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GUIDANCE FOR GOVERNMENTS

Environmental Management and Mining Governance

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Environmental management and mining governance

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The examples and case studies in this document present actual legislation and diverse experiences of stakeholders in environmental management in a wide range of jurisdictions. Presentation of legislation from a particular jurisdiction does not indicate endorsement of that jurisdiction's legislation or how it has been implemented or failed to be implemented in particular projects. However, it is useful to compare the various approaches around the world and to easily access actual language from legislation on a particular key topic. Likewise, presenting a case study from a particular jurisdiction does not indicate that the jurisdiction is managing all aspects of its mineral sector optimally. There is room for improvement in all jurisdictions; this guide provides opportunities to learn across different jurisdictions from different types of mining projects.

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The Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) supports more than 75 nations committed to leveraging mining for sustainable development to ensure negative impacts are limited and financial benefits are shared. It is devoted to optimizing the benefits of mining to achieve poverty reduction, inclusive growth, social development, and environmental stewardship.

The IGF is focused on improving resource governance and decision making by governments working in the sector. It provides a number of services to members including: in-country assessments; capacity-building and individualized technical assistance; and guidance documents and conferences which explore good international practices and provide an opportunity to engage with industry and civil society.

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PREFACE

At their 2019 Annual General Meeting, IGF member governments identified the need for guidance on environmental management practices and policies to help them better balance resource extraction with environmental protection. The health of natural resources and ecosystems underpins the health of communities and economies and must be protected and supported for any society to thrive in the long term.

IGF guidance documents are developed by the IGF Secretariat based on the IGF Mining Policy Framework (MPF) and good international practices. The MPF represents government approaches for managing the minerals sector in a manner that optimizes the sector's contributions to sustainable development.

Drawing from the MPF, this guidance document highlights the key issues, benchmarks, and standards in four main areas of environmental management in mining—water, biodiversity, waste, and emergency preparedness and response—and the role of governments in ensuring that each is effectively managed in support of sustainable development.

I am pleased to welcome this guidance, the latest in the IGF "guidance for governments" series of knowledge management products, and look forward to working with our members and other key stakeholders to make sure it is helpful to them in their critically important pursuit of greater sustainable development in mining.

Greg Radford

Director, Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development

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The biodiversity and emergency preparedness and response chapters were developed based on contributions from the following valued colleagues and collaborators:

- The Biodiversity Consultancy: Simon Furnell, Robin Mitchell, and Edward Pollard
- Safety Science Management Consulting: Robert Duda

This guidance document was revised based on input from IGF members and a wide range of other stakeholders, including participants in the following events:

- September 21–October 9, 2020: Governance for Extractive Industries (GOXI) online consultation, where IGF members and other stakeholders provided feedback and discussed issues surrounding the September 2020 *Guidance for Governments: Environmental Management and Mining Governance, Draft for Consultation*.
- January 19, 2021: IGF webinar (English), where IGF member representatives shared their challenges and provided feedback on the September 2020 draft guidance. Participants included representatives from Cambodia, Namibia, Nigeria, and Zambia.
- January 20, 2021: IGF webinar (French), where IGF member representatives shared their challenges and provided feedback on the September 2020 draft guidance. Participants included representatives from Chad, Guinea, Niger, and Senegal.
- January 21, 2021: IGF webinar (Spanish), where IGF member representatives shared their challenges and provided feedback on the September 2020 draft guidance. Participants included representatives from Argentina, Brazil, Chile, Colombia, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, Spain, and Uruguay.

The IGF also accepted comments on the publicly accessible September 2020 draft and executive summary of the guidance document through an open IGF webpage established for this purpose. These comments were accepted from September 2020 until publication of the final guidance document. IGF appreciates all comments received through the forums and webpage noted above.

We are grateful for the expert reviews and contributions of the International Council on Mining and Metals (ICMM), the International Union for Conservation of Nature (IUCN), the Mining Association of Canada (MAC), Natural Resources Canada (NRCan), and the United Nations Development Programme – Swedish Environmental Protection Agency (UNDP-SEPA).

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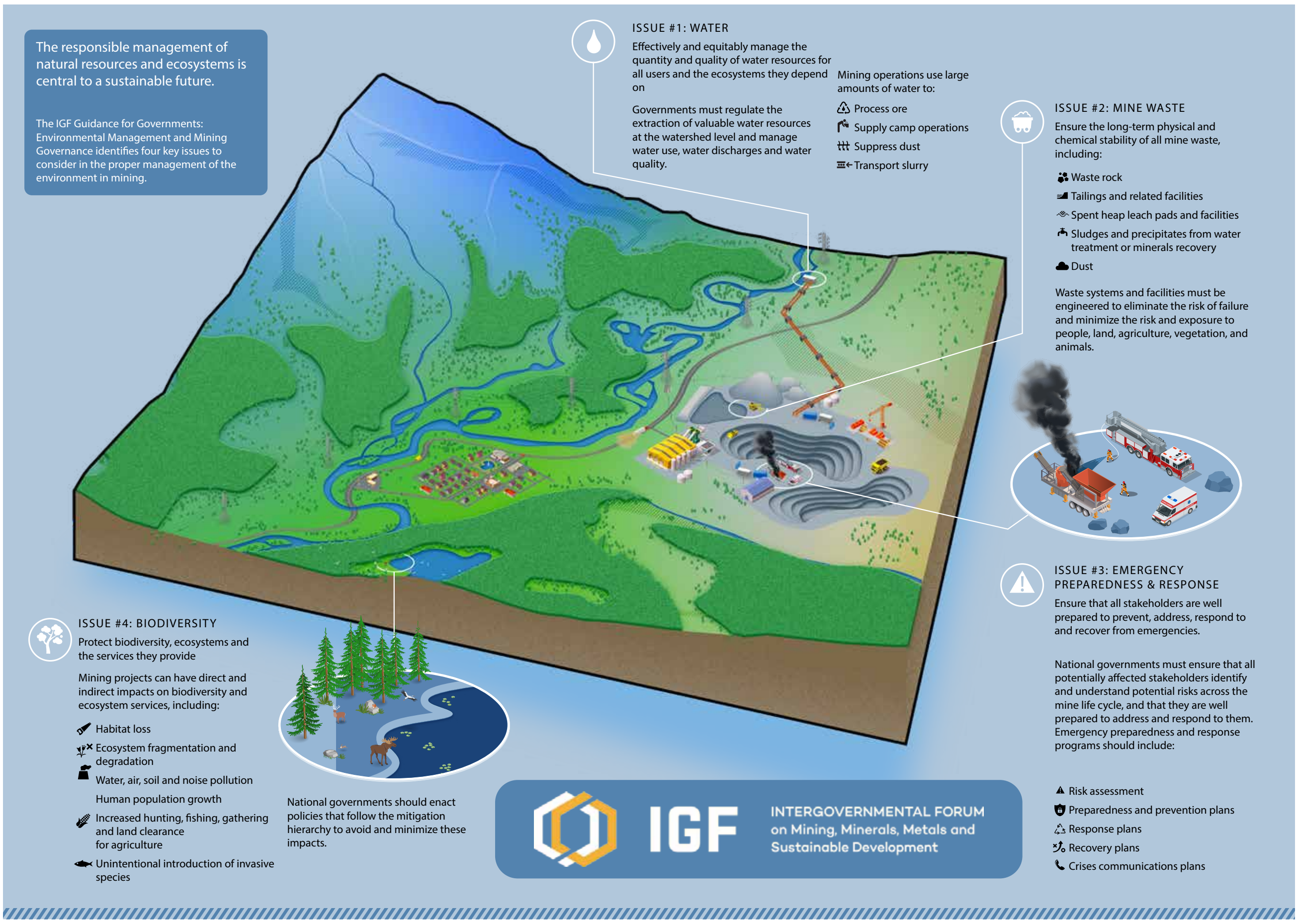
EXECUTIVE SUMMARY

FIGURE ES1. THE IMPORTANCE OF ENVIRONMENTAL MANAGEMENT IN MINING



THE IMPORTANCE OF ENVIRONMENTAL MANAGEMENT IN MINING

The responsible management of natural resources and ecosystems—including soils, plants, animals, water and air, and the services they provide—is central to the efforts of any society seeking to become more sustainable. The health of these resources, ecosystems, and services underpins the health of communities and economies and must be protected and supported for any society to thrive in the long term.

In this context, mineable deposits appear in locations both convenient and inconvenient. They can be close to or distant from human settlements and water sources; they can be surrounded by arable lands, breeding grounds, migration corridors, and ecologically sensitive areas; and they can be in remote areas prone to fierce storms, unstable hillsides, and seismic activity. Mining these deposits will always impact the environment and communities to a greater or lesser extent. The active and sustainable management of ecosystems and natural resources before, during, and after mining will help avoid negative impacts where possible (which may mean excluding mining in certain cases) and can minimize them elsewhere, remediate as necessary, and improve when feasible. Conversely, a failure to effectively manage the impacts of mining can not only threaten the continued viability of operations but can also undermine the relationships between a mining company, affected communities, and all levels of government.

This guidance document is designed to help Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) member states implement the IGF Mining Policy Framework (MPF). The use of the word "governance" in this document refers to the programs and regulatory tools at the disposal of governments to influence mining but excludes corporate governance unless specified as such. It focuses on the role that governments can play in ensuring the effective and sustainable management of the environment and natural resources by the mining sector using the legislative, regulatory, and policy tools and mechanisms at their disposal, including, in particular, environmental and social impact assessments (ESIAs) and environmental and social management plans (ESMPs). The guidance spans the mine life cycle, looking at what governments must do before, during, and after mining to ensure that the environment and its natural resources are continuously well managed. Drawing from the MPF, it highlights the key issues, benchmarks, and standards in four main areas of environmental management in mining—water, biodiversity, waste, and emergency preparedness and response—and the role of governments in ensuring that each is effectively managed in support of sustainable development. The topic chapters each provide an overview of the topic linked to the IGF's MPF; explore the key issues that governments, communities, and companies are grappling with; present the good international practices that are currently applied to that issue; and discuss the role that governments can play in ensuring strong environmental management.

