Resource Protected Area.
[6] Citigroup and Bank of America adopted policies reflecting the World Bank's Natural Habitats Policy (OP 4.04). However, it is not clear how these institutions will determine project lending activities' potential for degradation or destruction of protected areas—nor are there monitoring measures in place to ensure that such degradation does not occur.
[7] For example, Philippine Mining Law 1995 and Indonesian Forestry Law 1999. No mining occurs in wilderness areas in the United States; it occurs in less than 10 percent of national parks (Humphries 1996).

protected area.[8] In practice, however, some governments have allowed mining in protected areas by passing additional legislation or executive orders.[9]

Recognizing that high conservation value areas exist outside officially designated protected areas, some NGOs have sought consideration of such areas as "No-Go" zones for mining, a call that was echoed in the World Bank's EIR.[10] NGOs contend that some biologically valuable areas may become future protected areas while others are considered too environmentally or socially sensitive for mining to occur (e.g., areas with high species diversity, small islands, mountaintops, oceans, sacred groves, and conflict zones).[11]

Although many financial institutions and mining companies recognize the importance of conserving areas of high biodiversity, most prefer to define potential "No-Go" zones on a case-by-case basis, based on the likelihood that negative impacts to biodiversity will be mitigated.[12, 13] Some financial institutions have defined exclusionary lists prohibiting investment in industrial or extractive industry projects in "high conservation value," "intact," or "endangered" forests.[14]

For the most part, however, financial institutions with policies guiding investment in sensitive ecosystems have adopted the World Bank/IFC's safeguard approach, which precludes investment in projects that involve "significant conversion of critical natural habitats."[15] The World Bank keeps an internal list of areas that meet its definition of "critical natural habitat" owing to their species richness, degree of endemism, rarity, vulnerability of species, representativeness, and integrity of ecosystem processes. Investments in such areas may occur if the IFC determines that the project sponsor will implement "adequate" mitigation measures, there are no feasible alternatives for the project or it's siting, and the benefits are determined to outweigh the costs.[16] OPIC has taken the IFC natural habitats safeguard policy one step further by stating that all "critical natural habitats" are off-limits for industrial or extractive investment.

In practice, however, the World Bank's Natural Habitats Safeguard Policy has proven difficult to implement. There are no datasets that identify "critical natural habitats" in a way that would allow for their clear designation as "No-Go" zones in a global policy. Scientists still have an incomplete understanding of the relationship among species, their habitat requirements, and their resilience. Although there is considerable evidence in the literature suggesting that intact habitat is critical for ensuring species

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[8] However, the U.S. delegation to the 2000 World Conservation Congress also publicly dissented to the passage of Amman's recommendation 2.82.

[9] In 2004 the Indonesian Prime Minister signed an executive order allowing mining in protected forests, some of which are classified as IUCN I–IV protected areas.

[10] The final report of the Extractive Industries Review recommended that the World Bank not finance any projects that "affect critical natural habitats." The report does not define what such a commitment would mean. World Bank (2003: 57).

[11] Activist NGOs consulted by the Extractive Industries Review called upon the World Bank not to support projects in sacred groves. Activist civil society groups that signed the Bali Declaration strongly advocated for a global set of "no go" zones that would encompass small islands, mountaintops, and conflict zones, in addition to officially designated protected areas.

[12] Principle 7 of the ICMM Sustainable Development Principles states only that members will "[s]upport the development and implementation of scientifically sound, inclusive and transparent procedures for integrated approaches to land use planning, biodiversity, conservation and mining."

[13] EBI (2003: 39).

[14] Citibank states that it will only finance preservation and "light, non-extractive uses of forest resources in forest areas of high ecological value" (See www.citicorp.com). Bank of America's new forestry commitment precludes any industrial activities (forestry, mining, oil, gas) in primary forests, high conservation value forests, and other intact forests. Similarly, ABN Amro's forest policy states that the bank "does not finance projects or operations, which will result in resource extraction from, or the clearing of, either primary or high conservation value forests." ABN AMRO (2001). Belgian export credit agencies (Delcredre and FINEXPO) do not support projects operating in "endangered" forests.

[15] World Bank (1998). See also Citibank's environmental policy online at www.citigroup.com.

