Emerging Markets Investors Alliance

Actionable Intelligence for Responsible Investing

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ISSUE BRIEF: TAILINGS MANAGEMENT

- Tailings Storage Facilities (TSFs) are large structures that contain mining waste. Recent years have seen a number of high profile TSF failures, including Samarco and Brumadinho in Brazil, causing environmental damage and loss of human life.

- We review risks to emerging markets extractive firms associated with tailings failures and recap recent attempts to improve management and disclosure around tailings risks.

- The new Global Industry Standard on Tailings Management represents a step in the right direction, but falls short of best practice in a number of areas.

- We review the Global Tailings Data portal as well as the RMI Report 2020 to identify which countries and companies have the greatest exposure to tailings risk. Chile, Russia, South Africa, Peru, Brazil and Poland are the most exposed EM countries.

- Top-exposed EM tailings stocks include: Vale, Anglogold Ashanti, Evraz, Severstal, Sibanye-Stillwater, Phosagro, Antofagasta and KGHM.

Mine tailings reservoir in Magadascar, Photo credit: Sloot

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ISSUE BRIEF: **TAILINGS MANAGEMENT**

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Summary

Major tailings accidents in recent years such as at Samarco and Brumadinho in Brazil have awoken investors to risks posed by the long-term storage of mining waste. With an estimated 3500 tailings storage facilities (TSFs) worldwide, and more being built every year, accidents are likely to continue. We provide a primer on tailings risk in emerging markets and assess the new Global Tailings Portal dataset as well as the Responsible Mining Index to identify which countries and companies have the greatest exposure to tailings risk. Chile, Russia, South Africa, Peru, Brazil and Poland are the most exposed EM countries. Top exposed stocks are Vale, Anglogold Ashanti, Evraz, Severstal, Sibanye-Stillwater, Phosagro, Antofagasta and KGHM. We suggest ways investors can assess tailings risk in their portfolios and questions to ask management when engaging on this issue

01—TAILINGS MANAGEMENT: FRAMING THE ISSUE

Mining can be a dirty and dangerous business. Tailings dams -- embankments that store mining waste, often for decades -- are emblematic of long term risks from mining operations that can lurk hidden from the view of the public or investors. Although few outside the mining industry may know much about tailings dams and how they work, a trio of large tailings disasters in recent years has raised awareness of the risks of disasters involving mining waste:

2014: Mount Polley, Canada. In 2014, this gold and copper mine saw a spill of 23.6 million cubic meters (mm3) of tailings, causing the nearby Polley Lake to rise by 1.5 metres.

2015: Samarco, Brazil. At this iron ore mine, a joint venture between Vale and BHP BIlliton, a tailings dam ruptured and released 44 mm3 of tailings, the largest spill on record, killing 19.

2019: Brumadinho, Brazil. Iron ore mine operated by Vale where a dam burst in January 2019, killing 270.

The loss of life and devastation of these accidents increased the public's awareness of the risk of mine waste, and sent a clear message to the mining industry and investors that more action was needed to prevent such calamities.

Action has indeed come in the wake of these tragedies, as outrage over Brumadinho fast tracked a number of initiatives to improve tailings management and disclosure. Institutions supporting these reforms include the Church of England, the Council on Ethics Swedish National Pension Funds, the International Council on Mining & Metals (ICMM), Principles for Responsible Investing (PRI) and the UN Environmental Programme. Two particularly visible outcomes have been: 1) a new Global Industry Standard on Tailings Management (the "Standard"), published by the Global Tailings Review in August 2020 and; 2) a new dataset on global tailings facilities, the Global Tailings Portal ("GTP") helping investors better understand risks related to tailings.

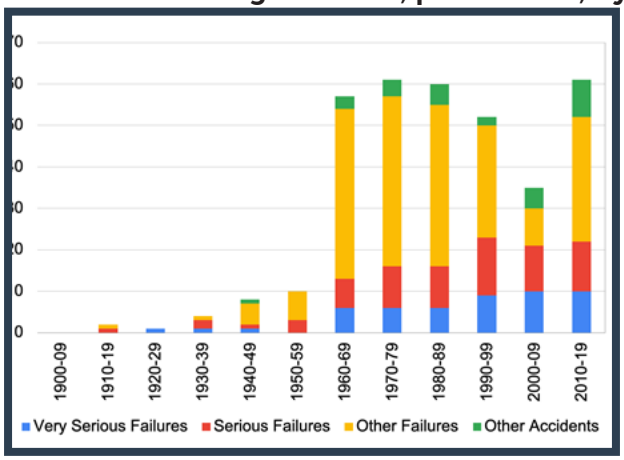
These developments are encouraging, but much more needs to be done to address tailings risks. Adoption of the Standard is mandatory for the 27 members of ICMM, but optional for the rest of the industry; investors should push companies to endorse it. As we discuss below, there are also additional steps companies can take that go beyond the recommendations of the Standard. And companies should expand their disclosures, allowing investors to assess the risks of further mishaps. Our analysis of the Responsible Mining Index tailings scores indicates a range of shortfalls among EM miners. Finally, we summarize below steps that investors can take when assessing this risk on their portfolio, and questions they should ask companies when pushing for best practices.

02–BACKGROUND: THE ROAD TO BRUMADINHO

Samarco and Brumadinho are perhaps the highest profile of a long string of tailings accidents that have accompanied the growth of the modern mining industry. In its 105-year database of tailings failures, the Center for Science in Public Participation (CSP2) lists the first modern tailings failure as having taken place at Aqua Dulce mine in Chile, following heavy rains in 1915. A few years later, at the nearby El Teniente copper mine, an earthquake resulted in a much larger spill (2.8 mm3 release) causing 54 fatalities, the first recorded tailings-related loss of life.

Since that time, according to CSP2, there have been 351 tailings dam accidents, responsible for nearly 3000 fatalities. The country that has seen the most failures is the United States (111), followed by Chile (34), Canada (28), China (18) and the Philippines (18). As FIgure 1 shows, tailings dam failures were relatively infrequent prior to 1960 but picked up significantly after that and have been fairly steady since that time at about 60 accidents per decade, on average, dropping somewhat in the 2000s and picking back up in the 2010s.

FIGURE 1.
Number of tailings failures, per decade, by type



Source: Center for Science in Public Participation

Biggest accidents

To put the recent accidents in context, Figure 2 ranks the top 8 historical tailings accidents by volume of release:

- **Samarco** was the largest accident by volume, caused by a rupture at the Fundão dam at the Germano iron ore plant in Mariana (MG) operated by Samarco Mineração, a joint venture between Vale S/A and BHP Billiton. The total release was 43.7 mm3.

- **Brumadinho** was the 7th largest by volume (9.6 mm3) but resulted in the highest number of fatalities (270).
- By geography: **3 of the top 8 disasters were in the Philippines**, 2 in the US, 2 in Brazil and 1 in Canada

FIGURE 2. LARGEST TAILINGS ACCIDENTS (RANKED BY VOLUME RELEASE)

	FAILURE	YEAR	RELEASE(MM3)
1	Samarco, Brazil	2015	43.7
2	Tailings Pond #2, Philex, Philippines	1992	32.2
3	Mt Polley, Canada	2014	23.6
4	Sipalay, Philippines	1982	15.0
5	Padcal, Philex, Philippines	2012	13.0
6	American Cyanamid, Florida	1962	11.4
7	Brumadinho, Brazil	2019	9.6
8	Cities Service, Florida, USA	1971	9.0

Source: Center for Science in Public Participation

Upstream and hybrid facilities have been twice as likely as downstream facilities to report stability issues, and six times as likely as dry-stack facilities, while taller/larger facilities tend to be more prone to failure [01].