WATER MANAGEMENT

The overall objective of a government's approach to water management is to protect the availability and quality of water for its population and its ecosystems, now and for future generations. This requires balancing competing demands for water among a number of users while ensuring access to safe drinking water and sanitation. Within a mining context, governments must not only govern the extraction of valuable water resources but must also oversee water use, water discharges, and water quality. The advantage of governments doing this is that they can manage water at the watershed level and the regional scale, where it is easier to affect the changes needed to meet sustainability goals.

Broadly, the MPF requires that governments manage the water issues associated with mining by:

- *Having appropriate environmental management standards in place for the use of surface and groundwater. These standards must be strictly monitored, and have appropriate penalties should they be compromised;*
- *Requiring that mining entities ensure that the quality and quantity of mine effluent streams discharged to the environment—including stormwater, leach pad drainage,*

process effluents, and mine works drainage—are managed and treated to meet established effluent discharge guideline values;

- *Requiring that mining entities ensure that water-leaching or percolating waste dumps, tailings storage areas, and leach pads have equivalent protection; and*
- *Requiring that mining entities have in place practices and plans that minimize the likelihood of impacts beyond the mining site, particularly potential transboundary impacts.* (IGF, 2013, p. 36)

It is important for governments to have an overall understanding of the potential water management risks and issues present in their mining sectors and to obtain expert advice and assistance as and where needed for effective control and governance through all mine phases. This includes water management in the post-mining transition if and when the responsibility for long-term management may revert to government. Using a risk-based framework that considers risks, their likelihood, and their consequences to determine water management priorities is typically a good place to start, given the broad range of risks that can arise around water management in the mining sector.

Drawing on international standards and practices, there are a number of key actions that governments can take to effectively manage water resources around mining:

1. Develop water management policies and programs at the watershed level.
2. Set mine effluent criteria and receiving water objectives based on site-specific conditions.
3. Through the ESIA review and mine permitting process, review the plans and set conditions for water use and discharges.
4. Through the ESIA review and mine permitting process, review and approve mine water management plans.
5. During construction, operation, and closure, track mine water management performance.
6. During construction, operation, and closure, enforce compliance to protect water resources.

BIODIVERSITY

When not properly planned, activities across the mine life cycle—from exploration through the post-mining transition—can have significant direct, indirect, and cumulative impacts on the natural world. From land-use change and deforestation to pollution, greenhouse gas emissions, and the unintended introduction of invasive species, there are many ways in which mining operations can influence local and national biodiversity and ecosystem services. Many of the impacts of mining on biodiversity are unavoidable but can be minimized and mitigated with good planning, and residual impacts may have to be addressed via actions in another landscape away from the mine location.

As such, communities and governments must balance their development priorities with their conservation needs. However, through collaborative planning, implementation, and monitoring and evaluation, these stakeholders can work with mining companies to ensure that economic value is generated with no net loss to biodiversity. In the best-case scenario, when properly planned and implemented, mining activities could even lead to a net gain for nature over the life of the mine.

Conserving and protecting biodiversity and ecosystem services have grown in importance for both governments and mining companies, in recognition of the role that biodiversity can play in supporting economies and operations and in maintaining the physical and mental well-being of surrounding individuals and communities, particularly those that more heavily rely on these services, including women and Indigenous groups. In response, companies are increasingly working with partners to find ways that they can avoid, minimize, and restore any negative impacts their activities have on biodiversity and offset those residual impacts that cannot be avoided.

Governments have a strong role to play here as well. Through their legal and policy frameworks, the MPF requires governments to avoid and minimize potential adverse effects of mining on biodiversity by:

- *Requiring that mining entities submit environmental management programs and updates for approval prior to permitting and whenever there are significant process or operational changes during the operating life of the mine;*
- *Identifying, monitoring, and addressing potential and actual risks to and impacts on biodiversity throughout the mining cycle; and*
- *Requiring that mining entities conduct monitoring on a continuous basis based on national standards and the conditions of the operating permit, compile and submit performance assessments to government, and publish regular reports that are readily accessible to the public.* (IGF, 2013, p. 36)

As a result of the close relationship between ore bodies and site-specific environmental conditions, and in order to maintain good relationships with mine-adjacent communities, companies should design, build, operate, and close their mines in a way that results in no net loss to biodiversity over the life of the mine, or—more positively—results in a net positive impact on biodiversity over time. One useful framework for achieving this is the mitigation hierarchy, which helps guide companies in reducing the significant negative impacts of their operations on priority biodiversity. It is based on the iterative application throughout the project's life cycle of four sequential steps: the preventive steps of avoidance and minimization and the remediating steps of rehabilitation/restoration and offsetting.

When considering the merits of a proposed mining project, governments will have to weigh the economic and development needs of the country and the local community against its conservation and environmental goals in a way that accounts for the needs and expectations of different stakeholders, including Indigenous communities, women, and children. However, active collaboration on biodiversity management and protection among governments, companies, and local communities is increasingly seen as a win–win–win. Governments can follow certain good international practices as they move toward improving the protection of biodiversity and ecosystem services:

1. Develop and adopt a national policy on biodiversity.
2. Integrate biodiversity considerations—including the mitigation hierarchy—into their national legislation and regulations, including requirements for ESIAs and ESMPs.
3. Establish and maintain adequate institutions for biodiversity protection.
4. Provide clear guidelines to the mining sector on biodiversity management, including offsets.
5. Establish mechanisms, platforms, and requirements for sharing information on biodiversity and ecosystems, as well as for reporting on how companies are implementing their biodiversity commitments.
6. Allocate adequate funding to support the implementation of their biodiversity policy and enforcement of their legal and regulatory requirements on biodiversity.

MINE WASTE MANAGEMENT

Mining typically moves and processes large amounts of materials to extract the target commodity, and during these processes, it produces excess materials known as mine waste. This waste can include waste rock, tailings, dissolving solutions from heap leaching, precipitates from water treatment and chemical recovery processes, and dust. Mine wastes can have some mineralization that is reactive or that could be released from the rock when it is mined, crushed, and exposed to air and water. If combined with process chemicals in the extraction process, there are risks of mining wastes releasing high concentrations of constituents that can be harmful in the receiving environment. In addition, large volumes of non-mineralized materials and excess materials from mineral processing need to be stored in perpetuity in manufactured structures, such as tailings facilities, that may have physical stability risks.

Waste management often extends well beyond mining operations into the post-mining transition, and the combination of the scale, duration, and magnitude of risk associated with mine waste, alongside recent high-profile accidents around tailings facilities, mean that applying a high standard to its management is of utmost importance to companies, communities, and governments.

Given the potentially significant impacts of poor management of mine waste, governments have a central role to play in ensuring that these by-products of the mining sector are managed effectively. The MPF requires that governments manage mining wastes by:

- *Ensuring that structures such as waste dumps and tailings storage facilities are planned, designed, and operated such that geotechnical risks and environmental* *impacts are appropriately assessed and managed throughout the entire mine cycle and after mine closure;*

- *Requiring that mining entities design, operate, and maintain mine waste structures according to internationally recognized standards; and*
- *Requiring that mining entities commission independent expert reviews and report to governments prior to development approval, when changes in design are proposed, and at regular intervals during the operating phase.* (IGF, 2013, p. 37)

The overall objective of mine waste management is to ensure the long-term physical and chemical stability of all mine waste management facilities. Achieving this objective will protect communities and their water resources and ecosystems while still supporting the mining needed in many areas to promote local economic prosperity.

As with many aspects of environmental management in mining, waste management should follow a risk-based framework to determine priorities. Waste management in mining is complex and incorporates a range of disciplines, including geology, geochemistry, civil engineering, and geotechnical engineering. In addition, engineered facilities need to incorporate site-specific design criteria for seismic conditions, local climate, and to accommodate climate change scenarios. It is important for governments to have an overall understanding of the potential issues and what affects them and to obtain expert advice and assistance where and as needed for effective control and governance through all mine phases. This includes once mining has finished and the mine has been closed if and when the responsibility for long-term management of facilities may revert to government. Climatic conditions and the impact of climate change on engineered structures and their systems also need to be considered when contemplating various operating and post-mining transition and closure conditions.

There are key actions that governments should take to ensure the effective and safe management of mine waste. Specifically, governments should:

1. Develop mine waste management standards based on site-specific risk prior to mine permitting.
2. Set quality requirements for tailings facility stability and establish requirements for independent tailings review panels based on site-specific risk.
3. Require accountability to reinforce good corporate management.
4. Through the ESIA review and mine permitting process, review and approve the mine waste management plans.
5. Consider financial mechanisms to manage facility risks in the long term.
6. During construction, operation, and closure, track mine waste management performance.
7. During construction, operation, and closure, enforce compliance to protect land and water resources, as well as worker and community safety.

EMERGENCY PREPAREDNESS AND RESPONSE

Emergency preparedness, management, communications, response, and recovery are increasingly important in the mining sector. Emergencies, including both internal mine site accidents and external natural and social hazards, can affect operations, workers, and communities, and the impacts can extend well beyond the boundaries of a mine to the communities, rivers, wetlands, farms, and infrastructure that surround the site. Emergency events can also affect operations and communities across the mine life cycle, with the risks extending from construction and operations through mine closure and the post-mining phase.

Working with companies, communities, and all levels of relevant authorities, governments must ensure that all potentially affected stakeholders identify and understand potential emergency situations across the mine life cycle and that they are well prepared to address and respond to them. This includes the development and communication of a government's emergency preparedness and response plan, one that is coordinated with mining entities and other affected stakeholders. It must include working with those stakeholders who are most vulnerable to such emergencies, which can include women and girls, Indigenous communities, persons with disabilities, and those belonging to ethnic minorities.

A strong culture of safety starts from the top of an organization, whether it be a government or a mining company. For a country, this culture starts with the government setting a strong example of safe practices and establishing expectations for safety throughout its legal framework. Emergency preparedness and response for mining are not just about what the mining companies put in place; they must be extensions of the regional and national emergency preparedness and response network. Putting in place a strong national culture of safety will not only support community health and well-being, but it will also will help attract mining companies and investors, as it reduces their risks and liabilities and helps protect their staff and assets.