[16] World Bank (1998).

survival, minimum habitat size requirements differ depending on the size and range of the species to be conserved.[17]

Conservation organizations such as the World Wildlife Fund (WWF) and Conservation International (CI) have mapped global conservation priorities, but the results are too coarse at a global level to be considered "No-Go" zones. For example, World Resources Institute's (WRI) intact forests maps for Russia and Canada are useful for identifying forests where caution may be warranted, but the landscapes mapped include broad swaths of forest where industrial activity may have been part of the landscape for decades. Implementing a commitment that precluded mining in all tropical forests might limit the options of many developing countries for improving their citizens' livelihoods if development were to proceed under the right conditions.

Biological criteria, such as species richness, endemism, intactness, and rarity can be used to determine when an environmentally sensitive area might qualify as a "No-Go" zone. Actual definition of "No-Go" zones will likely require a stakeholder engagement process that determines the degree of risk that affected stakeholders are willing to accept.[18]

Environmental Go/ No-Go Criteria

A basic assumption in proposing environmental Go/No-Go criteria for an advanced exploration project is that a catastrophic event could take place if a mine were to be built, even if the requirements of existing law are met. A catastrophic event might be defined as one which would cause significant long term damage to a resource that has been identified as critical to a place, and which would be directly impacted by catastrophic event at a mine.

In many regulatory jurisdictions in the US today there could still be a risk of a catastrophic event if conservative design or operating procedures are not followed, or if a natural disaster, for example a flood or earthquake, or another 'act of God' might occur. Regulatory agencies themselves have a limited range of authorities, and are often restricted from requiring any action of a permittee that is not explicitly authorized in statute or regulation. Another limitation of the regulatory system is that there is no entity that has either the responsibility or authority to address the question of "should this mine be built" in the overall context of the economic, social, and environmental benefits and impacts of the mine. Instead, the surrogates for this debate take place at various regulatory hearings, in the editorial columns of local and regional newspapers, at corporate annual shareholder meetings, on websites, and most relevant of all in the courts, where the issues argued are often endangered species, water and air quality, or the adequacy of an environmental impact statement – when the real issue is "should this mine be built."

Go/No-Go criteria might be viewed as an intermediate step in addressing the fundamental issue of "should this mine be built" because the Go/No-Go criteria evaluation process is comparing potential benefits against potential impacts. This is in contrast to the regulatory approach, which is that a permittee must show that they meet criteria (a), (b), (c), (d), etc. If they can show the regulator that they meet these criteria, then the regulator must issue a permit. The Go/No-Go criteria process weighs two competing values against each other, and results in a yes/no resolution to the mine proposal, at that point in time.

The use of Go/No-Go criteria has most often been used in conjunction with land designations that protect environmental or social resources, as described in the Background section above. Go/No-Go criteria might also be applied in a more technically oriented manner by evaluating situations that have proven problematic at other mines and could, through unpredictable circumstances, lead to a catastrophic event

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[17] Beier (1993: 94–108); Laidlaw (2000: 1639–48); Terborgh (1992: 283–92); Thiollay (1989: 128–37); Armbruster and Lande (1993: 602–10).

[18] Miranda et al. (2003: 46–47); FOE-I (2002); Dudley and Stolton (2002: 9, 12).

that would cause significant long term damage to a resource which has been identified as critical. Criteria like these would probably be most helpful to governmental and non-governmental organizations charged with managing lands with designated purposes.

Weighing a designated purpose(s) against the benefits and risks of mining would be more straightforward than it would to conduct an environmental impact review. The regulatory agency seldom has the same clear mandate to protect a designated resource, for which risks can be relatively easily identified, and it seldom has the level of discretion that a land management organization has in weighing a broad range of factors into a final decision. Nonetheless, it would be possible for a regulatory agency to utilize a Go/No-Go process if it were given the level of discretion required to weigh a broad range of factors into its evaluations and decisions.

The technical Go/No-Go criteria below are only examples, not an exclusive list. They are drawn on a background of geology, geophysics, hydrology, and geochemistry. They do not include biology, fisheries and animal science, cultural heritage, or a number of other disciplines that would be relevant to a more complete list of environmental Go/No-Go criteria.