Despite efforts noted below to improve standards around tailings management and disclosure, accidents are likely to continue. Since Brumadinho ruptured last year, 8 new known accidents have taken place, according to CSP2, including a large

[01] Towards Zero Harm, "Lessons from tailings Facility Data Disclosures"

spill reported to have occurred at the Luming Mine in China (2.3 mm3 release). Although limited official information has been released about this accident, some independent researchers have reported evidence of significant environmental damage, based on satellite imagery [02].

The cost of tailings spills

The cost to operators -- and investors -- from accidental tailings releases can be significant. A 2015 paper (written before the Mount Polley or subsequent Samarco/ Brumadinho accidents), estimated costs of public damages from 9 serious tailings accidents from 1990-2013 in a range of $29m to $1.4b per accident, with an average cost of $543m [03].

$29m to $1.4b — **Range of costs from 9 serious tailings accidents, 1990-2013**

$3b+ — **Potential costs from Samarco**

$4.8b+ — **Potential costs from Brumadinho**

The recent big accidents have come with even higher price tags. For Samarco, the all-in costs are likely to be over $3b according to one source, while Vale has estimated a $4.8b loss from Brumadinho (source). Both figures could ultimately be even higher, as ongoing lawsuits, clean up efforts and regulatory penalties play out.

Past efforts to improve tailings management

Despite mounting evidence in recent decades that tailings structures pose significant risks to the environment and public safety, steps to improve standards comprehensively have been limited. The Mount Polley disaster spurred the formation of *an expert panel to review the breach,* which concluded that the "business as usual" approach to tailings management was inadequate. The panel issued 7 recommendations, although subsequent researchers have noted that few of them were implemented [04].

[02] The Luming Mine tailings spill: so what happened next? (AGU Blogosphere, March 2020)
[03] "The Risk, Public Liability & Economics of Tailings Facility Failures", Bowker Associates Science & Research In The Public Interest (2015). Figures are in 2014 dollars.
[04] See Mount Polley Disaster — Six Years Later is B.C. Any Safer?, BC First Nations Energy and Mining Council (2015)

A year later, in the wake of the Samarco disaster, pressure for action increased further. The UN Environmental Programme and GRID-Arendal published a report, *Mine Tailings Storage: Safety Is No Accident,* calling for increased oversight, while ICMM put out a position statement, *Review of Tailings Management Guidelines and Recommendations for Improvement* (2016). However some observers argued that too little was being done to reform tailings management [05]. As we will see below, the scale of the Brumadinho disaster provoked a more comprehensive and global approach to tailings management reform.

[05] https://www.earthworks.org/blog/no_more_mining_disasters/

03–TAILINGS: THE BASICS

Tailings are the materials remaining after a sought-after metal or mineral has been removed from naturally occurring rock. Rock that contains a sought-after metal is called ore. The higher quality the ore, the greater the concentration of metal. Over the past few decades, the amount of tailings waste produced has increased substantially as demand for metals has grown and the quality of ore has fallen.

Tailings -- a mixture of ground rock, water, and leftover chemicals from the mining process -- tend to be liquid and mud-like. During the operational life of the mine, tailings are stored in tailings storage facilities (TSFs) [06] -- usually taking the form of large outdoor embankments held in place by local rock and possibly the tailings themselves. In some cases, miners remove water from the tailings to make a more stable variant known as filtered or dry stack tailings, which eliminate the need for dams. This process is expensive however, and can be cost-prohibitive for mines that produce large volumes of tailings. As a result, most tailings storage facilities store "wet tailings".

Wet tailings pose a risk to their environments and communities when they breach their embankments and flow into surrounding areas. This risk is heightened by the high toxicity of many tailings, which can contain high concentrations of heavy metals as well as other toxins such as radioactive materials or cyanide. This toxicity both poses an immediate risk and can create lasting environmental impact, with many supposedly "restored" tailings sites remaining inhospitable moonscapes for decades.

Although tailings are generally considered in a mining context, it should be noted that energy producers can also make use of tailings facilities. Oil sands tailings ponds[07] , which allow the solids in the byproduct of the tar sands extraction process to settle, are also seen as a significant environmental risk [08] . Nevertheless the primary focus of this Brief is tailings associated with mining operations.

Many TSFs are composed of rock walls that can be among the largest human-made structures on earth. Some tailings facilities have walls up to 200ft high and over 10 miles long [09]. The lifespan of a TSF can be decades or more, given that even after the

[06] While the term tailings storage facility and tailings dam are often used interchangeably, tailings storage facility is preferred because the embankments no longer act as a dam if the tailings are removed when the mine closes down.
[07] https://www.nrcan.gc.ca/energy/publications/18752
[08] https://www.nrdc.org/sites/default/files/media-uploads/edc-and-nrdc-one-trillion-litres-of-toxic-waste-and-growing-albertas-tailings-ponds-june-2017.pdf
[09] https://www.theneweconomy.com/energy/top-5-mega-dams-were-they-worth-the-cost (The New Economy, Aug 2020)

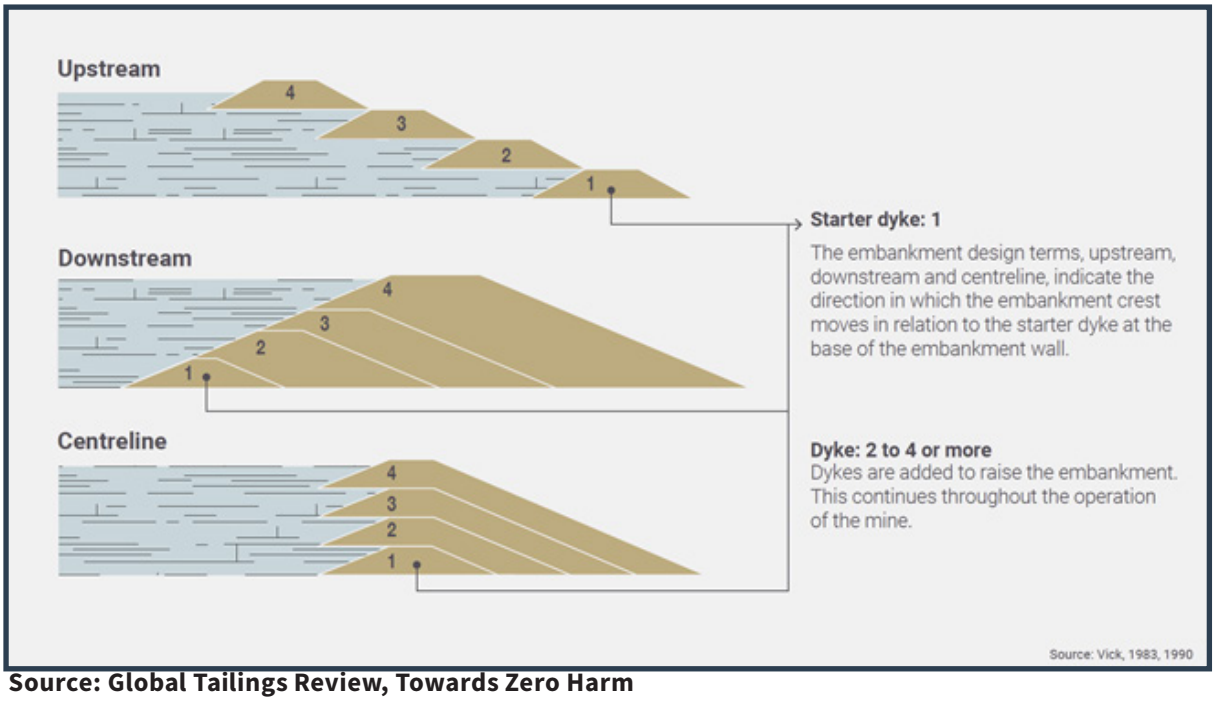
facility is closed it can take many years for the tailings to dry and stabilize.