Preparing for emergencies through formal programs—whether within a mining company, government, or community—is above all else about prevention and about working to protect populations and ecosystems. A series of high-profile accidents in the sector, including the Brumadinho tailings dam failure in Brazil and the jade mine collapse in Myanmar, combined with the increasing impacts of a changing climate have underscored the need for national and local governments, mining companies, workers, and communities to work together to identify possible risks and develop, test, implement, and improve emergency preparedness before, during, and after mining.

To this end, governments must work with companies and communities to ensure that all potentially affected stakeholders identify and understand potential emergency situations, that they communicate their efforts, and that these efforts lead to stronger recovery. Specific attention should be paid to ensure that stakeholders with limited access to decision-making mechanisms, particularly women, are equally included in this process. Governments should require that mining companies operating in their jurisdiction develop and implement an emergency preparedness and response program, which, as stated in the MPF, should include:

- *Requiring all mining operations to have an emergency preparedness and response program in place prior to commencement of operations, and ensuring that the program be reviewed, tested and updated on a regular basis;*
- *Basing all elements of the emergency preparedness program on ongoing, inclusive consultation and cooperation with local communities, government, and other relevant stakeholders.*
- *Ensuring that monitoring of the effectiveness and responsiveness of the emergency preparedness program is conducted by companies in cooperation with communities and all levels of government.* (IGF, 2013, p. 37)

There are key actions that governments should take to ensure that they, mining entities, communities, and other stakeholders are well prepared to manage, respond to, and recover from emergency situations. Specifically, governments should:

1. Ensure companies develop comprehensive emergency preparedness and response plans grounded in risk assessment prior to the granting of mining permits. The plans should include five principal components: risk assessment; prevention and preparedness; response plans; recovery plans; and crisis communication plans.
2. Require that the development, implementation, testing, and monitoring of emergency preparedness and response plans are consultative, inclusive, and reflective of the risks borne by the most vulnerable stakeholders, including women, children, and Indigenous Peoples.
3. Necessitate that companies regularly test, review, and update emergency preparedness and response plans to reflect the changing context.

GAP ANALYSIS

In order to implement the MPF's guidance on environmental management, there are several things that governments must do before, during, and after mining to ensure that those operating in their mining sectors effectively manage water resources, protect biodiversity and ecosystems, properly store and dispose of waste materials, and prepare for and respond to emergencies. Using the legislative, regulatory, and policy tools at their disposal, governments can design, implement, and enforce a legal framework that supports responsible and effective environmental management in mining that protects communities, supports the private sector, and helps with the achievement of national environmental objectives and the UN Sustainable Development Goals (SDGs).

Conducting a gap analysis based on the information presented in this guidance document is an effective way for governments to identify their strengths, gaps, and opportunities in environmental management for mining and to develop a path forward for achieving their environmental objectives. It is a five-step process: review, assess, prioritize, implement, and monitor and evaluate.

FIGURE ES2. ENVIRONMENTAL MANAGEMENT GAP ANALYSIS

1. **REVIEW** THE EXISTING LEGAL AND REGULATORY FRAMEWORKS

As a first step, governments should conduct a review of their existing legal and regulatory frameworks to understand what they are currently doing or requiring on all four aspects of environmental management across the mine life cycle, including in their ESIA and ESMP requirements. This information can be presented in a table listing, for example, everything that the government requires of proponents on water management before, during, and after mining, and so on.

2. **ASSESS** STRENGTHS, GAPS, AND OPPORTUNITIES

A government can then use the review from the previous step as the basis for assessing their legal frameworks, comparing their progress on all four aspects of environmental governance with good international practice. This will help them to identify an initial list of their strengths, gaps, and opportunities for improving legal frameworks on environmental management; it may be, for example, that their progress is high on requirements for water management before mining commences, but that there are opportunities for further strengthening the laws, policies, and regulations that govern water during mining and after mine closure.

3. **PRIORITIZE** ACTIONS AND REFORMS

Having assessed the government's legal framework across each of the four pillars of environmental management and assigned a level of progress to each, the government can now prioritize those actions that must be taken to improve environmental management in the mining sector. For those standards where progress is lowest, the government should identify the social, economic, and environmental risks associated with inaction and the benefits of reform, and subsequently prioritize those actions it must take to minimize any risks, maximize any benefits, and strengthen its legal frameworks for environmental management.

4. **IMPLEMENT** ACTIONS FOR IMPROVED GOVERNANCE OF ENVIRONMENTAL MANAGEMENT

With a list of priorities prepared, the government can develop a roadmap for how it will adjust or reform its legal framework on environmental management to achieve its policy objectives and meet its international commitments, articulating how they will get from where they currently are to where they need to be. This plan should be developed in a participative and inclusive way to ensure that it reflects a variety of stakeholder perspectives and has their support and should reflect the roles and responsibilities of those that will implement it. Once a realistic and inclusive roadmap has been developed and adopted, the relevant parties can set about implementing it. This will likely require considerable resources and the participation of several different ministries, departments, and agencies, as well as the participation of communities and other relevant outside stakeholders.

5. **MONITOR AND EVALUATE**

The government should establish systems, capacities, and partnerships to continuously monitor and evaluate its legal framework on environmental management to ensure that it continues to meet international standards and benchmarks. Ongoing monitoring and evaluation efforts will allow the government to manage change and adjust frameworks as needed over time to reflect changing good international practices and evolving knowledge. These efforts should include communities with an emphasis on vulnerable groups.

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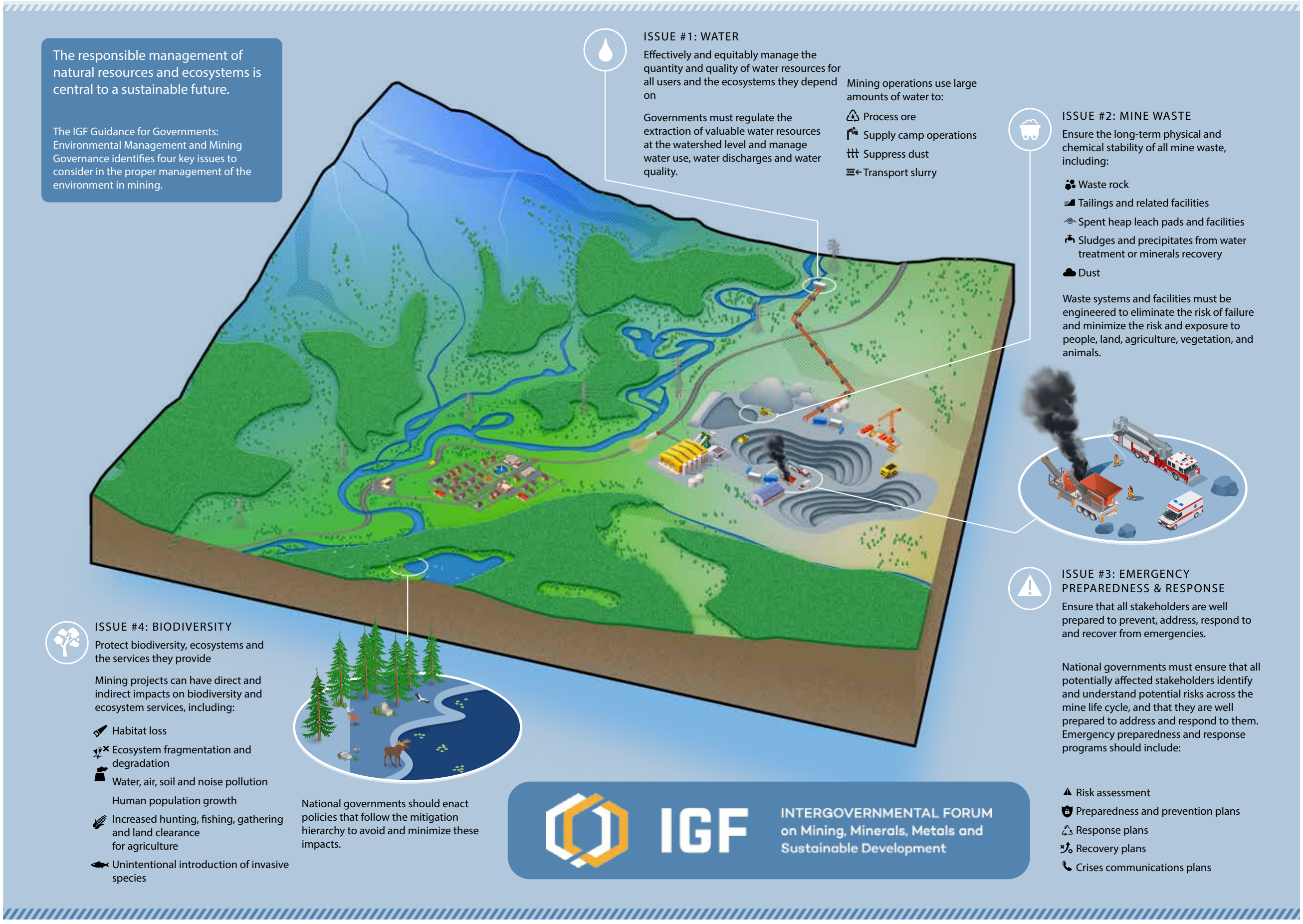
ACRONYMS AND ABBREVIATIONS

APELL	Awareness and Preparedness for Emergencies at the Local Level
BAP	biodiversity action plan
CBD	Convention on Biological Diversity
CH	conservation hierarchy
DMIRS	Department of Mines, Industry Regulation and Safety
EBRD	European Bank for Reconstruction and Development
EHS	Environmental, Health and Safety
EPA	Environmental Protection Agency
ESIA	environmental and social impact assessment
ESMP	environmental and social management plan
EU	European Union
GARD	Global Acid Rock Drainage
GIBOP	Global Inventory on Biodiversity Offset Policies
ICMM	International Council on Mining and Metals
ICOLD	International Commission on Large Dams
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development
IISD	International Institute for Sustainable Development
IFC	International Finance Corporation
INAP	International Network for Acid Prevention
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IWRM	Integrated Water Resources Management
IUCN	International Union for Conservation of Nature
MAC	Mining Association of Canada
MH	mitigation hierarchy
MPF	Mining Policy Framework
NNL	no net loss
NPI	net positive impact
PR	Performance Requirement
PS	Performance Standard
SADC	Southern Africa Development Community
SDG	United Nations Sustainable Development Goal

SEA	Strategic Environmental Assessment
TBC	The Biodiversity Consultancy
TSM	Towards Sustainable Mining
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization

CHAPTER 1: INTRODUCTION

FIGURE 1. THE IMPORTANCE OF ENVIRONMENTAL MANAGEMENT IN MINING



THE IMPORTANCE OF ENVIRONMENTAL MANAGEMENT IN MINING

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In this context, mineable deposits appear in locations both convenient and inconvenient. They can be close to or distant from human settlements and water sources; they can be surrounded by arable lands, breeding grounds, migratory corridors, and ecologically sensitive areas; and they can be in areas prone to fierce storms, unstable hillsides, and seismic activity. Mining these deposits will always impact the environment and its resources to a greater or lesser extent. The active and sustainable management of these ecosystems and natural resources before, during, and after mining will help to avoid negative impacts where possible (which may mean excluding mining in certain cases) and can minimize them elsewhere, remediate as necessary, and improve when feasible. A failure to effectively manage the impacts of mining on the environment can not only threaten the continued viability of operations but can also undermine the relationships between a mining company, affected communities, and all levels of government.

