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MEMORANDUM

To: Global Tailings Review, consultation@globaltailingsreview.org
From: Ann Maest, PhD; Buka Environmental
Date: 27 December 2019
Re: Comments on Global Tailings Standard, Draft for Public Consultation, November 2019

Introduction

The comments in this memorandum are in response to the Global Tailings Standard Draft for Public Consultation ("the Standard") by the United Nations Environment Program (UNEP), the International Council on Mining and Metals (ICMM), and the Principles for Responsible Investment (PRI), dated November 2019. I am an environmental geochemist who works for communities in the Americas potentially affected by mining activities, including tailings and other mine facilities. My areas of expertise are groundwater and surface water quality, geochemical characterization of mine wastes, and the fate and transport of natural and anthropogenic contaminants in the environment. Thank you for the opportunity to submit comments on the draft Global Tailings Standard. My comments focus on geochemical characterization, adaptive and tailings facility management, approaches to minimize the volume and toxicity of tailings in surface impoundments, and stakeholder engagement. A general summary of the recommendations is contained in the Summary section.

Geochemical Characterization

The geochemical characterization issues are largely related to a lack of definition in the Standard. The consequence classification suggested in Table 1 shows that gradations in toxicity of the process water and the acid generation and contaminant leaching potential of the tailings can move the consequence of a dam failure from significant to extreme – but no definitions for the gradations are presented. The geochemical characteristics of the supernatant and pore water and especially of the tailings themselves can control the extent and recoverability of ecosystems after a dam failure. A system must be developed or pointed to for the gradations, or the consequence distinctions are meaningless.

Acid generation and metal leaching potential

Table 1 in the draft Standard incorporates acid generation and metal leaching potential in its risk rationale. As acid generation and metal leaching potential increases, the risk increases. The Standard has only requirement for determining the geochemical characteristics of the tailings:

> REQUIREMENT 1.2: Prepare and regularly update detailed site characterization of the tailings facility site(s) that includes geomorphology, geology, geochemistry, hydrogeology, geotechnical, seismicity and hydrology. The physical and chemical properties of the tailings shall be determined and regularly updated.

The requirement has no specificity and does not refer to a best practice guidance for any of the site characterization elements. The level of detail in the Standard is being debated, but including a reference to widely accepted guidance would help ensure this requirement is more evenly understood and complied with. For geochemical characterization I suggest referring to the industry-sponsored GARD Guide (INAP, 2009). Chapter 4. Defining the Problem – Characterization[1] and Chapter 5. Prediction[2] discuss the rationale for designing a characterization program, what it means to have representative and an adequate number of samples, and the various test methods that can be used to assess acid drainage and metal leaching potential. Because more is always leached from tailings than acid and metals, I suggest using acid drainage and *contaminant* leaching potential to capture non-metals such as sulfate, nitrate, and selenium and metalloids such as arsenic and antimony. A small related point is the use of "low neutral leaching potential" in Table 1 under the Significant, Environmental cell. I assume this is a typographical error and should be "low metal leaching potential," which should be changed to low contaminant leaching potential.

Table 1 has gradations of acid generation and metal leaching potential, but no guidance is presented on the meaning of these terms (e.g., low, high, very high). One option is to use representative measured acid-base accounting results (or a range), and if the neutralization:acid production potential ratio (NP:AP ratio) is 3 or higher, the acid generation potential would be low; if between 1 to 3, the potential would be moderate, if <1, the potential would be high; and if <-1, the potential would be very high. Similarly, if leach test results on the tailings produce water does not exceed water quality standards (e.g., aquatic life criteria), the contaminant leaching potential would be considered low; if concentrations exceed standards by 1 to 10 times, the potential would be intermediate; and if concentrations exceed standards by more than 10 times the potential would be high. The approaches used by Kuipers and Maest (2006; e.g., see pgs. 25 and 31) are similar.

Process water toxicity and co-disposal of other mine wastes

In a similar vein, gradations in process water toxicity are used to help classify the consequence of dam failure in Table 1. However, the term "process water" is not defined, and neither is the term "toxicity." I believe process water refers to supernatant water in the tailings facility, but it could also refer to pore water in the tailings in the impoundment. The terms process water and toxicity need to be defined, and a measurable way to determine low, medium, and high toxicity must be included or referred to in the Standard.

[1] http://www.gardguide.com/index.php?title=Chapter_4
[2] http://www.gardguide.com/index.php?title=Chapter_5

Tailings impoundments are often used as the dumping grounds of a mine site. Water treatment brines, wastes from mercury emission control systems (e.g., retorts), sediment or precipitates from contact water impoundments, water recycled and evaporated from the tailings toe pond, and other mine-influenced water and sediment are disposed of or placed in tailings impoundments throughout the mine life. The effects of these additions are rarely considered or modeled in a conceptual site model or in remediation. Co-disposed mine-influenced waters and wastes should be tested chemically and evaluated for the risk to the physical and chemical integrity of the dam, the impoundment, and the surrounding water and soil resources that could be affected if tailings fluids leak or are spilled from the impoundment.