1. Hydrology

An understanding of minesite hydrology is critical in the ability to predict the movement of contaminants on and off of the minesite. Since most ore deposits are associated with bedrock, many minesites have relatively shallow groundwater systems limited or bounded by bedrock. While the depth of many minesite aquifers is relatively shallow, the boundary between bedrock and aquifer is often indistinct because of fractures, faults, and other changing features of the bedrock.

1.1. Risk permanent damage to lakes, streams, or wetlands by:

1.1.1. Dewatering/Water table drawdown

It is normal for both underground workings and open pit mines to require dewatering during mining operations to make mining safe for mine workers. When the groundwater table is lowered by barrier wells or by pumping mine sumps it is possible to lower local water tables to the extent that natural springs may dry up, or steams to be dewatered to some extent. These impacts can have both environmental and economic impacts. And even though the change in groundwater level is arguably temporary – for the life of the mine – aquifer rebound to its original groundwater level can be both slow, and in some cases permanently altered. For example evaporation from a pit lake, or the permanent discharge of mine drainage, can permanently alter groundwater level.

Go/No-go Criteria:* *Is it is likely that mine dewatering will be required which would cause drawdown to the point where water levels would threaten springs, groundwater uses (e.g. drinking water wells), or stream flows that would jeopardize aquatic life?

1.1.2. Contamination

Confining mine-related contamination to the minesite is probably the most common, and one of the most important, problems associated with mining. No mine is planned with offsite contamination. Besides the obvious direct impacts of offsite mine contamination itself, there are several indirect impacts of offsite contamination. If there is unpredicted water contamination that has an effect on local drinking water, agricultural, or fisheries uses, the affected communities are not likely to trust the predictions of the mining company on other issues that could impact these same communities.

First, there is the loss of trust in the reputation of the mining company. Before mining began local people had been assured that there would be no contamination coming from the mine, but that prediction proved false.

Second, many problems not related to the contamination are now associated with (blamed on) the mine contamination, even though it is unlikely, or impossible, that these problems were caused by the mine-related contamination. These associated, but unrelated problems further erode confidence and trust in the mining company's ability to recognize and solve offsite contamination problems.

Go/No-Go Criteria: ***Is there a likelihood, related to orebody type, mine location, and mining method, that contamination from the minesite might exceed water quality standards for human health, aquatic life, or water quality standards for other designated water uses off the minesite?***

2. Geochemistry

Understanding the geochemistry of the material to be mined, both ore and waste rock, is critical in being able to predict whether the mined rock will pose potential contamination problems during and after mining. The most problematic class of minerals that pose potential water contamination problems, but not the only ones, are metal sulfide minerals. These mineral are not stable in the environment of the earth's surface. When exposed to air and water by mining they oxidize (decompose) generating weak sulfuric acid which then mobilizes trace metals that are highly toxic to aquatic life, and a few trace metals that pose significant risks to human health (e.g. mercury and arsenic).

A significant portion of the rock removed during mining is waste – that is, it is not processed for the target metal or mineral, but is typically placed close to the mine in large waste rock piles. Typically there is as much waste rock produced as ore, but the ratio of waste-to-ore can vary from ten times as much ore as waste rock (in an underground mine), to ten times as much waste rock as ore (in an open pit, precious metal mine). The waste rock can contain as much as, or more, mineralization as the ore. The waste rock just doesn't contain enough of the target metal or mineral to justify the cost of processing it to remove the metal/mineral. This waste rock can, however, pose a significant contamination risk to water due to its sulfide content.

Knowing that there are sulfide minerals in the rock, and how much sulfide is present, is relatively straightforward. Predicting how quickly the sulfide minerals will decompose, how much will remain in solution, and what the final geochemical products on the sulfide decomposition will be, is problematic.

2.1. Permanent (perpetual) water treatment predicted

The science involved in predicting whether there will be acid drainage and/or metals leaching is improving. However, it is difficult, if not impossible, to predict how long the acid drainage and/or metals leaching will continue, with a couple of exceptions: (1) if there will be no surface or ground water drainage from the mine; or, (2) if the acid drainage and/or metals leaching is related only to the processing of ore during mine operations.