This guidance document is designed to help Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) member states implement the IGF Mining Policy Framework (MPF). It focuses on the role that national governments can play in ensuring the effective and sustainable management of the environment and natural resources by the mining sector, using the legislative, regulatory, and policy tools and mechanisms at their disposal. Drawing from the MPF, it focuses on four main areas of environmental management in mining: water management, biodiversity management, waste management, and emergency preparedness and response.

KEY THEMES FOR ENVIRONMENTAL MANAGEMENT

Water management is a critical issue for mining. Water is a common resource, and clean water is a human necessity. Its management frequently raises questions around access, rights, availability, control, and quality, often due to competing water requirements from agriculture, industry, conservation, and domestic use. Given that mining requires considerable quantities of water for ore processing, cleaning, maintenance, and staff use, companies typically need to spend a considerable amount of time, energy, and resources managing the water that comes into and flows out of their operations. This includes constantly controlling and managing any excess water (such as rainfall, runoff, or groundwater) that may come in contact with mine operations. Governments working with mining companies to ensure that water resources are properly and effectively managed will help balance the company's needs with those of other users, including the most vulnerable, while minimizing the risk of tensions and conflict between competing users.

Biodiversity and ecosystem services can be significantly affected by mining due to factors such as land clearance for facilities and infrastructure, pressures linked to increasing human populations, habitat loss, pollution, and the unintended introduction of invasive species. Conserving and protecting biodiversity and ecosystem services have grown in importance for both governments and mining companies in recognition of the role that biodiversity can play in supporting economies and operations and in maintaining the well-being of surrounding communities. In response, companies are increasingly working with partners to find ways that they can avoid, minimize, and restore any negative impacts their activities have on biodiversity and offset those residual impacts that cannot be avoided.

Mine waste management is of crucial importance to both governments and companies. Mining usually exposes mineralized rock at a much quicker rate than natural erosion processes, and the newly exposed materials release metals and chemicals as they are exposed to water and air. In combination with the process chemicals needed in extraction, there are risks of mining wastes releasing high concentrations of constituents that can be harmful in the receiving environment. In addition, large volumes of non-mineralized materials and excess materials from mineral processing often need to be stored in perpetuity in engineered structures (e.g., tailings facilities) that may have physical stability risks. Waste management often extends well beyond mining operations into the post-mining transition, and the combination of the scale, duration, and magnitude of risk associated with mine waste, alongside recent high-profile accidents around tailings facilities, mean that applying a high standard to its management is of utmost importance to companies, communities, and governments.

Emergency preparedness and response are increasingly important in the mining sector. Emergencies, including both internal mine site accidents and external natural and social hazards, are sudden, unintended events that can significantly affect the ability of a mining company to carry out its business. They can affect operations, workers, and communities, and their impacts can extend beyond the boundaries of a mine to the villages, waterways, wetlands, and farms that surround the site. Emergencies can affect operations and communities across the mine life cycle, with the risks extending from construction and operations through mine closure and the post-mining phase. Governments must work with companies and communities—with specific attention paid to women, Indigenous communities, and vulnerable groups—to ensure that all potentially affected stakeholders identify and understand potential risks; that they are well prepared to prevent, minimize, and manage emergencies; that they can communicate their efforts; and that these efforts lead to a stronger recovery.

In addition to the four main MPF areas of environmental management outlined above, this guidance document incorporates and addresses some important cross-cutting issues associated with environmental management, including climate change, worker health and safety, and the United Nations Sustainable Development Goals (SDGs), including those on life on land, life in water, and gender equality. Climate change is crucially important to environmental management. Through increasing temperatures, more variable precipitation rates, sea-level rise, and increasing intensity and frequency of extreme weather events, climate change could negatively affect such things as the effectiveness of water management practices, the stability of waste and chemical storage facilities, and the health of local biodiversity and ecosystems. Worker health and safety is linked to sound water management, pest and invasive species management, the physical and chemical stability of mine waste management facilities, and emergency response measures. Effective environmental management will also be needed for meeting the SDGs through the protection of water resources, terrestrial and marine biodiversity, and the health and well-being of staff and communities. In concert with the SDGs, the World Bank Climate-Smart Mining program has important goals and measures that should be considered, given that mining has a critical role to play in providing the needed raw materials for transitioning to clean energy (Hund et al., 2020).

ENVIRONMENTAL MANAGEMENT BEFORE, DURING, AND AFTER MINING

The focus of this guidance spans the mine life cycle, looking at what governments must do before, during, and after mining to ensure that the environment and its natural resources are continuously well managed. Many of the activities described below—including risk assessment and management, and the participatory preparation of environmental and social impact assessments (ESIAs) and environmental and social management plans (ESMPs)—will be undertaken prior to the granting of the mining permit or licence. Others, including the implementation of control measures and their monitoring and evaluation, will take place throughout production. The closure of the mine is not the end of this process; several activities will continue on into the post-mining transition, as watersheds continue to be protected and waste storage facilities are surveyed and maintained.

This process includes looking at how these four areas of environmental governance are incorporated into both policy and legal frameworks and requirements for the ESIA process and ESMPs. Both the broad legal framework and, more specifically, the ESIA and ESMP requirements are central to a government's effective environmental management and are briefly described below. The integration of environmental management into these tools, mechanisms, and processes, backed up by enforcement, will help to ensure that effective plans are developed; that they are adequately resourced; and that they are implemented, tested, monitored, and evaluated throughout operations and beyond the mine's eventual closing.

THE ROLE OF GOVERNMENTS: LEGAL FRAMEWORKS FOR ENVIRONMENTAL MANAGEMENT

The legal frameworks for environmental management in mining typically stretch across several different jurisdictions, laws, ministries, departments, and agencies. These range from the overarching principles of environmental rights and natural resource management enshrined in a country's constitution, to specific water and land protection requirements in a range of laws and regulations, to guidance on good international practices, to international commitments ratified by the state. The wide breadth of applicable national legislation and international commitments requires that governments work hard to ensure these legal instruments are consistent and compatible across ministries. Mining, environment, and water ministries are likely the key ministries administering the applicable legislation; however, other relevant ministries may include those administering transportation, agriculture, energy, land use, gender, and health. The types of legal instruments linked to the management of water, biodiversity, mine waste, and emergency response include:

- A Mining Act and associated regulations and codes
- An Environmental Protection and/or Management Act
- ESIA regulations

- A Water Act
- A Land Act
- A Biodiversity or Protected Areas Act
- A Waste Management Act
- A Health and Safety Act
- A Hazardous Materials or Waste Act
- An Emergency Preparedness Act

A long-standing legal challenge for managing natural resources is that they are common resources with often uncertain ownership and rights. Granting rights to nature is an emerging trend in national legal frameworks, originating from Indigenous views of the rights of nature. Bolivia has granted nature rights in its Laws on the Rights of Mother Nature; Ecuador granted rights to Mother Earth in its constitution in 2008. Legal rights have also been granted to the Atrato River in Colombia, the Ganges and Yamuna rivers in India, and the Whanganui River in New Zealand. The legal rights allow the river to litigate for damages from pollution or use. Representatives such as individuals or communities can enforce the rivers' rights.

Relevant international commitments to improved environmental management could include: the UN Framework Convention on Climate Change, the Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands, the Basel Convention for Controlling Transboundary Movements of Hazardous Wastes and Their Disposal, the Stockholm Convention on Protecting Human Health and the Environment From Persistent Organic Pollutants, and the Minamata Convention on Mercury.

The legal framework pertaining to environmental management in mining should cover the ministries and agencies responsible for implementation, monitoring and enforcement, the government's environmental objectives and goals, the required content of and review process for ESMPs and ESIAs, permitting conditions and requirements, specific criteria for environmental protection, financial assurance requirements (particularly for mine closure), and penalties for non-compliance. It is important that there is coordination across ministries to be efficient, effective, and consistent. This may include centralizing functions, designating a lead agency, or providing training and education.

Country-specific conditions and capacities for implementing the legal framework for environmental management should be an underlying theme when developing and revising the legal framework. Implementation of the legal framework will have the most chance of achieving a country's sustainability goals if it is simple, clear, consistent, and easy to implement. Opportunities should also be considered in the legal framework for requiring financial and independent technical support from mining proponents for information review and inspections, should the government be lacking the resources needed to fully carry out these functions.

THE ROLE OF GOVERNMENTS: ESIAS AND ESMPS

Beyond the broader legal framework, ESIAs and ESMPs are both critical tools for ensuring effective environmental management in mining.

ESIAs are a tool used to identify and evaluate the potential environmental and social impacts of a proposed mining project prior to the granting of a mining licence or permit (IGF, 2020). While the legal frameworks that guide the development of ESIAs will vary across jurisdictions, broadly, these assessments should describe in ample detail the baseline conditions at the site (including water and biodiversity), possible risks and impacts associated with proposed project-related activities, and proposed mitigation and management actions required to limit impacts to acceptable levels.