Tailings characterization methods learned from past dam failures

The expert report on the January 2019 Brazilian Feijão Dam I failure showed that dam failure was cause in part by the high iron percentages in the tailings and the oxidation and resulting bonding of the iron particles, which rendered the tailings mass more brittle (Robertson et al. 2019). The brittle behavior led to a lack of observable deformation before failure (so looking for indicators of deformation would not have shown that anything was wrong) and the sudden and rapid failure from brittle strength loss. Scanning Electron Microscope (SEM) and other mineralogic and geochemical techniques are needed for tailings characterization during and after mining ceases, especially at iron ore mines, yet an up-to-date set of methods is not available in best practice guidance documents. As we learn more from past failures, best practice characterization measures will need to be regularly updated to ensure that the most relevant and comprehensive approaches are incorporated in tailings management and assessment guidance.

Adaptive Management

Requirement 8.3 reads like a requirement for adaptive management, but it refers to trigger response action plans (TARPs), a term that is less well known in the industry.

> REQUIREMENT 8.3: Analyze monitoring data at the frequency recommended by the *EOR*, and assess the performance of the facility, clearly identifying and presenting evidence on any deviations from the expected performance and any deterioration of the performance over time. Promptly submit evidence to the *EOR* for review and update the risk assessment and design, if required. Performance outside the expected ranges shall be addressed swiftly through *critical controls* or *trigger response action plans* (TARPs).

The definition of TARP in the glossary is vague: “A planning tool used for managing or responding to critical situations caused by specific events.” The Initiative for Responsible Mining Assurance (IRMA) has a more comprehensive definition of adaptive management (IRMA, 2018):

> Adaptive Management is a structured, iterative process of robust decision-making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. It includes the development of management practices based on clearly identified outcomes, and monitoring to determine if management actions are meeting desired outcomes. If outcomes are not being met, the process requires

development and implementation of management changes to ensure that outcomes are met or re-evaluated.

Adaptive management is mentioned specifically in Requirements 2.4[3] and 7.7,[4] but no detail and no reference to guidance are provided. A clearly defined Adaptive Management Plan (AMP) linked to tailings monitoring results should be required in the Standard. The details of AMP requirements do not need to be included in the Standard, but generally the AMP should include:

- Numeric expected performance criteria
- Numeric triggers levels between good and worrisome conditions related to monitoring results[5]
- Mitigation measures designed for each performance criterion or trigger aimed at avoiding a catastrophic or other type of facility failure
- An evaluation of the effectiveness of the measures taken
- Reporting responsibilities for the facility owner/operator and responses by the regulatory agency and to relevant stakeholders
- An annual AMP report for the tailings facility that reviews any triggers met, actions taken, the effectiveness of the actions, and any modifications that need to be made to the AMP. The report should be made public, and a meeting should be held to explain the results to any potentially affected communities and other interested stakeholders.

Examples of mining AMPs that include plans for tailings facilities include Minto Explorations Ltd. (2018) and Glencore (2018).

Tailings Facility Management and Responsibilities

Tailings facility operation and management are covered in Topics III and IV of the Standard, but discussion of tailings impoundment liners and air quality assessment are lacking.

The word “liner” does not appear at all in the Standard. Filtered/dry and drained tailings still need liners to prevent adverse water quality effects to downgradient areas. Tailings facilities must be lined with a geomembrane (or similarly effective) liner and incorporate a leachate collection system if the risk of contamination of downgradient water resources is likely, including if the tailings are predicted to generate acid or leach contaminants at concentrations exceeding applicable standards.

[3] … If new data indicates that the impacts from the tailings facility differ from those assumed in the original assessments, the management of the facility shall be adjusted to reflect the new data using adaptive management best practices.

[4] Ensure that the ESMS is designed and implemented to align decisions about the tailings facility with the changing environmental and social context as identified in the knowledge base, in accordance with the principles of adaptive management.

[5] For example, measured pressure on the dam, water levels in dam/impoundment piezometers, supernatant pool characteristics, tailings chemistry, and other characteristics.

Whether tailings are deposited in a filtered/dry or saturated state, the effects of dust on resources such as crops, soil, wildlife, plants, surface water, and human health should be predicted and monitored. Concurrent reclamation with covers that will limit dust production and infiltration to groundwater should be required during operation and at closure.

Requirement 5.2 should explicitly include the effects of climate change on water balance and water management – and facility sizing. The requirement reads:

> REQUIREMENT 5.2: Develop and implement water balance and water management plans for the *tailings facility*, taking into account the knowledge base, upstream and downstream hydrological basins, the overall mine site, mine planning and operations and the integrity of the *tailings facility* for all stages of its lifecycle.