If it is predicted that acid drainage and/or metals leaching will occur after mine closure, and collection and water treatment will be required, then there is significant financial risk to the public in estimating the amount needed in the financial surety to cover water treatment post-closure. Unfortunately it is virtually impossible to predict whether post-closure water treatment for acid drainage and/or metals leaching will be required for 10, 20, or 30 years. The science needed to make this prediction is just not available today. So if active water treatment is required post-closure, it should be assumed that perpetual water treatment will be required until it can be empirically demonstrated that water treatment is no longer needed. The analog might be trying to predict the weather on a defined day a year in advance. You know what season it will be, but predicting what the high and low for that will be, and whether there will be rain, snow, or neither, is largely an educated guess.

It is also difficult to estimate replacement and operating costs for a present-day industrial facility in the far future. Attempting to estimate these costs in perpetuity puts the public at significant risk of underestimating the amount of money needed to operate and replace the water treatment facility. If the financial surety is not sufficient to meet the costs of operating and maintaining the treatment facility, it will almost certainly be the public that is obligated to meet the deficit, or to bear the cost of degraded water quality if treatment is discontinued or degraded.

There is a risk that the financial vehicle used for the financial surety may not be available or viable when it is required for treatment. Financial institutions, and even government institutions, have a finite life. If these institutions change significantly, or fail, the potential for damage (i.e. water pollution) is still there, but the means to meet this need now falls on an institution that was not responsible for the problem.

If active water treatment is required after mine closure, then the amount of money required to meet the commitment of water treatment for an indefinite time poses too much financial risk to the public. If water treatment can be limited to passive/self-sustaining water treatment, then the financial and environmental risk to the public is low. Passive/self-sustaining water treatment is that which can run with little or no maintenance required. Active water treatment, which includes some biological treatment systems, is that which requires temporary or constant management by man, and is a risky long term solution to containing contamination.

Go/No-go Criteria:* *Will the amount and/or concentration of seepage water after mine closure require collection and active water treatment for the foreseeable future? If it cannot be demonstrated that a self-sustaining natural closure can be attained, then allowing mining would place an unreasonable risk on the public.

2.2. Long term storage of acid generating waste in an oxidizing environment

If there is potentially acid generating and/or metals leaching (PAG/ML) minerals present in the mine waste, i.e. tailings, waste rock, and mine workings, then this material must be placed in an environment where the geochemical reactions can be regulated and reduced to a minimal level. Typically this is done either by placing the PAG/ML waste under water, or by encapsulating the PAG/ML waste in material with enough buffering minerals present to neutralize or precipitate any contaminants produced.

However, whether a given waste storage approach will work is typically dependent on both the geochemistry and amount of the PAG/ML material. The chemical and biological reactions of some PAG material is so strong that they can continue even when the material is placed under water. And, if there is little or no buffering material present in the area of the mine, encapsulating PAG/ML rock may not be possible.

If PAG/ML material cannot be placed in an environment where the geochemical reactions can be regulated, then the only alternative is collection and treatment of the acid drainage and/or metals leaching.

Go/No-go Criteria:* *If potentially acid generating waste, including tailings, waste rock, and mine workings, cannot be permanently placed in an environment where acid rock drainage and/or metals leaching can be permanently prevented, then it would not be safe to proceed with a mine.

3. Mine Engineering

3.1. Tailings dam design that minimizes the risk of dam failure

Large tailings dams built to contain mining waste, among the largest dams and structures in the world, must stand in perpetuity. A catastrophic release of a large amount of tailings could lead to long term environmental damage with huge cleanup costs. Tailings dams have failed at a rate that is significantly higher than the failure rate for water supply reservoir dams.[19] The causes for the higher incidence of tailings dam failures between tailings and water supply reservoir dams are probably shaped by two factors: (1) the ability to use construction types for tailings dams that are more susceptible to failure; and, (2) the fact that tailings dams are most often constructed in sequential ‘lifts’ over several years that make quality control more challenging relative to water supply dams that are constructed all at once.

We know that our technology and science have limits, and that there are significant economic incentives to make present day decisions about risk less, rather than more, conservative about the magnitude of these risks. In looking at the long term risk from tailings impoundments to other resources, policy makers should view the risks from a conservative probabilistic perspective rather than relying on assumptions about specific hazards that are likely flawed.

3.1.1. Seismic risk

There is a risk that a large earthquake might cause catastrophic failure of a tailings dam, with the release of a large amount of tailings, and could lead to long term environmental damage with huge cleanup costs. The probability of such a catastrophic failure is low, but the consequences should it occur are very high.