As with all work on managing water, waste, biodiversity, and emergency preparedness, ESIAs are grounded in risk management: systematically evaluating the risks that might emerge around particular project activities or interventions. The risk management process involves identifying the hazards associated with the (proposed) mine site that might threaten staff or operations and the surrounding communities and environment; analyzing and assessing the risks associated with these potential hazards; designing and implementing the control measures needed to eliminate the hazard or minimize the risk of injury or harm; and even rejecting proposals if the risks cannot be mitigated (Department of Mines, Industry Regulation and Safety [DMIRS], 2018). Throughout the process, the proponent should consult and communicate with potentially affected stakeholders, and once implemented, the implementation of control measures should be monitored, evaluated, and modified as needed (DMIRS, 2018).

The proposed mitigation and management measures to respond to and address these project risks and impacts will form the basis of the project's ESMP (IGF, 2020). This plan, or plans, should provide the details of how the proponents will implement the protection and mitigation measures they have committed to across the mine life cycle, including any relevant legal commitments. Within each ESMP, there may be standard operating procedures that present the steps and protocols workers need to follow to implement the ESMP. While the degree of complexity of the ESMP should be commensurate with the level of activity and risk of the project, common elements include (IGF, 2020):

- Mitigation plans
- Environmental and social monitoring programs
- Emergency response plans
- Stakeholder engagement and capacity-building plans
- Budgets
- The process by which the ESMP will be integrated into the mining project.

While often paid for by the permit applicant, ESIAs should be conducted by independent experts, and—as with ESMPs—they should be developed in a consultative manner, involving communities and other potentially affected parties in risk and impact assessment and the design of mitigation and management measures. Governments should provide clear guidelines to proponents on what is required from them in their ESIAs and ESMPs; these guidelines will help to align the ESIAs and ESMPs with the government's own environmental management objectives (IGF, 2020).

Both documents will be prepared as part of the application process for a mining permit or licence, and the government's careful review of each will be central to their decision making on whether or not a proposed mining project should be approved. The process helps governments to carefully consider how the proposed project will be implemented to ensure that it only proceeds in a manner that protects the environment and advances the social and economic interests of current and future generations. Where mining permits are granted, ESMPs then serve as the reference documents for the permit holder, government monitoring agencies, communities, and other key stakeholders throughout the life of the mining project (IGF, 2020).

OVERVIEW OF THE GUIDANCE

The purpose of this document is to help IGF member states implement the MPF. It includes a summary of good international practice in governing environmental management in the mining industry. Case studies, tools, and additional resources are included throughout to help the user in understanding and improving their governance options for the management of water, biodiversity, waste, and emergency preparedness. While professional organizations have published technical guides on environmental management, guidance focused on governments and environmental management remains largely lacking in the literature. This guide aims to fill this gap for governments and other stakeholders who would like to improve environmental management in the mining sector.

Not all of the guidance is applicable for every jurisdiction. Environmental management issues will vary according to a host of factors, including underlying environmental and climatic conditions and the types of mineral deposits for each site. Governments should take these unique characteristics into consideration when designing their approach to environmental management. And while the guidance presented in this document is designed particularly for IGF member states, the good international practices and examples provided may also be useful for non-members, companies, civil society organizations, community leaders, and others who are interested in optimizing sustainable outcomes from mineral development and governance.

ORGANIZATION OF THE GUIDANCE

This guide is organized as follows:

- Chapter 1: Introduction
- Chapter 2: Water Management
- Chapter 3: Biodiversity
- Chapter 4: Mine Waste Management
- Chapter 5: Emergency Preparedness and Response
- Chapter 6: Environmental Management Gap Analysis

The topic chapters will each provide an overview of the topic linked to the IGF's MPF; explore the key issues that governments, communities, and companies are grappling with; present good international practices that are currently applied to that issue; and discuss the role that governments can play in ensuring strong environmental management. Chapter 6 will discuss what governments can do before, during, and after mining across all four topics to ensure effective environmental management across their country's mining sector. Where applicable and available, examples are provided to highlight good international practice, lessons learned, opportunities, and challenges.

HOW TO USE THE GUIDANCE

Governments are encouraged to use the following steps to incorporate the guidance into their legal frameworks.

1. Understand the legislative context for each management topic within their jurisdiction through a thorough review of national laws, regulations, and policies, along with international commitments.
2. Review the good international benchmarks and practices presented in this guidance document and in the additional resources provided.
3. Complete a gap analysis to determine the differences between good international practices and the country's current legislative framework and performance while factoring in any contextual or situational limitations.
4. Use the guidance to develop an action plan for addressing any existing gaps, including a detailed estimate of the tasks, required human and financial resources, and a schedule.

LIMITATIONS OF THE GUIDANCE

The guidance presented in this document, while incorporating the input of technical experts, does not detail the technical aspects of environmental management; instead, it focuses on good international practices. This guidance is not a substitute for the level of informed, multidisciplinary expert guidance that is needed to address the unique characteristics of any local development project. Accordingly, this guidance presents good international practices, examples, and tools instead of attempting to provide law or policy models. Governments will need to build a diverse team with the requisite skills to address environmental management issues in their unique circumstances.

The guidance focuses mainly on land-based, large-scale mining and does not address artisanal, deep-sea, or riverine mining. Please refer to IGF's 2017 *Guidance for Governments on Managing Artisanal and Small-scale Mining* for more information.

Discussions on climate change, as it relates to environmental management, are limited to the implications of climate change on environmental management; the guidance does not address, for example, the impact that carbon emissions from a mine site will have on a changing climate (i.e., direct and indirect greenhouse gas emissions and carbon sequestration). Gaseous emissions are also excluded. Industrial wastes that cover multiple industries are also not covered in detail in this guidance. In particular, the following are excluded: hydrocarbon use, storage, transport, disposal, and spill remediation; putrescible wastes; non-putrescible wastes; and wastes from general maintenance of equipment and vehicles. Dust is included in the waste management section since there are mineral-specific dust issues to be considered; however, other airborne emissions are excluded from this guidance. Noise and light pollution are also excluded.

ADDITIONAL RESOURCES

In addition to the resources provided in the references and in boxes throughout the guidance, you can find additional materials in a range of languages at www.IGFMining.org. This guidance document may lead to additional future resources, including training courses and online materials. If you are interested in more information or would like to request additional training or materials, please contact the IGF Secretariat at Secretariat@IGFMining.org.

CHAPTER 2:

WATER MANAGEMENT

FIGURE 2. WATER MANAGEMENT

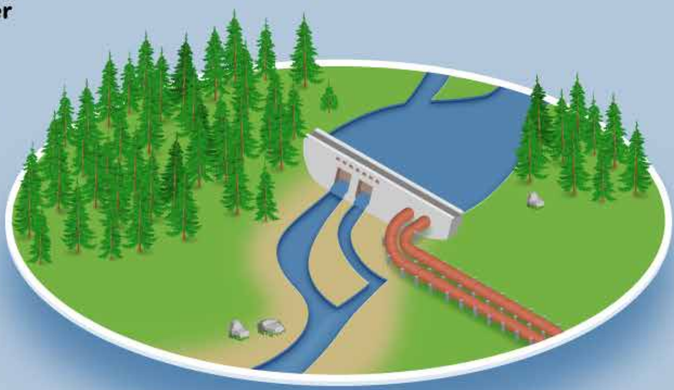
ISSUE: WATER MANAGEMENT

Effectively and equitably manage the quantity and quality of water resources for all users and the ecosystems they depend on

Governments must regulate the extraction of valuable water resources at the watershed level and manage water use, water discharges and water quality.

Mining operations use large amounts of water to:

- Process ore
- Supply camp operations
- Suppress dust
- Transport slurry



OVERVIEW

Mining is a water-intensive industry. From mineral processing and slurry transport to dust suppression and meeting the water needs of employees, large-scale mining operations extract and use a significant amount of both groundwater and surface water across the mine life cycle. The same is true of artisanal and small-scale mining operations, as well as quarries. In the United States in 2015, for example, 5,526 million cubic metres (m^3) of water was used in mining operations, accounting for 1% of the country's total water use (Dieter et al., 2018). An estimated 516 million m^3 of water was required in 2018 to operate Chile's copper mines in the country's arid north (Lutter & Giljum, 2019).

Competing demands for water resources—from the mining sector, agriculture, households, and other industries and sectors, and for conservation and leisure—ensure that governments will always play a critical role in water management throughout the life of a mine, not only at the site itself but across watersheds and potentially beyond national borders. This role involves not only governing the extraction of valuable water resources but also overseeing water use, water discharges, and water quality. When poorly managed, water can be a source of grievance and conflict around mining operations, and while water use and management may receive the greatest attention in arid regions where mining competes with community needs for drinking water and irrigation, it is a crucial issue in most jurisdictions. And its importance is only likely to increase in the context of climate change. When well managed, mining can provide opportunities where there may be synergies between users. For example, treated mine water could be used by other industries. Balancing competing demands for water while guaranteeing the human right to safe drinking water and sanitation (UN General

Assembly, 2016) is a central responsibility of governments and will be paramount to the achievement of SDG 6 on water and sanitation. As noted by former UN Secretary-General Kofi Annan, "Fierce national competition over water resources has prompted fears that water issues contain the seeds of violent conflict. If all the world's peoples work together, a secure and sustainable water future can be ours" (UN, 2002).

According to the IGF MPF, governments need to manage the water issues associated with mining by:

- *Having appropriate environmental management standards in place for the use of surface and groundwater. These standards must be strictly monitored, and have appropriate penalties should they be compromised;*
- *Requiring that mining entities ensure that the quality and quantity of mine effluent streams discharged to the environment—including stormwater, leach pad drainage, process effluents, and mine works drainage—are managed and treated to meet established effluent discharge guideline values;*
- *Requiring that mining entities ensure that water-leaching or percolating waste dumps, tailings storage areas, and leach pads have equivalent protection; and*
- *Requiring that mining entities have in place practices and plans that minimize the likelihood of impacts beyond the mining site, particularly potential transboundary impacts.* (IGF, 2013, p. 36)

This chapter will provide an overview of the central water management issues in mining, including water rights, use, and quality. It will then outline some of the key good international standards and practices that can be applied to effectively manage water resources. The chapter will close with more detailed guidance on what governments can do to support sound water management in the sector.