According to one source, extracting the 40 elements needed to produce a single mobile phone produces 7.5 tons of tailings [10]. As global demand for minerals has grown, new tailings dams to store mine waste have been built across the globe, with 320 new tailings dams constructed over the past ten years [11]. Looking ahead, metals demand associated with global economic growth, alongside the transition to low carbon energy, suggests a need to increase production of many commodities. Copper demand, for example is, expected to jump as much as 50% over the next 20 years to keep up with demand for consumer electronics, electric vehicles, and renewable energy sources like wind turbines [12]. These trends suggest that tailings production and TSF construction will continue to grow at double-digit rates over the next few decades.

Types of Tailings Storage Facilities

There are three main types of TSF designs-- upstream, downstream, and centerline-- each type referring to the direction in which embankments are raised as additional tailings are stored. The safest tailing dam design for a specific mine depends on a variety of environmental factors unique to the site.

FIGURE 4
TSF design types



Source: Global Tailings Review, Towards Zero Harm

[10] https://www.miningmagazine.com/geomechanics-ground-control/news/1386691/managing-future-tailings (Mining Magazine, August 2020)
[11] https://graphics.reuters.com/MINING-TAILINGS1/0100B4S72K1/index.html (Reuters Graphics, July 2020)
[12] https://sustainablecopper.org/meeting-future-copper-demand (Copper Alliance, August 2020)

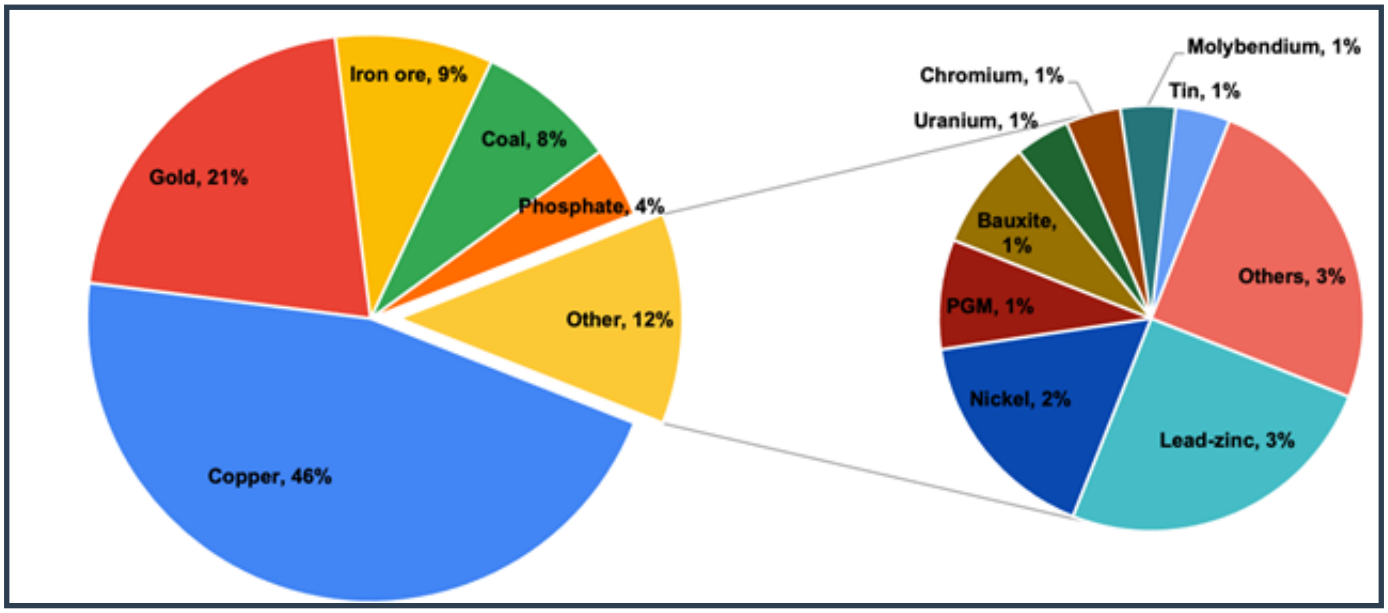
The upstream method is generally viewed as the least stable, because the tailings themselves are used to build additional embankments. Upstream facilities have been involved in nearly 60% of tailings dam failures since 1910, despite representing just a third of design types globally [13]. Some experts have argued for an outright ban on upstream tailings dams -- such as the Safety First guidelines discussed below -- however such a recommendation fell outside the scope of the new tailings Standard. Both Samarco and Brumadinho involved upstream embankments, while Mount Polley was a centreline design that was modified during operation to use upstream raises [14] .

ONE MIX: LED BY COPER

Nearly half of TSFs globally are associated with production of copper, with a further 21% used for gold mining, followed by iron ore (9%) and coal (8%). The remaining dams are put to use mining a wide range of metals (Figure 4).

Iron ore's single-digit share may come as a surprise, given that Samarco and Brumadinho -- the sites of the biggest and deadliest spills, respectively -- were both iron ore mines. This is likely a function of Brazil's challenging terrain and climate, as well as lapses in maintenance and surveillance, rather than a feature of the iron ore itself.

FIGURE 4
Distribution of tailings dams, by ore type



Source: Global Tailings Review, Towards Zero Harm

[13] "A Comprehensive Review on Reasons for Tailings Dam Failures Based on Case History", Advances in Civil Engineering (2019)
[14] https://www.thechemicalengineer.com/news/brazil-bans-upstream-dams (The Chemical Engineer, August 2020); http://www.vancouversun.com/technology/expert+panel+investigating+mount+polley+tailings+collapse+receives+submissions/10706760/story.html