Tailings impoundments have been around for about a century.[20] The construction and care of a tailings dam is a relatively new phenomenon to society and to mining, which historically disposed of its waste in the most convenient way. Tailings dams are also fundamentally different from water supply dams in several respects.

First, unlike a dam built for impounding water, which can ultimately be drained if the structural integrity becomes questionable, a tailings dam must be built to stand in perpetuity. This consideration should impose additional design requirements, especially with regard to the seismic and hydrologic events the dam might experience. Once a tailings dams is built it is not economically or environmentally viable to move the waste that is impounded behind the dam. The dam must hold this waste safely in perpetuity. We don’t know how long ‘perpetuity’ means, but 10,000 years (e.g. the approximate time since the last ice age) is a minimum approximation.

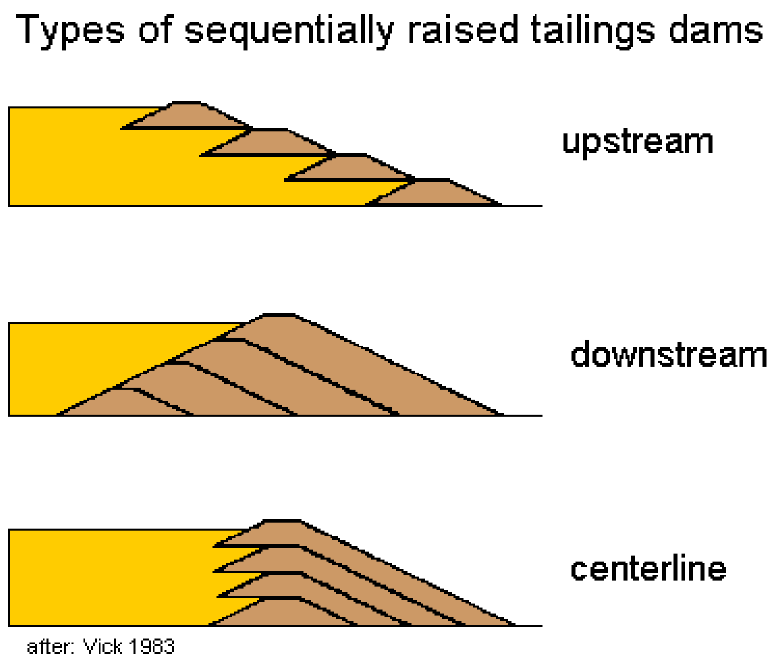
The estimated largest earthquake that could occur at any given location is called the Maximum Credible Earthquake. The Maximum Credible Earthquake (MCE) is defined as the greatest earthquake that reasonably could be generated by a specific seismic source, based on seismological and geologic evidence and interpretations.[21] The Maximum Credible Earthquake is often associated with a recurrence interval of 10,000 years.[22]

Second, while water supply dams are all of the downstream-type construction, the construction of tailings dam can be either (1) downstream; (2) centerline; (3) upstream; or, (4) a combination of any of the previous methods.

[19] Davies, M.P., 2002, p. 32
[20] See MMSD, 2002, for a short summary of the history of modern mining.
[21] Alaska Department of Natural Resources (2005), p. 6-6
[22] Weiland (2008)

Downstream construction is the safest type of construction from a seismic standpoint, but is also the most expensive option.

Upstream construction is the least secure because it relies on the stability of the tailings themselves as a foundation for dam construction.[23] Tailings are generally placed behind the dam in a slurry from the mill, and can remain saturated for long periods. Saturated, unconsolidated material is very susceptible to liquefaction under seismic loading. Upstream dam construction, often using the coarse fraction of the tailings is the cheapest option, and is still routinely employed in tailings dam construction today.



Centerline construction is a hybrid of downstream-type dam construction, and from a seismic stability standpoint the risk is lies between that of centerline and upstream types.

The unintended release of the waste behind a tailings dam imposes real costs on society. There is a direct economic cost associated with cleaning up the waste that would escape from a failed impoundment, which can run into the hundreds of millions of dollars.[24] If there is no cleanup the long term environmental costs will be borne by local communities, both natural and human, and could be even larger than the direct cleanup costs.