This chapter presents why it is important to:

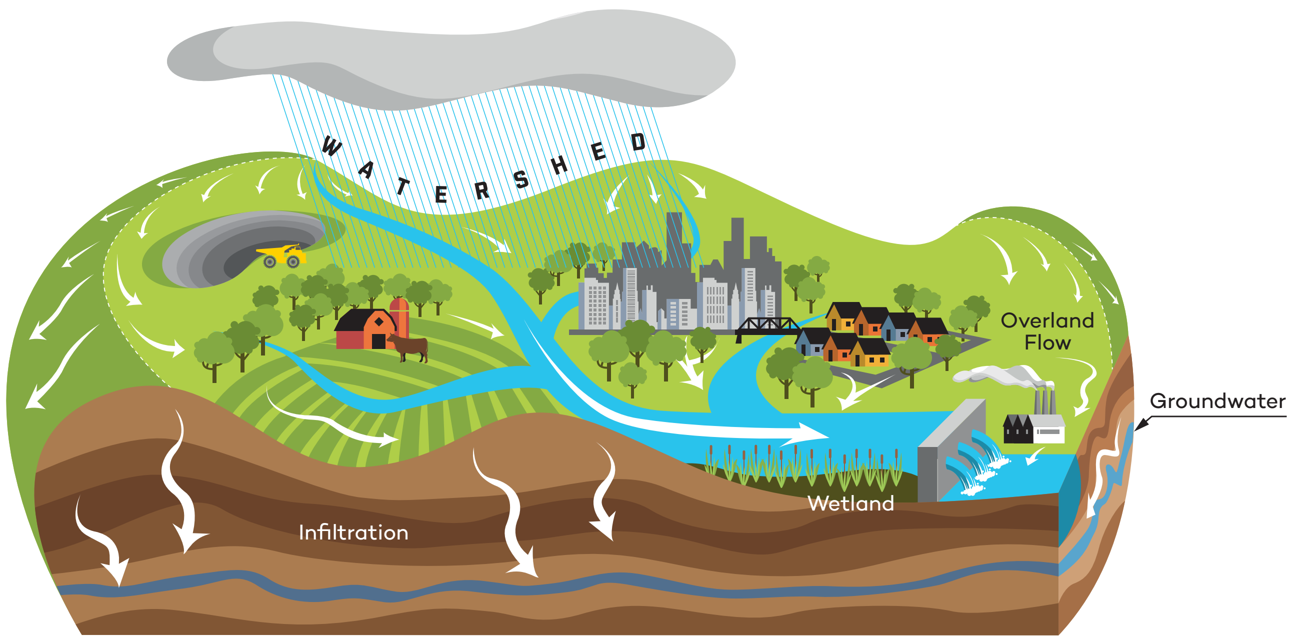
1. Consider water management at the watershed level when setting objectives for water use and discharges.
2. Set effluent quality and quantity guidelines based on receiving water objectives and site-specific conditions.
3. Control water use and discharges through surface water and groundwater permitting.
4. Review and approve water management plans prior to permitting and monitor the results of implementation throughout all mine phases.
5. Allocate financial and human resources for timely and effective reviews of monitoring data.
6. Enforce compliance with water permits.

KEY ISSUES

The overall objective of a government's approach to water management is to protect the availability and quality of water for its population and its ecosystems, now and for future generations. Water is mobile, varies by season, dissolves and transfers pollutants, is difficult to quantify, and is both underground and at the surface (Young & Loomis, 2014). The protection of water resources applies to both surface water and groundwater and recognizes that these two systems are linked. Water is also a common resource and should not be individually owned but rather open and shared by all. These innate characteristics make water vulnerable to the tragedy of the commons, with everyone using the resource for their individual needs and goals and no one taking responsibility for the common good of all users (Hardin, 1968).

It falls on governments to control and oversee the protection of this common resource. The advantage of governments doing this is that they can manage water at the watershed level and regional scale, where it is easier to effect change to meet sustainability goals. Figure 3 illustrates the types of uses water has as it moves through the watershed, from rainfall through surface and groundwater flows.

FIGURE 3. SCHEMATIC SHOWING WATERSHED DYNAMICS AND MULTIPLE USES OF WATER



WATER RIGHTS

UN Resolution 64/292 (2010) recognizes the right to safe and clean drinking water and sanitation as a human right and calls upon states and the international community to provide the financial resources, capacity building, and technology necessary to scale up efforts—particularly in developing countries—to provide safe, clean, accessible, and affordable drinking water for all people. At the national level, this is often complicated by the fact that rights can be claimed by communities in some areas, granted by the government in some areas, or be undefined. As a result, water rights can often become a source of conflict among large-scale mines, other industrial users, communities, local authorities, and artisanal and small-scale miners, and governments need to control and fairly define the rights of users to minimize the risk of conflict.

It is imperative that governments put in place a legal framework to address the high risk of water-related social conflict with mining. Governments are in a unique position to address the drivers of these conflicts: they have the required authority to do so and the power to directly influence many of the causes and effects of water-related conflicts.

Some examples of social conflicts around water in mining include:

- The **Oyu Tolgoi copper-gold mine development** in Mongolia: The project required the diversion of the Undai River, which led to grievances among the local population of herders. High tensions between the company, government, and the herders (who were supported by non-governmental organizations) eventually resulted in the development of a tripartite agreement on water management among the three stakeholder groups (Compliance Advisor Ombudsman, 2019).
- The **PolyMet copper-nickel project** in the United States: The company has been trying to secure approvals and permitting for over 10 years and has yet to obtain water discharge permits in the Saint Louis River watershed (Boissoneault, 2020). The local population, concerned about the mine's potential impact on the river, is working to secure legal rights for the river itself so that citizens could represent the waterway in court (Levang, 2020).

BOX 1. WOMEN AT THE HEART OF WATER SECURITY

Women play a central part in the provision, management, and safeguarding of water (International Conference on Water and the Environment, 1992). They are the primary collectors of water for families around the world, and it is important that governments recognize this key role and provide opportunities for women to meaningfully participate in the development and implementation of water management policies and programs. This will support development, which is accelerated by ensuring that women and girls have access to clean water and facilities for drinking, cooking, sanitation, and hygiene. Placing women at the heart of water security will also help move toward the achievement of two SDGs: Goal 5, achieve gender equality and empower all women and girls, and Goal 6, ensure access to water and sanitation for all.

MINE WATER USE

The extraction and processing of ore in mines, and the operation of those mines, requires a significant amount of water. In metal mines, hydrometallurgy is used to recover minerals through a process by which the ore is ground finely, and water and chemicals are added to leach or float the targeted minerals. Cyanide and acid heap leaching, when employed, also require water to wet the ore material and leach out the target minerals. Water is also needed to wash coal. In addition, mine operations need water to meet the needs of their employees (drinking water, sanitation), as well as water for on-site cleaning and dust suppression. Table 1 summarizes the main mine water uses and sources of potential contaminants. Water use, recycling, and reuse must first be optimized to allow for efficient operations, minimize treatment requirements, and ensure that sufficient clean water is maintained in the lakes, rivers, and natural systems around the mine site for community use and to support ecosystems and biodiversity. For example, a 430-km pipeline brings treated wastewater from Taif, Saudi Arabia, east to the Al Duwayhi gold mine owned by Saudi Ma'aden (Shamseddine, 2017).