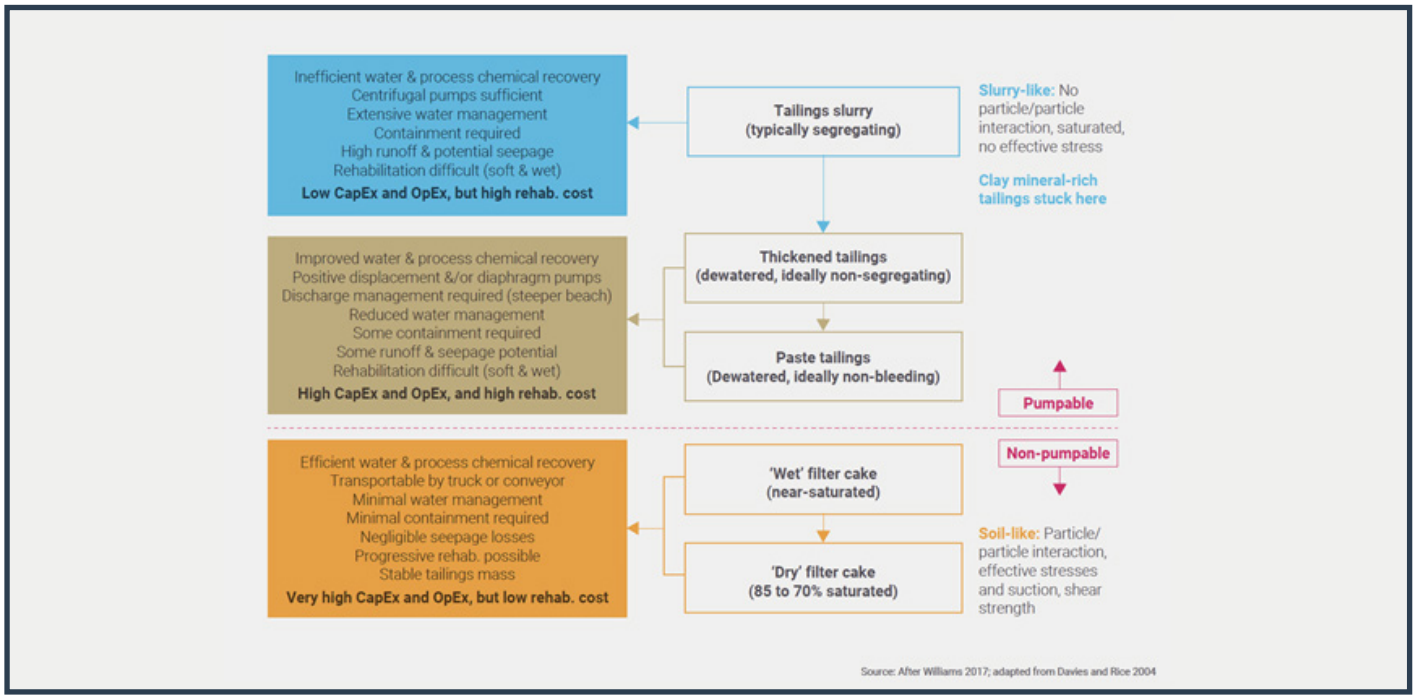
Life stages of a tailings facility

In many cases, TSFs are in a continual state of construction as their embankments are raised to store the continuous inflow of tailings. The condition of a facility is thus continually changing, and so its safety must be continually evaluated. Unlike core mining operations, TSFs produce no revenue, and this may be one reason that historically tailings management operations have been outsourced by mining companies. Such practices may increase the risk that TSF do not receive the full attention and scrutiny of management to ensure safe stewardship of these assets.

Key life stages of a tailings facility include the following:

- Design & Construction. Companies need to carefully consider a range of engineering elements including soil mechanics (pore pressure, mobilized sheer strengths); geology (stratigraphy, geomorphology, hydrogeology); and hydrology (precipitation).
- Maintenance. This involves constant monitoring of the stability and viability of the structures as they grow. A well-resourced inspection programme, staffed by qualified personnel, is essential for ensuring compliance with legal requirements, including permit or licence conditions.
- Closure. Once a tailings facility is retired from use, the tailings and structure may remain for many years. Closure and planning for post-mining land use should be developed with community input. Issues such as tailings stability and water quality should be monitored carefully over the long term. The extent to which rehabilitation is possible is a function in part of the nature of the tailings being stored (FIgure 5).

FIGURE 5
Different types of tailings and associated cost profiles



Source: Global Tailings Review, Towards Zero Harm

What causes tailings dams to fail?

Although tailings structures can fail for a variety of reasons, two major trigger events are earthquakes and extreme rainfall, and it is worth noting that the latter risk is being exacerbated by climate change as storms become more severe globally. There are three general types of TSF failure :

- **Overtopping.** If the spillway is insufficient to store excess water -- e.g. during extreme storms -- water spills over the facility perimeter, causing erosion and breach.

- **Foundation failure.** This occurs when the soil and/or rock beneath the tailings facility is not strong enough to bear the stresses from the overlying embankment. Tailings can "liquefy" under certain conditions such as seismic activity or static loading, compromising stability.

- **Piping.** Seepage through the embankment or the foundation of the dam can lead to erosion, rupture and discharge.

New technologies

There have been advances in some mining technologies that offer the prospects of reducing tailings footprints and risk. Drystack tailings, or filtered tailings, involve removal of water content from the mining waste, rendering them more stable. Drystack tailings have a much better safety record and lower reclamation costs, as noted in Figure 5, but require a higher initial investment.

A technology with the potential to reduce tailings footprint is In-Situ Leaching (ISL). Under this process, chemical solvents are injected into an ore body, dissolving minerals underground which are then pumped to the surface. This can allow for mineral extraction without physical mining of the rock, reducing or even eliminating the need for tailings. This technique has the benefit of being less environmentally invasive in many respects, but brings a separate set of concerns related to groundwater contamination.

Another noteworthy approach to tailings management goes by the name of "Designer Tailings". This framework seeks to predict the likely nature of tailings generated by a mining operation and the potential environmental liabilities as well as opportunities for reuse, recycling and reprocessing. This life-cycle approach to tailings management has the potential of decreasing the environmental footprint over the full life of the tailings operation.

National regulation and classification standards

Laws and regulations governing TSFs are a local matter and vary significantly among countries. Key regulatory elements can include :

- **Permitting.** Tailings facilities are generally included in the permitting for the mine that they serve. Permit applications include environmental and social impact assessments, design basis reports, dam safety review process, emergency preparedness, maintenance and surveillance plans and closure plans.

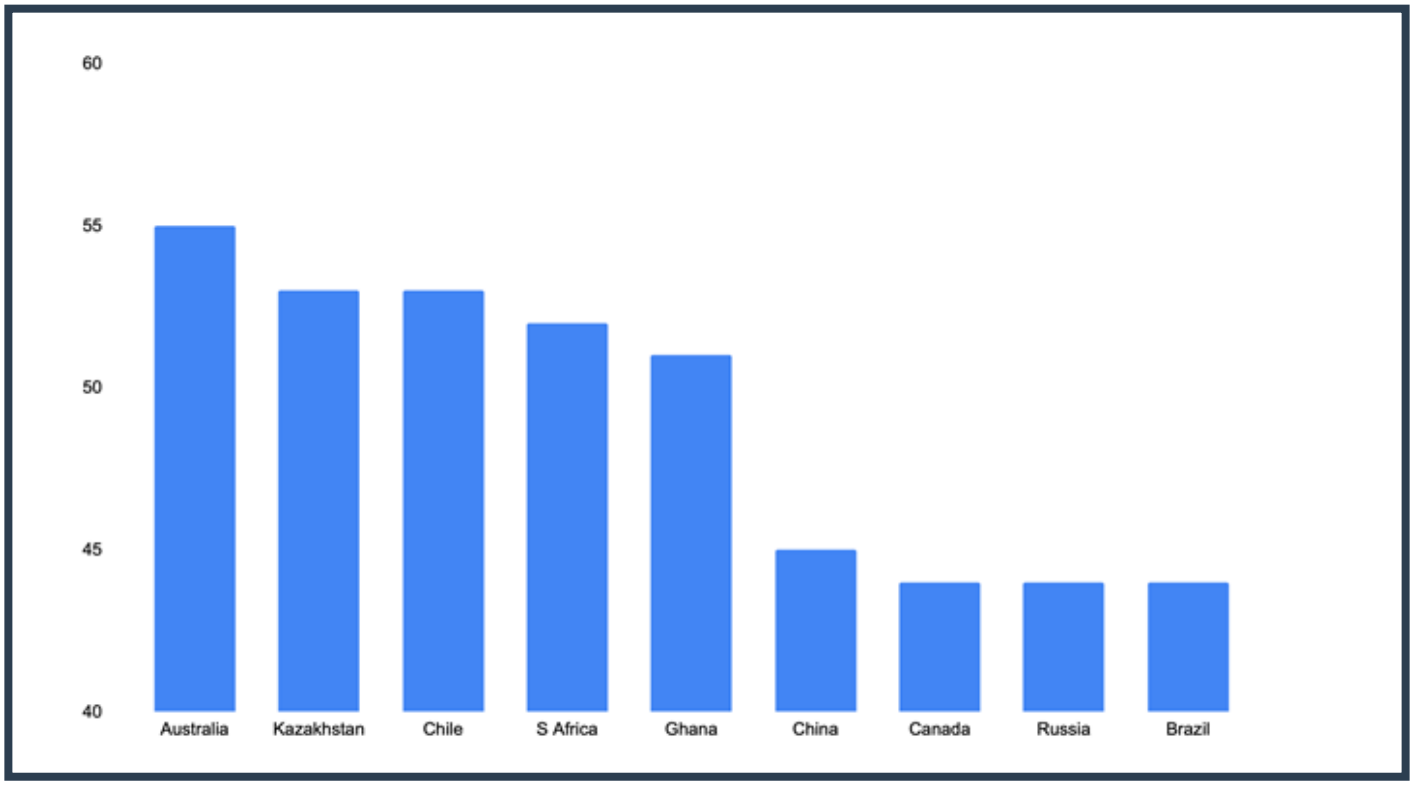
- **Monitoring.** Regulators monitor a range of metrics through reporting and inspection protocols.