Go/No-go Criteria:* *Is it likely that a tailings dam can be engineered to withstand a maximum credible earthquake no farther than 10 kilometers from the dam site? Numerical modeling must be used to verify the seismic stability of the dam design. If a tailings dam location cannot located in a place that allows these design criteria to be implemented, then it would not be safe to proceed with a mine.

3.1.2. Hydrologic risk

Meteorological events led to most of the tailings dam failures, with seismic events triggering the second most failures.[25] Upstream-type dam construction was involved with more of these incidents than any other type.[26]

The water storage capacity of a tailings dam and the water release capacity, via a spillway, is governed by the choice of the maximum hydrologic event (storm and/or snow melt) that the facility will experience over its life. The International Commission on Large Dams recommends that the Probable Maximum

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[23] Davies, M.P. (2002), p. 35
[24] For example the Los Frailes dam break (near Seville, Spain), April 1998. As of August 2002 the cleanup cost was 276 million Euros (El País/El Mundo, August 3, 2002)
[25] Rico, et. al. (2008), p. 846
[26] Rico, et. al. (2008), p. 849

Flood, not a lesser event, be used as the design event for mine closure.[27] Yet even today the design hydrologic event for dam construction may not be the Probable Maximum Flood, but a lesser event.

The choice of a lesser event makes dam construction less expensive, and is often justified by evaluating the risk of potential impacts of dam failure. The risks evaluated are most often focused on the potential for loss of human life and damage to existing infrastructure. Long-term environmental impacts and cleanup costs are not emphasized, and often not considered.

***Go/No-go Criteria:* During mining operations a tailings impoundment must be able to hold the maximum probable flood event, plus snowmelt (if any), and have adequate freeboard remaining to withstand wave action and storm surge at the same time. If a tailings dam location cannot located in a place that allows these design criteria to be implemented, then it would not be safe to proceed with a mine.**

3.2. Waste dump design

All mines produce waste rock – rock that does not contain enough of the mineral of interest. The waste rock from underground mining usually comes from the shafts and tunnels that are necessary to reach the ore zone. Waste rock from an open pit mine usually constitutes half to ten times the amount of ore mined. In both the underground and open pit cases the waste rock can contain enough sulfide minerals, and/or neutral drainage-leaching minerals as the ore. Waste rock in generally located as close to the place it is mined as possible, because moving this material is one of the largest expenses incurred by mining.

Unlike tailings ponds, which can be lined if the tailings can readily produce contamination, waste rock piles are virtually never lined, even though the waste rock can contain as much as, or more, potential contaminants as the ore. There are economic and engineering barriers to placing waste rock on a liner. In all honesty the primary consideration is economic – it would be very expensive to line waste rock dumps at a mine. Because no one lines waste rock dumps, it would be a huge economic penalty for a new mine to line waste rock dumps if their competitors did not. Until we see a legal requirement to provide the environmental protection of a lined waste dump, we are unlikely to see anyone voluntary attempt this.

From an engineering perspective there are also potential problems with lining a waste dump. Tailings are relatively uniform in size, and when placed on a liner exert fairly uniform pressure on a liner. Waste rock, on the other hand, is very inhomogeneous. In time the larger, denser pieces of waste rock will gradually work their way to the bottom of the waste rock pile, and could affect the integrity of the liner. There has been little or no research done on this subject.

The standard way to deal with contamination emanating from a waste dump is to collect the contaminated seepage by using barrier walls, and/or barrier wells, to stop the down gradient flow of contaminated water. This approach can be effective if the hydrogeologic and geotechnical background data collection has been adequate. If this work has not been done adequately, contaminants can escape via fracture systems or faults.

3.2.1. Long term stability

Like tailings dams, waste dumps must be designed and engineered to maintain their integrity in perpetuity. The design considerations include modeling for seismic stability. Generally a waste rock dump with a shallow slope (3H:1V or greater) will be seismically stable, but it does take more room to build a waste rock dump at these slopes, and that may not be available in naturally steep areas. Waste rock dumps can be stable at steeper slopes, but it would depend on the size and composition of the waste

[27] ICOLD (2001), p. 31

material, and the steeper sloped waste rock dumps (generally 2.5H:1V to 1H:1V) are more susceptible to seismic and static failures, and are also too steep to hold a top liner, if that is needed.