Although climate change is mentioned in a footnote related to the Requirement 1.1, I believe climate change needs to be more explicitly included in certain requirements, especially those related to water balance, water management, and design of facilities.

It is fairly common to have one flotation facility and tailings impoundment for multiple mines in the same geographic area. Such a situation is not addressed in the Standard. If multiple mines are using the same tailings and flotation facilities, a mutually agreed upon responsibility plan shall be outlined each year that identifies and splits the costs for remediation/restoration in the case of a tailings dam failure.

Approaches to Minimize the Volume and Toxicity of Tailings in Surface Impoundments

Requirement 5.1 addresses alternative options to minimize the amount of tailings and water placed in external tailings facilities – although it only says they should be "considered." The requirement would of course be stronger if the word "evaluate" was used instead of "considered." Again, no guidance is referred to that could serve as the basis for evaluating whether this requirement has been met.

Requirement 5.1 is focused on reducing the amount of water and material but not on the toxicity of the material or water. Table 1 uses the toxicity of the tailings water and the acidity and contaminant leaching behavior of the tailings to assign different consequence levels of a spill. Accordingly, Requirement 5.1 should be expanded to include reducing the toxicity and chemical effects of the water and tailings in the case of a spill. One of the best ways to accomplish reduced toxicity of tailings from sulfide ores is desulfurization – or removing pyrite and potentially other sulfide minerals that are not removed in the normal flotation process.

Desulfurized/depyritized tailings will lower the acid generation and contaminant leaching potential, including a lower likelihood of leaching arsenic, cadmium, and other toxic metal(oid)s associated with sulfide minerals. Desulfurized tailings can be disposed of separately in a more

secure manner and can also be more safely used as impoundment covers or sold as products. Ohlander et al. (2012) discuss depyritization/desulfurization of sulfide tailings.

Stakeholder Engagement

The word "stakeholder" is not defined the Standard. The section called The Role of Other Stakeholders (p. 4) implies that stakeholders include investors, insurance companies, local communities, and civil society organizations. The Introduction to the Standard also lists some stakeholders: "…multiple stakeholder perspectives, including those of local communities, civil society groups, regulators, investors, insurers, and the mining industry."

The definition in IRMA (2018), taken from IFC is: Persons or groups who are directly or indirectly affected by a project, such as rights holders, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively. Stakeholders can also include indigenous peoples, artisanal miners, and other water users who could be adversely affected if a tailings dam broke or mine-influenced water from the impoundment affected water resource availability or quality.

In places the Standard distinguishes communities or potentially affected communities from other stakeholders (see, e.g., Requirement 2.3 and 15.2). The term "stakeholder" should be defined in the glossary, and the Standard should be reviewed to ensure that potentially affected communities are explicitly included in all relevant requirements.

Summary

The following general recommendations are suggested for the next draft of the Global Tailings Standard. Details on the recommendations can be found in relevant sections of the text.

Geochemical Characterization:

- A best practice guidance for geochemical characterization should be presented. The GARD Guide is recommended.
- The gradations in acid generation and contaminant leaching potential, which help define the consequence of the tailings, must be defined.
- The terms process water and toxicity need to be defined, and a measurable way to determine low, medium, and high toxicity must be included or referenced in the Standard.
- Co-disposed mine-influenced waters and wastes should be tested chemically and evaluated for the risk they pose to the physical and chemical integrity of the dam, the impoundment, and the surrounding water and soil resources that could be affected if tailings materials leak or are spilled from the impoundment.
- As we learn more from past failures, best practice characterization measures will need to be regularly updated to ensure that the most relevant and comprehensive approaches are incorporated in tailings management and assessment guidance.

Adaptive Management:

- A clearly defined Adaptive Management Plan (AMP) linked to tailings monitoring results should be required in the Standard.
- An annual AMP report for the tailings facility should be required that reviews any triggers met, actions taken, the effectiveness of the actions, and any modifications that need to be made to the AMP. The report should be made public, and a meeting should be held to explain the results to any potentially affected communities and other interested stakeholders.

Tailings Facility Management and Responsibilities:

- Tailings impoundment liners, air quality impacts, and concurrent reclamation should be addressed in the Standard.
- Climate change needs to be more explicitly included in certain requirements, especially those related to water balance, water management, and facility design.
- If multiple mines are using the same tailings and flotation facilities, a mutually agreed upon responsibility plan shall be outlined that splits costs for remediating the effects of a tailings dam failure.

Approaches to Minimize the Volume and Toxicity of Tailings in Surface Impoundments:

- Requirement 5.1 should be expanded to include reducing the toxicity and chemical effects of the water and tailings in the case of a spill. One of the best ways to accomplish reduced toxicity of tailings from sulfide ores is desulfurization.

Stakeholder Engagement

- The term "stakeholder" should be defined in the glossary, and the Standard should be reviewed to ensure that potentially affected communities are explicitly included in all relevant requirements.

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