[15] Towards Zero Harm, "The Role of Technology and Innovation in Improving Tailings Management",

- **Financial assurance.** Given the risk of abandonment of tailings facilities before closure and reclamation, regulators may require performance bonds or liability insurance to assure the costs will be met to maintain and wind down the facility over its full life.

One part of evaluating the strength of a company's approach to tailings management involves an assessment of the strength of the local regulatory framework. Chapter XIII of Towards Zero Harm offers a 15-point framework for evaluating the strength of local regulation in 9 countries -- 7 of which are emerging markets. In Figure 6, we have summed the scores across the 15 parameters to give a sense of the relative strength of these frameworks, although this should not be seen as a precise ranking. Among the EMs, Kazakhstan, Chile and South Africa come out strongest, while China, Russia and Brazil have considerably weaker regulatory scores.

FIGURE 6
Quality of local regulation scores (higher = better)



Source: Towards Zero Harm, "Comparative Analysis of Tailings-related Legislation in Key Mining Jurisdictions"

[16] For a full description of regulatory frameworks see Towards Zero Harm, "The Role of the State"

04–POST-BRUMADINHO REFORMS: THE INITIATIVE AND THE NEW STANDARD

Despite a string of dozens of tailings accidents in recent decades, some bringing significant damage, it took the Brumadinho disaster to provoke a new level of concern and action to address tailings risks. This led to a renewed push for reform in tailings management and disclosure.

Investor Initiative

Swiftly following the Brumadinho disaster, the Church of England Pensions Board and the Council on Ethics of the Swedish National Pension Funds convened a new group called the Investor Mining and Tailings Safety Initiative (the "Initiative') in late January 2019. The Initiative eventually grew to include well over 100 international investors representing over $14 trillion in assets under management. A range of stakeholders participated in the Initiative's activities, including mining company representatives, technical advisors, government representatives and representatives of the communities impacted by the disaster in Brumadinho.

The focus of the Initiative was to improve understanding of tailings dam risks, increase the extent and quality of disclosure, and encourage best practice and standards in the management of mine tailings. Over the course of 2019 and early 2020, the Initiative hosted a number of investor roundtables as well as a Global Tailings Summit focused on broadening the understanding of tailings issues among the investors community.

The Initiative also spearheaded the creation of the first comprehensive database of tailings facilities, the Global Tailings Portal or GTP (https://tailing.grida.no), maintained by GRID-Ardenal, a non-profit environmental communications centre based in Norway. Below we take a closer look at this database.

The Global Tailings Review

Following Brumadinho and the Investor Initiative's call for a new industry tailings standard, the International Council on Metals & Mining (ICMM) launched the Global Tailings Review (GTR) in March 2019. ICMM is an industry group composed of 27 of

the world's largest miners, and the review was convened together with the Principles for Responsible Investment (PRI) and the United Nations Environment Program (UNEP). The Swiss biologist and environmental scientist Bruno Oberle served as Chair.

The GTR drew on the input of a multi-stakeholder advisory group (assembled by the co-conveners) and an expert panel (selected by the chair), representing a range of scientific and operational expertise. Following 18 months of preparation, the GTR published an initial draft of the new Standard in late 2019, and the final version in August 2020. Although this timeline fell short of the GTR's initial goal of publishing a new standard within 1 year from the Brumhadino disaster, it nevertheless represents a notable achievement given the large number of participants in the creation of the document and the challenges of completing the working following the onset of the covid pandemic.

The Global Industry Standard on Tailings Management

The Standard is directed at operators -- defined as any entity exercising ultimate control of a tailings facility -- and is organised around 6 topic areas, including 15 principles and 77 specific requirements. The topic areas are as follows:

1. **People.** Due diligence should identify and address communities and rights that are most at risk from a tailings facility. Project affected people must be afforded opportunities for meaningful engagement in decisions that affect them.

2. **Operators.** Operators should develop knowledge about the social, environmental and local economic context of a proposed or existing tailings facility, and as part of this, to conduct a detailed site characterisation.

3. **Performance.** Performance standards should be raised for designing, constructing, operating, maintaining, monitoring, and closing tailings facilities. Operators should be able to upgrade a facility or reduce the consequences of a potential failure. A comprehensive monitoring system and performance-based approach must be taken for the design, construction and operation of tailings facilities.

4. **Management and governance.** This requires the assignment of responsibility to key roles. critical systems and processes, such as the Tailings Management System, as well as independent reviews, which are essential to upholding the integrity of a tailings facility throughout its lifecycle

5 **Preparedness.** Operators should plan ahead, build capacity and work collaboratively with other parties, in particular communities, to prepare for the unlikely case of a failure.

6 **Disclosure.** Public disclosure of information about tailings facilities is required, as is transparency and participation in global initiatives to create standardised, independent, industry-wide and publicly accessible information about tailings facilities.

Limits to the Standard's scope

Early on, the GTR took the decision to limit the scope of the standard. In particular, the Standard did not include the following:

- **Detailed technical design criteria for tailings facilities**
- **Exclusion or banning of any technologies**
- **The addressing of riverine, deep sea and non-tailings related storage facilities**
- **Coverage of standards for rehabilitation of affected areas**

These limitations have been the basis of some criticism of the Standard, noted below.

Other GTR documents

Alongside the Standard, the GTR also published a pair of accompanying documents:

- **Towards Zero Harm.** This compendium of 19 research papers provides a wealth of supporting information about tailings from a range of perspectives, several of which inform this Brief
- **A Consultation Report,** providing an in depth review of the consultations around the Draft Standard. Produced by Traverse (formerly OPM Group), an environment-focused engagement and consultation practice, the report provides details of the feedback that was received on each of the 17 principles as well as some overall takeaways on the Standard.

How will the Standard be implemented?

A key question is how the Standard will be incorporated into mining management -- and thus play a role in reducing the number and severity of tailings failures. In a chapter in Towards Zero Harm, the GTR Chair postulates several alternatives for implementation, ranging from purely voluntary guidance to local regulation to establishing an international regulatory body:

- **Global guidance:** It could be "left to individual organisations to determine how they wish to use the Standard. An example of this approach would be the UNEP's well-established Awareness and Preparedness for Emergencies at Local Level (APELL) programme."

- **Industry self-regulation:** Industry organisations such as the ICMM could "agree to formally adopt the Standard and make it a requirement." This has in fact been done. Another example of this approach would be the Mining Association of Canada's Towards Sustainable Mining scheme.