Go/No-go Criteria: Can waste rock dumps be designed to withstand maximum credible earthquake and probable maximum precipitation events? If a waste rock dump location cannot positioned in a place that allows these design criteria to be implemented, then it would not be safe to proceed with a mine.

3.2.2. Dump cover design

Numerous cover designs have been applied to the top of waste rock dumps in an effort to minimize the infiltration of water into waste dumps. These designs have met with varying degrees of success, and the implementation of cover designs can be dependent on site-specific factors, like the slope angle and presence/absence of suitable cover material in the vicinity.

Go/No-go Criteria: Will the waste rock dump(s) require a designed cover to shed water, minimize infiltration, and/or promote reclamation revegetation? If a waste rock dump location cannot positioned in a place that allows these design criteria to be implemented, then it would not be safe to proceed with a mine.

3.2.3. Dump seepage collection

The primary approach to preventing contamination from leaving the immediate vicinity of a waste rock dump is seepage collection. This can be done through a number of approaches, but all of them require a good understanding of the hydrology and geotechnical nature of the area around and under the waste rock dump. Predictions of the amount and geochemical composition of the contamination coming from a waste dump can be modelled if the appropriate geochemical and hydrological information is collected.

Go/No-go Criteria: All waste rock dumps should have passive seepage collection systems for the long term collection of seepage. If a waste rock dump location cannot be positioned in a place that allows this design criteria to be implemented, then it would not be safe to proceed with a mine.

4. Reclamation

4.1. The costs of reclamation, closure, and all post-closure expenses must be conservatively calculated and placed in trust prior to these obligations are incurred by a mining operation.

Reclamation planning typically includes re-contouring the slopes of waste dumps to stable angles. However, the angle at which a slope is considered stable is sometimes an issue. Reestablishing vegetation to approximate pre-mining conditions is an accepted goal, but quantitatively measuring whether revegetation is successful is seldom done. Backfilling of mined out underground areas and open pits is typically done only when it is economically competitive with other waste storage options.

4.1.1. Financial Surety

The mining sector is vulnerable to significant fluctuations in metals prices, and many companies have gone bankrupt, sometimes before mine closure or reclamation is complete. Because closing a mine can typically cost tens of millions of dollars, regulators need a dependable source of funds to pay for the physical reclamation of the mine site as well as the necessary oversight by government officials

The purpose of a financial surety is provide the financial resources necessary to close the mine at any point in its lifetime due to the bankruptcy of the mine operator. Having a government agency close a mine is much more expensive than having a mining company do this work. There are a number of reasons for this, including the need for the government agency to supervise the closure operations, to draw up final work plans for the closure that can be put out to bid, to provide for the mobilization/demobilization of the contractor's equipment, and more. Estimates for the cost to the government for closing a mine, as opposed to a closure conducted by the mining company itself, generally range from 35% - 65% more than the direct costs to the mining company.[28]

There may also be potential problems in identifying a responsible party, even if a financial surety is still technically in-force. Corporate mergers, spin-offs, or the consolidation of financial institutions, can complicate the accountability for a financial guarantee. In addition, a party responsible for a large financial surety may find it more financially expedient to litigate a multi-million dollar financial surety claim than to pay it off. The cost of potential litigation, and the environmental and management costs of a significant delay in accessing financial surety money, is never considered in calculating a financial surety amount.

Go/No-go Criteria: If the potential mine design suggests that the cost of reclamation would pose a financial burden that is significantly greater than that for similar mines, and would be difficult for the mine operator to meet, then it is unlikely that the mine could proceed.

Synopsis

At this time no regulatory agency has adopted Go/No-Go criteria for mining, but a recent example of a Go/No-Go analysis for a mining project is available from Rio Tinto.[29] Even though this analysis is of an iron mine complex, the structure of the model, as well as some of the criteria that were developed, is applicable to hard rock mines. Developing Go/No-Go criteria for a regulatory agency will be more difficult than for a company in that regulations must take into account environmental, social, and economic values. Regulatory agencies have more legal restrictions in developing criteria and regulations than do private corporations. However, developing Go/No-Go criteria for mining could protect public values, save industry unnecessary investment in further exploration, and avoid lengthy litigation.

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[28] For example, see USFS 2004, and CSP2 (2000)
[29] Green (2011)

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