TABLE 1. MINE WATER SOURCES AND POTENTIAL CONTAMINANTS

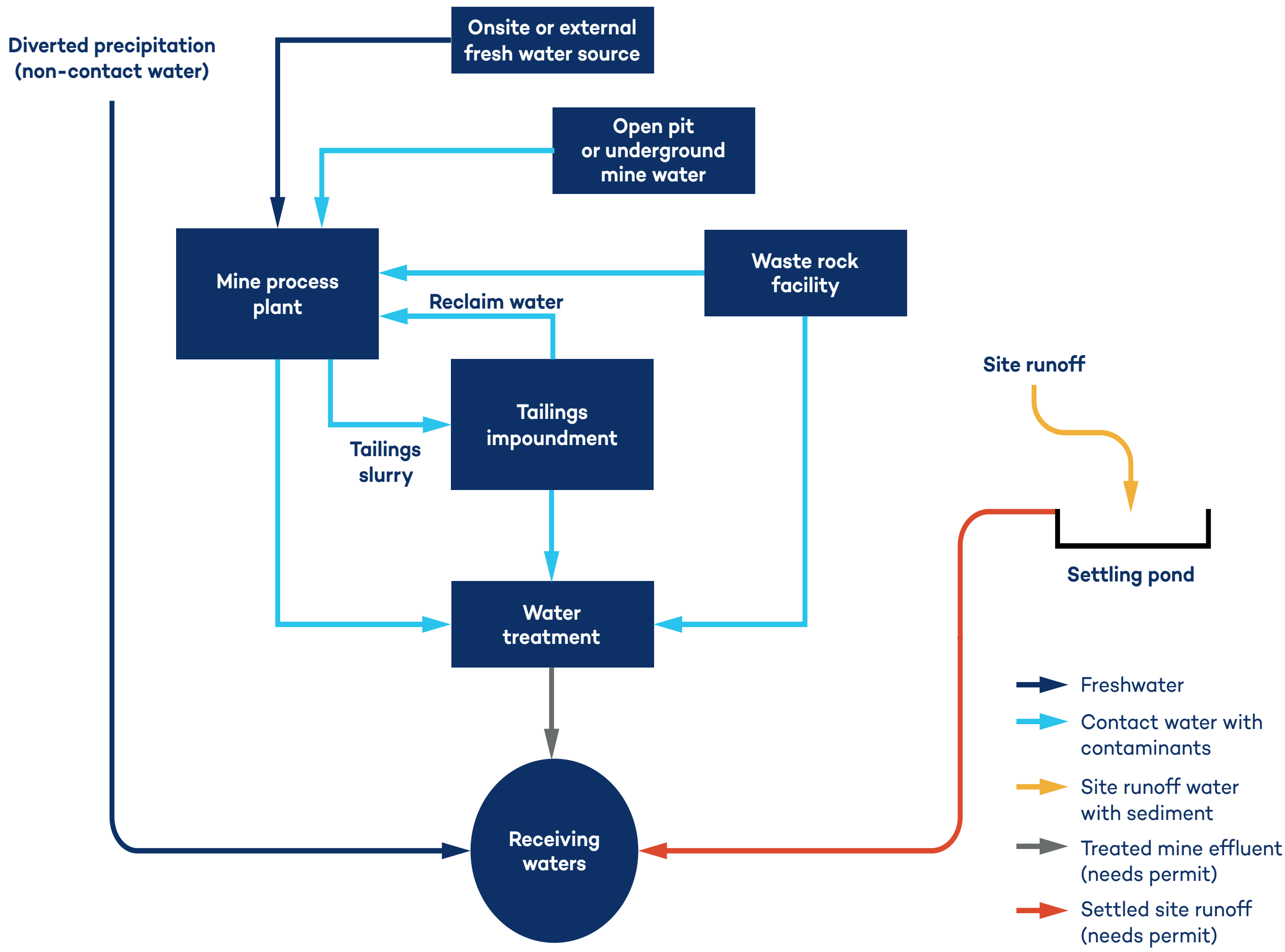
MINE WATER SOURCES	METHOD OF CONTACT	POTENTIAL CONTAMINANTS
Runoff and groundwater seepage into or out of mine workings (underground or open pit) Waste rock runoff and seepage	Water dissolves or moves chemical constituents from rock and blasting residues. Concentrations vary depending on recycling, seepage rates, and meteorological conditions at the site.	Suspended sediments Metals, metalloids, nonmetals Sulphates, salts, anions, cations Nutrients (nitrogen and phosphorus species)
Mineral processing (physical separation, hydrometallurgy, pyrometallurgy, electrometallurgy) Tailings facility seepage and pond release Tailings pond	Water dissolves or moves chemical constituents from rock, blasting residues, and process reagents. Concentrations vary depending on recycling, seepage rates, and meteorological conditions at the site.	Suspended sediments Metals, metalloids, nonmetals Sulphates, salts, anions, cations Nutrients Reagents (depending on process; e.g., xanthates, kerosene, cyanide, etc.)
Mine site runoff	Water erodes sediments from exposed surfaces. Hydrocarbons may be washed from areas with vehicle traffic, maintenance, or storage areas.	Suspended sediments Hydrocarbons
Clean water diversions	Constructed to minimize the amount of water that comes in contact with the potential contaminants.	Suspended sediments (during construction) None (once operating as intended)

Controlling the quantity and quality of water that comes into and leaves a mine site is a central part of all operations. Current good international practices for water control in mine design include:

- Using water diversions to minimize the amount of water contacting mine and processing materials
- Recycling water to minimize the operation's freshwater requirements
- Collecting and managing contact water in a manner that minimizes treatment requirements
- Controlling and treating water to meet discharge requirements.

Controls need to consider all scenarios, including stormwater, drought conditions, and the implications of climate change. Figure 4 presents a simplified mine water balance and water quality schematic that shows one example of the primary flow paths of clean and contact water around a mine.

FIGURE 4. A SIMPLIFIED EXAMPLE OF MINE WATER BALANCE AND WATER QUALITY MODEL SCHEMATIC



Source: Goldsim, n.d.

BOX 2. ADAPTING TO CLIMATE CHANGE

Effective water management is becoming increasingly important as the world's climate changes. Increasing temperatures, changing rainfall patterns, rising sea levels, and a growing intensity and frequency in extreme weather events will affect how much water is available throughout the year in many parts of the world. These changes could increase water scarcity in some areas and may cause increased frequency and intensity of rainfall, snowfall, and flood events in other areas. Governments need to adapt their legal and policy frameworks on water to respond to these changes: these frameworks, particularly around mine water management, should provide clarity on the government's position and plans on climate change adaptation. Government climate change policies may specify the country's goals, objectives, and accepted climate change scenarios for engineering designs and predictive modelling for mine water management. At the project level, policies could require regular updates to water balances, contingency measures, and adaptive management plans to respond to a changing climate. Companies must also adapt their water management planning and processes to be effective in this dynamic environment. Additional information on adapting to climate change can be found in International Council on Mining and Metals (ICMM, 2019a), *Adapting to a Changing Climate: Building Resilience in the Mining and Metals Industry*.

WATER QUALITY

Each type of rock or material that is mined has unique characteristics that not only produce a commodity that humans need but also have distinct potential effects on the environment—and on water quality. Mining accelerates the rate of exposure of rocks to both air and water by increasing the exposed surface area, which can result in the release of chemicals into the receiving environment that may reach toxic concentrations. Potential sources of water contaminants from mining can come from ore stockpiles, waste rock, tailings, spent leach piles, and mine and waste residue stockpiles, as well as from mining operations, including mineral processing reagents such as mercury, explosives residues, and from the use of fuel, oil, and grease. If released uncontrolled into the receiving environment, these contaminants may be toxic and can have severe impacts on ecosystems, biodiversity, and human health. The complex nature of water systems means that these impacts are often long lasting and can be very costly to remediate.

Water quality predictions for a mine should be based on detailed modelling in the ESIA process and should take into consideration: the detailed seasonal variability in meteorological, hydrological, and water quality conditions; the geochemical characterization of mine materials; the proposed mine designs; and the chemical dynamics of the operation. Figure 5 illustrates the basic principles of mine water impact analysis that are dependent on water chemistry, flow rates, and the downstream users that need to be protected. The predicted quality of effluents leaving the mine should meet accepted standards for the protection of downstream uses, which may include aquatic life (i.e., fish, benthic invertebrates, and algae), livestock, crop irrigation, and household consumption.

FIGURE 5. BASIC PRINCIPLES OF MINE WATER IMPACT ANALYSIS

Upstream

Upstream water quality (C) multiplied by flow (Q) equals the background chemical load (L)
Cu x Qu = Lu

Mine Effluent Discharge

Mine discharge quality multiplied by flow equals the chemical load from the mine
Cm x Qm = Lm

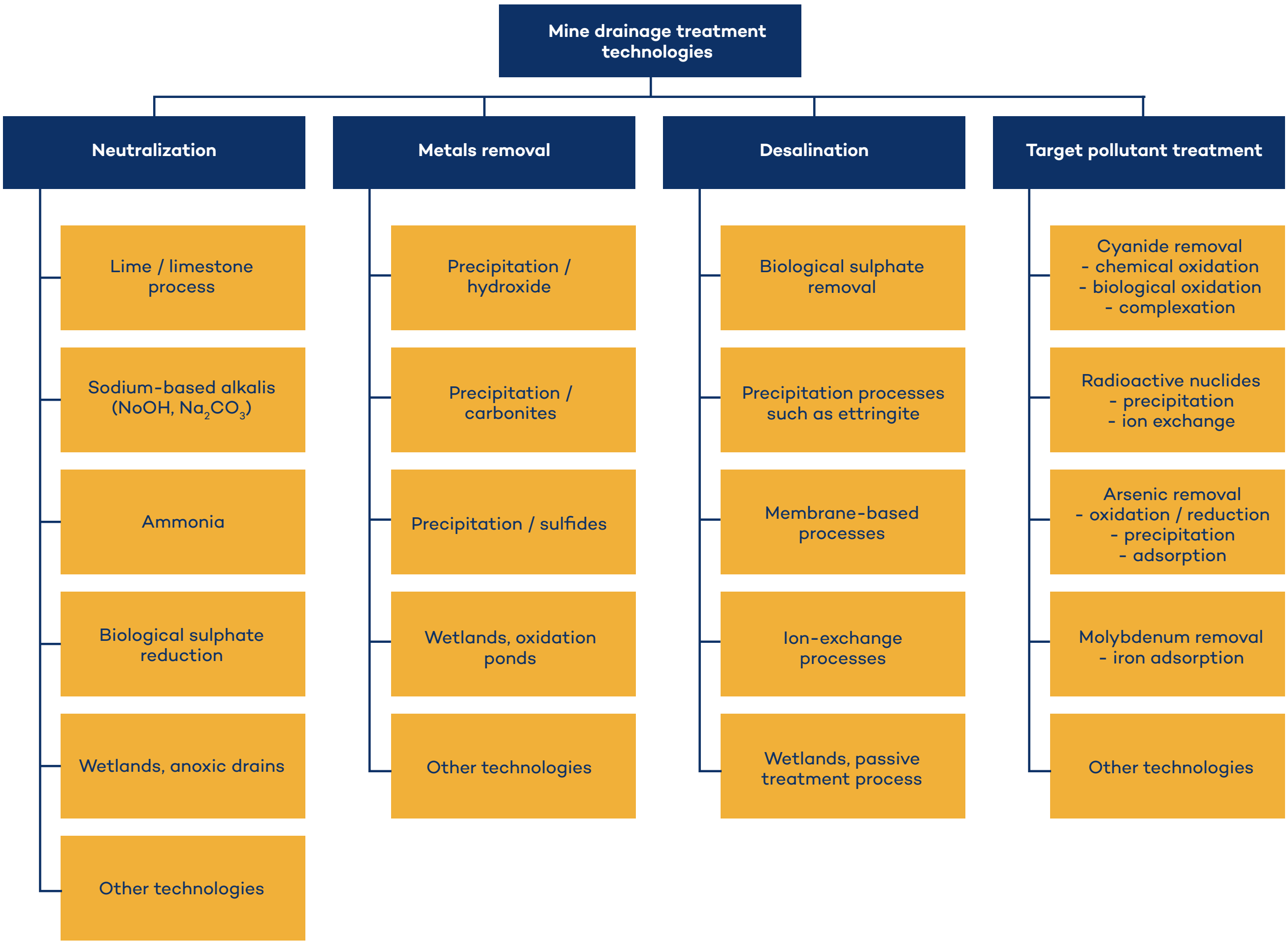
Downstream

Downstream water quality equals the upstream load plus the mine load divided by total flow
Cd = (Lu+Lm)/(Qu+Qm)

Water treatment is a crucial component of mine water quality and water management and can include both active and passive treatment options. The water treatment options chosen will depend on several factors: the ore and waste rock characteristics, the mine's design, the water quality predictions in the ESIA, testing, and costs. Treatment is then optimized during mine construction and across the operation. Water treatment options are limited by the removal efficiencies of the technology and the costs; therefore, mine designs should first minimize water needs through design and innovation.