- **State-based regulation:** Countries or jurisdictions could "undertake to require or promote implementation through legislation, regulations, guidelines or other regulatory mechanisms"

- **Third-party regulation:** Other economic actors such as banks, insurers and investment funds could "make compliance with the Standard a condition for investing in a company, approving loans for projects, providing insurance for tailings facilities, and so on."

- **Independent entity:** An independent entity could be "established to host the Standard, test conformance, and report assessment outcomes in the public domain.

The Standard states that certain tailings-related issues -- such as the restoration of abandoned or facilities -- are more effectively dealt with through local regulations.

05–REACTIONS TO THE STANDARD / OTHER FRAMEWORKS

The **Emerging Markets Investors Alliance** organized a discussion on the Standard with members of its Extractive Industries working group, and the following points were noted:

* **Generally positive feedback on the Standard.** From an emerging markets perspective, where disclosure and management standards are generally weaker, it is important to have a comprehensive framework that can apply to all miners. The **rapid development** of the standard following Brumadinho was also noted.

* The process was seen by many as being **relatively open and balanced** between a range of stakeholders. Not all agreed with this, however, and some argued that the leading role of ICMM resulted in a standard that was more limited in scope than it might have been. Others countered that ICMM's involvement was necessary in ensuring a standard that would ultimately be adopted by key industry players.

* It was noted positively that the Standard applies to **non-operators** as well as operators.

* Some raised concerns over **how this Standard will be ultimately implemented and enforced.** In particular, some expressed concern over the willingness and ability of smaller miners to comply with the Standard.

Earthworks, a nonprofit organization focused on sustainable mineral and energy development that has developed its own set of recommendations and around tailings management (Safety First), has expressed its disappointment with some aspects of the Standard. The organization published a Scorecard that compares aspects of the Standard with Safety First, highlighting a number of shortcomings:

Earthworks reaction to Standard

- **Overly limited in scope.** Most of Earthworks' concerns relate to the limited scope of the Standard, noted above, which was established early on in the GTR process.
- **No mention of need to reduce mining waste.** Earthworks noted that declining ore grades has led to a rising quantity of mining waste and that it is important for mining companies to minimize waste through efficiency, reducing the need for TSFs.
- **No ban on upstream dams.** In particular, Earthworks has argued for an outright dam on upstream facilities given their poor safety record.
- **No support for drystack/filtered tailings.** Drystack tailings involve removal of water content, rendering them significantly more stable. These should be encouraged explicitly as a favored technology, argues Earthworks, despite the higher capital costs.
- **No addressing of aqueous dumping.** The Standard does not recommend a ban on aqueous dumping, in which tailings are deposited directly into oceans, rivers or streams, an ecologically destructive practice.
- **No FPIC mandate.** As noted in our Issue Brief on Community Consent, the Free, Prior and Informed Consent (FPIC) process is seen as best practice for mining companies in dealing with indigenous and other local communities affected by mining. Although the Standard recommends that companies "work to obtain" consent for indigenous and tribal people, it stops short of requiring FPIC.
- **Weak on assurance/liability.** The Standard lacks strong provisions around financial assurance (bonding) and liability insurance. Specifically, it allows companies to self-bond and self-insure, which doesn't protect local governments and taxpayers from having to cover the cost of tailings dam pollution.

Other tailings standards and institutions

The Standard is the most recent in a series of frameworks that attempt to address tailings management. These include :

- **Mining Association of Canada (MAC).** MAC developed Management Protocol and Guide to the Management of Tailings Facilities, which it first published in 1998 and has updated in a 3rd edition in 2017, consistent *Towards Sustainable Mining,* the association's responsible mining framework.

- **International Conference on Mining and Metals (ICMM).** In its Tailings Governance Position Statement, ICMM produces some high level guidance on how mining companies should think about tailings management.

- **Initiative for Responsible Mining Assurance (IRMA).** In its *Standard for Responsible Mining* (2018), IRMA lays out recommendations for the management of mining waste that are generally in alignment with the MAC tailings standard. However in its standard, IRMA notes that the focus on tailings management may be overly restrictive given that other large mine waste facilities such as waste rock or heap leach facilities (which are used to process/extract metals from ores, but also end up as long-term waste sites) also pose environmental and safety threats.

- **Safety First: Guidelines for Responsible Mine Tailings Management.** As noted above, Earthworks and MiningWatch Canada, in collaboration with technical experts from the U.S. and Brazil, released 16 guidelines for tailings management in June of 2020. The Safety First Guidelines emphasize rigorous safety controls, community consent, and corporate accountability measures. The guidelines have been endorsed by over 150 organizations and experts from 24 countries.

- **Responsible Mining Foundation (RMF)**. In its Framework 2020, the RMF sets out a number of best practices in its topic on tailings management (F.02). The Framework asks companies to commit not to use aqueous disposal; to disclose full information on its TSFs; and to track and improve performance of its TSFs. Below we disclose how RMF rated emerging markets mining companies on these measures.

[17] Towards Zero Harm, "Summary of Existing Performance Standards for Tailings Management" compares and contrasts the first 3 of these with the new Standard

- **Sustainability Accounting Standards Board (SASB).** SASB launched a consultation to revise its mining disclosure standards to capture the risks associated with tailings risks. The revision could be implemented later this year.

06—ON THE LOOKOUT FOR TAILINGS RISK IN EM

How can investors in EM extractive companies assess their exposure to tailings risks? A first step is to examine the Global Tailings Portal (GTP) database (https://tailing.grida.no). As mentioned above, this database was created from the responses to questionnaires sent to mining companies by the Investor Mining and Tailings Safety Initiative in 2019.

The GTP provided us a copy of the database as of July 2020. As of mid-September, the GTP website states that it has data on 1745 tailings storage facilities at 748 mine sites, representing 266 mining companies. As of July, the dataset represented 87% of the market capitalisation of publicly listed companies in the industry, according to GTP.

The data in the GTP is sourced from the questionnaires sent by the Investor Mining and Tailings Safety Initiative. This consists of datapoints on each TSF including location, age, operating status, physical properties, hazard categorization, ownership, management and closure plans among others.

FIGURE 7:
Current data in Global Tailings Portal

Source: : Global Tailings Portal

This data allows us to assess both individual TSF data as well as to make some general comments on the distribution and features of tailings facilities globally. However there are a number of gaps in the data and cases where only some data has submitted, or in other cases no data has been submitted. Thus we would see any picture painted by this analysis as indicative. The GTP has informed us that the

data portal is about to undergo some changes following an update of the disclosure questions.

Most exposed countries

In Figure 8 we aggregate the GTP data by country to arrive at the following country-based sums of tailings facilities. In terms of total volume of tailings storage, the United States has the most TSFs, followed by Canada, Chile, South Africa, Australia, Brazil and Russia. It is interesting to note that Brazil, despite being home of 2 of the biggest tailings disasters, is only 6th in terms of global tailings volume, although it does have the second largest number of active facilities (130), after Australia. Emerging Market countries feature prominently on this list, with 7 of the top 10 and 15 of the top 20 countries being EMs.

FIGURE 8:
Countries with the most tailings facilities (EMs in bold)

		TSF STORAGE CAPACITY		NUMBER OF TSFS		AVERAGE
	COUNTRY	TOTAL	ACTIVE	TOTAL	ACTIVE	HAZARD*
1	USA	10,988	6,248	263	67	1.7
2	CANADA	5,748	3,451	227	91	1.8
3	**CHILE**	4,825	4,015	37	20	1.9
4	**SOUTH AFRICA**	4,799	2,961	212	106	1.4
5	AUSTRALIA	4,587	3,416	303	135	1.4
6	**BRAZIL**	3,858	1,961	260	130	1.5
7	**RUSSIA**	3,676	3,629	46	35	2.1
8	**PERU**	2,520	2,305	77	33	1.3
9	**ARGENTINA**	976	31	16	8	2.0
10	**KAZAKHSTAN**	688	573	20	16	1.8
11	SWEDEN	639	589	8	4	1.3
12	**POLAND**	634	634	1	1	1.0
13	**GHANA**	472	359	22	15	1.4
14	**MEXICO**	449	379	38	19	1.5
15	**BOTSWANA**	403	243	15	12	1.3
16	**ZAMBIA**	365	345	5	3	1.7
17	**EGYPT**	200	200	1	1	1.0
18	**SURINAME**	168	116	12	1	1.0
19	**TANZANIA**	145	143	5	4	1.0
20	NEW ZEALAND	132	37	8	2	1.5

Storage capacity is in mm3. Hazard score measures the potential impact of an accident, ranging from 1 (most risky) from 3 (least risky). Source: Global Tailings Portal

We have also calculated the average hazard score of each country -- the potential consequences if the facility were to fail -- by standardizing the reported hazard scores on a scale of 1 (most dangerous) to 3 (least). On this basis, Peru, South Africa, Brazil and Peru have tailings with higher risk, on average, from catestrophic dam failure.

Most exposed companies

Figure 9 lists the mining companies with the most tailings in storage, by volume, in the GTP database. Three of the top 10 are EM-based companies: Vale, Anglogold Ashanti and Evraz. Other EM companies with top tailings exposure include Severstal, Sibanye-Stillwater, Phosagro and Los Pelambres (Antofagasta).

FIGURE 9:
Mining companies with largest tailings exposure (EM companies in bold)

		TSF STORAGE CAPACITY		NUMBER OF TSFS		AVERAGE
		TOTAL	ACTIVE	TOTAL	ACTIVE	HAZARD*
1	Freeport McMoran	4,852	3,680	77	18	1.3
2	Rio Tinto	3,580	1,177	77	34	2.1
3	BHP	2,853	1,344	76	15	1.6
4	Anglo American	2,222	1,731	110	52	2.1
5	**Vale**	1,827	943	86	41	1.4
6	Teck	1,692	1,405	38	9	1.5
7	Newmont	1,379	952	71	20	1.6
8	**AngloGold Ashanti**	1,162	670	33	14	1.2
9	ArcelorMittal	1,073	1,024	19	14	1.4
10	**Evraz**	1,070	1,039	6	3	1.7
11	Kinross Gold Corporation	1,002	478	14	9	1.1
12	**Severstal**	937	937	5	5	2.0
13	Hibbing Taconite Company	846	846	1	1	2.0
14	**Sibanye-Stillwater**	754	509	23	18	1.2
15	Lundin Mining	739	722	12	7	1.8
16	**Phosagro PJSC**	734	734	2	2	1.0
17	Xstrata plc	701	-	9	-	1.7
18	Boliden	697	659	10	7	1.0
19	**Minera Los Pelambres S.A.**	692	692	2	2	1.0
20	Nevada Gold Mines	638	496	23	8	1.9

Storage capacity is in mm3. Hazard score measures the potential impact of an accident, ranging from 1 (most risky) from 3 (least risky). Source: Global Tailings Portal

Largest individual tailings facilities

We list the largest individual tailings facilities globally. The largest TSF in the database is Rio Tinto's Kennecott tailings in Magma, Utah, which entered service in 1906 and was only retired in the late 1990s having accumulated nearly 1500mm3 of waste. Earlier this year, the company reported a 5.7-magnitude earthquake in the area, which caused it to suspend mining operations at Kennecott, although the company stated that its mammoth TSF remained in stable condition. Nevertheless, this event serves as a reminder that legacy risks remain to this and many other TSFs that have been closed.

Although most of 10 largest facilities are in the US and Canada, a number of of EM TSFs make the top 20, led by Evraz's KGOK, KGHM's Zelazny Most, Severstal's Karelsky Okatysh and TSFs at Impala Platinum's Rustenburg mine.

FIGURE 10:
Largest tailings facilities globally (EMs in bold)

	Company	Mine	Year of Constr	Storage	Status	Hazard Reported	Reclass
1	Rio Tinto	Kennecott	1906	1,562	Inactive	High	High (1)
2	Teck	Highland Valley Copper	1977	1,190	Active	Extreme	High (1)
3	Freeport McMoran	Sierrita	1970	1,083	Active	Extreme	High (1)
4	**JSC "EVRAZ KGOK"**	KGOK	1966	939	Active	Very high	High (1)
5	Hibbing Taconite Company	Hibbing Taconite	1974	846	Active	Moderate	Medium (2
6	ArcelorMittal Mining Canada GP	Mont Wright TSF	1981	725	Active	Very High	High (1)
7	Freeport McMoran	Bagdad	1985	653	Active	Very High	High (1)
8	**KGHM Polska Miedz S.A.**	Zelazny Most Reservoir	1977	634	Active	Category A	High (1)
9	Rio Tinto	McGill	1900	634	Closed	Low	Low (3)
10	Rio Tinto	Kennecott	1999	632	Active	Moderate	Medium (2
11	**Severstal**	Karelsky Okatysh	1982	578	Active	Class 2	Medium (2
12	Boliden	Aitik	1968	550	Active	Category A	High (1)
13	**Impala Platinum limited**	Impala Rustenburg	1978	546	Active	High	High (1)
14	BHP	Escondida	2002	498	Active	Very High	High (1)
15	Ergo Mining (Pty) Ltd		1978	483	Active	High	High (1)
16	**Phosagro PJSC**	ANBP	1963	482	Active	Hazard class I	High (1)
17	Anglo American	Los Bronces	1994	480	Active	Major	High (1)
18	Anglo American	Collahuasi	2005	467	Active	Low	Low (3)
19	Xstrata plc	Minera Alumbrera	1998	450	Inactive	Very High	High (1)
20	**Minera Los Pelambres S.A.**	Los Pelambres	2009	419	Active	High	High (1)

Storage capacity is in mm3. Reported hazard uses the terminology used in the Investor Initiative questionnaire, which we standardize to our 1-3 scale in the adjacent column. Source: Global Tailings Portal

RMI Report 2020

Finally, we include a look at what the Responsible Mining Foundation's Responsible Mining Index (RMI) has to say about tailings risk. The RMI 2020 measures 38 mining companies, of which 22 are in emerging markets, on 43 topics grouped into 6 thematic areas.

FIGURE 5
Mining Companies included in the RMI 2020

DM	EM
Anglo American, ArcelorMittal, Barrick Gold Corp, BHP, ERG, First Quantum Minerals, Fortescue, Freeport-McMoRan, Glencore, MMG, Newcrest Mining, Newmont, Orano, Peabody Energy, Rio Tinto, Teck	AngloGold Ashanti, Antofagasta, Banpu, Buenaventura, Bumi Resources, China Shenhua Coal India, CODELCO, Evraz, Exxaro Resources, Gold Fields, Grupo México, Industrias Peñoles, Navoi MMC, NMDC, Nordgold, Polymetal, RUSAL, Sibanye-Stillwater, Vale, Vedanta Resources, Zijin

The Environmental Responsibility thematic area includes a topic on Tailings Management, which consists of 3 indicators:

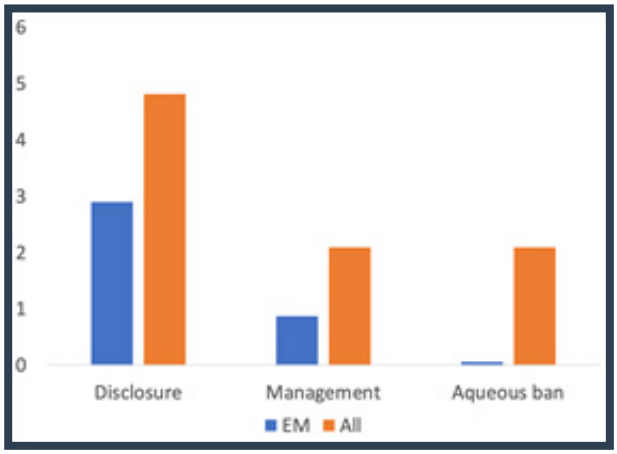
1. **"The company commits to not use riverine, lake or marine disposal of tailings."** ***(Commitment)***

2. **"Where applicable, the company publicly discloses information about the location and safety of all its tailings storage facilities."** ***(Action)***

3. **"Where applicable, the company tracks, reviews and acts to improve its performance on addressing potential risks related to its tailings facilities, including seepage and tailings dam failure."** ***(Effectiveness)***

We summarize RMI's scores for the emerging markets miners as a whole on these indicators, compared with the full RMI coverage universe. Clearly, the EM scores across all 3 tailings indicators are weaker than in the DM mining companies being measured.

FIGURE 11
Average score of EM mining companies on tailings in RMI



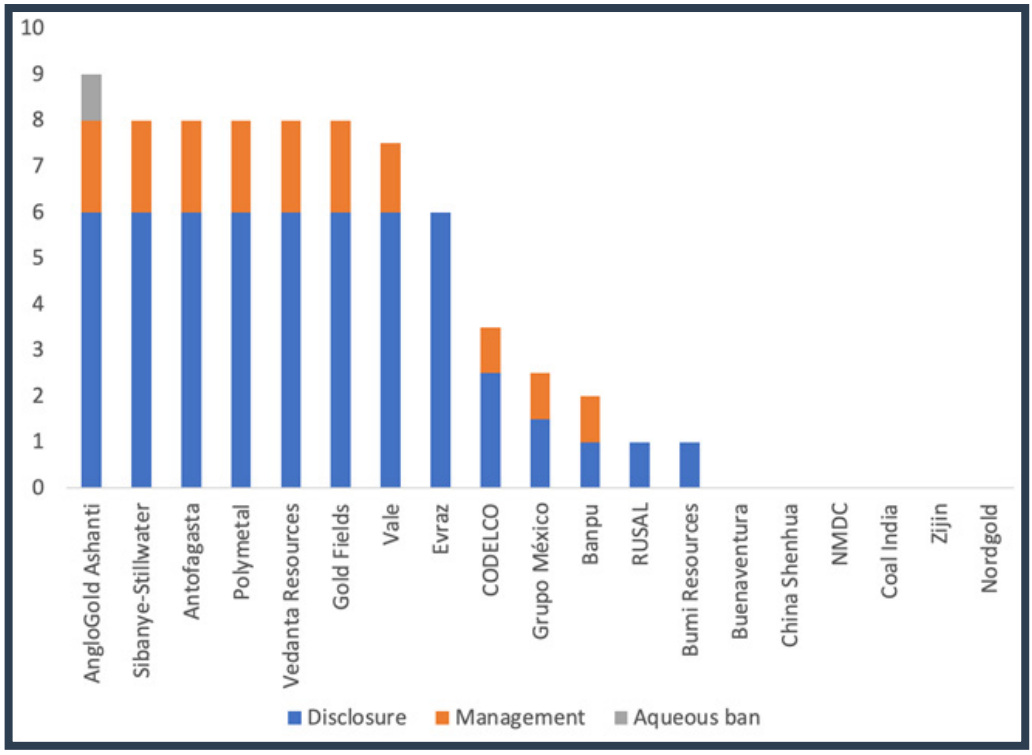
Source: Responsible Mining Foundation, RMI 2020

We also display the performance of the individual EM miners on the 3 tailings indicators. 8 miners score similarly well here: AngloGold Ashanti, Sibanye-Stillwater, Antofagasta, Polymetal, Vedanta, Gold Fields, Vale and Evraz. All score consistently well in terms of tailings disclosure, but less so in tracking and management of risks. And there is very little commitment being made on aqueous tailings disposal. Even these top EM companies scoring 8-9 fall well short of the maximum score of 18.

The remaining miners score considerably worse overall than these leaders, with 6 miners receiving a 0 across the board: Buenaventura, China Shenhua, NMDC, Coal India, Zijin and Nordgold.

FIGURE 12
Tailings Scores of EM Miners in RMI

Out of a maximum potential score of 18



Source: Responsible Mining Foundation, RMI 2020

07–HOW INVESTORS SHOULD ASSESS TAILINGS RISK

Putting together the above background information and company factors, we recommend that investors take the following steps when assessing an investment or portfolio of investments for tailings risk.

1. Assessing risk

As a first step, investors should attempt to assess the level of tailings risk in a company or portfolio.

1. Many mining companies, and some oil & gas companies, operate tailings facilities. This is particularly true for copper, gold, iron ore and phosphate producers. Absent contrary information, investors should assume an extractive company operates tailings facilities.

2. The Global Tailings Portal (https://tailing.grida.no) is a good first stop for evaluating company tailings exposure. However this database is still being developed and is not complete. Disclosures in a company's sustainability or integrated report can also be relevant.

3. According to the GTP, the following emerging markets companies have the most tailings by volume: Vale, Anglogold Ashanti, Evraz, Severstal, Sibanye-Stillwater, Phosagro, Antofagasta and KGHM. Investors in these companies should be particularly attuned to this issue.

4. Another source on the quality of tailings management and disclosure by global minings companies is the RMI Report 2020. The RMI gives strong ratings on disclosure to AngloGold Ashanti, Sibanye-Stillwater, Antofagasta, Polymetal, Vedanta, Gold Fields, Vale and Evraz. However these firms receive weaker scores on the tracking and management of tailings risks as well as actions to prevent aqueous tailings disposal. The remaining EM miners in the RMI score considerably worse overall, with 6 miners receiving a 0 across the board: Buenaventura, China Shenhua, NMDC, Coal India, Zijin and Nordgold.

5 Investors should be aware of the regulatory frameworks of the countries in which their companies operate. Companies operating TSFs in countries with weaker regulations deserve greater scrutiny. Research by the GTR rates Kazakhstan, Chile and South Africa as having relatively stronger regulatory frameworks, and China, Russia and Brazil as relatively weaker.

2. Engaging companies

Company disclosures on tailings may be insufficient, requiring investors to engage directly. When speaking with management, investors should use the opportunity to assess tailings risk head on and advocate for best practices and transparent disclosure.

1 Ascertain a company's commitment to the new Standard. If a company has committed to adopting it, determine over what time frame. If it has not made such a commitment, determine why not.

2 Ask companies to consider adoption of a more rigorous tailings framework, such as the recommendations in Safety First Guidelines.

3 Specific commitments to encourage: a ban on upstream TSF design; a ban on aqueous tailings release; limits to TSF density; appropriate financial assurance and public liability insurance.

4 Encourage consideration of technologies that reduce tailings footprints such as filtered tailings, in-situ leaching and designer tailings.

5 Advocate companies to commit to management of and disclosure on all mining waste, including waste rock or heap leach facilities, in addition to tailings.

6 Determine whether a company has disclosed full details of all TSFs to the Investor Mining and Tailings Safety Initiative and in its Sustainability or Integrated Report. If not, urge the company to do so.

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