Figure 6 provides a summary of the mine drainage treatment options that can be used for addressing the range of water quality issues at a mine site. A number of different technologies and techniques are typically used to control water quality at a site, including neutralization, metals removal, desalination, and target pollutant treatment. The U.S. Environmental Protection Agency's (EPA) (2014) *Reference Guide to Treatment Technologies for Mining-Influenced Water* is a summary of mine water treatment options and includes an appendix with summaries of treatment efficiencies and costs. New technologies continue to be developed to meet industry-wide and site-specific treatment challenges.

FIGURE 6. MINE DRAINAGE TREATMENT OPTIONS



INTERNATIONAL STANDARDS AND PRACTICES

Many good international standards and practice guidelines are available for mine water management. These standards and practices cover: (1) the overarching principles of water stewardship and integrated management; (2) international conventions; and (3) technical standards, as outlined below.

BOX 3. RESOURCES ON WATER MANAGEMENT

For further information on water management, please see the following resources:

DHI Water Policy (Denmark), United Nations Environment Programme–DHI Centre for Water and Environment (Denmark), & UNESCO World Water Assessment Programme. (2009). *Integrated water resource management in action*. https://unesdoc.unesco.org/ark:/48223/pf0000181891

European Union (EU). (n.d.). *Water protection and management*. https://www.europarl.europa.eu/factsheets/en/sheet/74/water-protection-and-management

ICMM. (n.d.). *A practical guide to catchment-based water management for the mining and metals industry*. https://www.commdev.org/pdf/publications/ICMM-WaterGuide.pdf

ICMM. (2019). *Adapting to a changing climate: Building resilience in the mining and metals industry*. https://www.icmm.com/en-gb/guidance/environmental-stewardship/adapting-climate-change-2019

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WATER STEWARDSHIP AND INTEGRATED MANAGEMENT STANDARDS

Central to many good international standards and practices is the concept of Integrated Water Resource Management (IWRM), which is a strategy for managing water resources used by governments at the national level. Water management at the scale of an individual mine then fits within this broader government management framework. From the accepted definition, IWRM is "a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (United Nations Environment Programme [UNEP] et al., 2009).

Water management is a cross-cutting theme across all eight IFC Environmental and Social Performance Standards and is central to Performance Standard 3 (PS3) on Resource Efficiency and Pollution Prevention. PS3 calls on clients of the IFC to avoid or minimize the adverse impacts of their activities on human health and the environment through pollution avoidance and minimization and to promote the more sustainable use of water resources (IFC, 2012c).

The Mining Association of Canada's Towards Sustainable Mining (TSM) program includes a Water Stewardship Protocol and Water Stewardship Framework that set benchmarks against which companies can measure their water management programs (MAC, 2017, 2018b). The water management programs are rated against criteria for water governance, operational water management, watershed-scale planning, and water reporting and performance indicators.

Guidance on catchment-based water management from a mining perspective is provided by the ICMM in *A Practical Guide to Catchment-Based Water Management for the Mining and Metals Industry* (ICMM, n.d.a). This catchment-based approach for companies recommends that ICMM members gain awareness about the water issues surrounding the project, assess the issues, and respond with an appropriate and comprehensive water management plan. This guidance ties in well with how governments can approach watershed-based management.

INTERNATIONAL CONVENTIONS

National legal frameworks for water management need to be consistent with international agreements. International conventions that pertain to water management and mining include the Ramsar Convention on the conservation and use of wetlands; the Minamata Convention on Mercury to limit the use of mercury in mining to protect water resources and human health; and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) to govern cooperation on transboundary water resources. There are also other transboundary water agreements that may need to be considered in the water management framework. There are over 3,600 transboundary water agreements that work to manage and protect the shared water resources of neighbouring countries throughout the world, including agreements, initiatives, and commissions managing rivers like the Nile, Mekong, and Indus (United Nations Department of Social and Economic Affairs, 2014).

TECHNICAL STANDARDS

The IFC Environmental, Health and Safety (EHS) Guidelines also provide standards for water management and water quality in the general guidelines and guidelines specific for mining (IFC, 2007a, 2007b). These EHS guidelines provide recommendations on how mines should manage water resources, including using a detailed water balance plan, implementing a sustainable water supply management plan, minimizing water use, managing impacts, and consulting with communities (IFC, 2007a). The guidelines for mining include effluent quality guidelines but also indicate that the criteria must consider whether there is sufficient assimilative capacity in the receiving environment.

The Global Acid Rock Drainage (GARD) Guide (INAP, 2014), developed by the INAP, also provides good international practice guidance on mine water management. It includes guidance on how to predict, prevent, mitigate, treat, manage, communicate, and consult about acid rock drainage and metal leaching, both significant challenges for mine sites. This guidance has been used by mining companies and recommended by governments as a required standard worldwide to guide sustainable mine design and protect water quality in the long term.

Another industry-specific standard is the International Cyanide Management Code. It provides principles for good international practices for gold mines, silver mines, and producers that use cyanide in the areas of production, transportation and storage, handling and use, operations, decommissioning, worker safety, emergency response, training, and engagement. These management measures are geared toward worker and public health and safety and making sure that cyanide does not get released and harm the environment. The International Cyanide Management Code was developed as a result of a cyanide spill in Barskoon near the Kumtor mine in Kyrgyzstan in 1998 and a tailings spill into the Danube River at the Aural Mine near Baia Mare in Romania in 2000. It was developed by a multistakeholder Steering Committee under the guidance of the UNEP and the then-International Council on Metals and the Environment (now ICMM) and has been shown to have improved the performance of the industry (International Cyanide Management Code, 2020).

The U.S. Environmental Protection Agency, the European Union, and many nations also have water quality standards to guide mine permit conditions that were developed and continue to be updated based on the scientific literature on toxicity.

ROLE OF GOVERNMENT

Drawing on good international standards and practices, there are a number of key actions that governments can take to effectively manage water resources around mining. These key actions are aligned with the MPF and are presented in a sequence related to policy development and the mine life cycle. Specifically, the key actions of governments include:

1. Develop water management policies and programs at the watershed level.
2. Set mine effluent criteria and receiving water objectives.
3. Through the ESIA review and mine permitting process, review the hydrology, water chemistry predictions, and management plans and set conditions for water use, reuse, and discharges.
4. Through the ESIA review and mine permitting process, review and approve mine water management plans.
5. During construction, operation, and closure, monitor and evaluate mine water management performance.
6. During construction, operation, and closure, enforce compliance to protect water resources.

WATERSHED MANAGEMENT: CONSIDER WATER MANAGEMENT AT THE WATERSHED LEVEL WHEN SETTING OBJECTIVES FOR WATER USE AND DISCHARGES

Beyond their responsibility to ensure the water rights of their citizens and to support agriculture and industry, governments are uniquely placed to manage water resources at the watershed scale. This stands in contrast to an individual, private entity, or company, each of which can only manage their actions around water at a small scale within the footprint of their control. In order to effectively manage watersheds, governments require an understanding of the watershed's meteorology, hydrology, hydrogeology, water quality, community water uses, community water values, and industrial water uses for both surface and subsurface water flows. An important step for governments is to begin to generate or acquire this data set. As the dataset is built and understood, the government can adjust its water management objectives, policies, and legal requirements.

Watershed-level management can be a daunting task. Governments can consider simple tools such as conducting surveys and/or organizing multistakeholder watershed management roundtables or committees to discuss and help governments understand user interests. The watershed group can then serve as a starting point for building a framework around watershed management. For example, the IFC set up a South Gobi Water and Mining Industry Roundtable in Mongolia to help protect community interests, share information, build capacity, and support mining (IFC, 2013b).

A strategic environmental assessment (SEA) is another tool that can be employed by governments to analyze these data and assess the potential impacts and risks within the watershed. An SEA for a watershed should address the range of users, impacts and risks, and governance options. It should be a transparent process and should include engagement with all relevant stakeholders.

The EU's river basin management plans are good examples of using a strategic assessment in developing watershed management plans. Under the EU Water Framework Directive 2000/60/EC, management plans have been developed and are being implemented for most river basins in the EU, and these plans integrate the needs of all countries within each river basin.

Some of the options for watershed management that exist for governments include to:

- Legally designate water protection or conservation zones (for example, for headwaters feeding a reservoir used for potable water for the community).
- Regulate maximum water extraction limits for the watershed that maintain flows for communities and for the survival of fish and other aquatic life.
- Set water quality guidelines to protect humans, agriculture, livestock, and fish and other aquatic life.
- Set policies for accepted water uses.
- Develop water remediation programs if the watershed is already impacted.
- Establish setbacks from open water, significant groundwater seepages, and sensitive near-surface aquifers.
- Set policies for permissible water uses, including mining if mineral concessions exist in the watershed.

BOX 4. CASE STUDY: MONGOLIA
REGULATING MINING IN HEADWATERS AND THE PROTECTION OF WATER IN ENVIRONMENTAL MANAGEMENT PLANS

Legal restrictions on mining depend on a country's values, goals, and programs. Mongolia's legal framework sets boundaries for the protection of its water resources through its Law on Prohibition of Mineral Exploration and Mining Activities in Areas in the Headwaters of Rivers, Protected Water Reservoir Zones and Forested Areas 2009.

To abide by the law, environmental management plans must contain "measures to ensure that mining operations are conducted in the least damaging way to the environment" (Minerals Law, Article 39.1.3). The plans must "identify comprehensive preventive measures to protect air and water, humans, animals and plants from the adverse effects of mining operations" (Minerals Law, Article 39.1.3). Additional details required in environmental management plans include:

1. Storage and control of toxic and potentially toxic substances and materials;
2. Protection, utilization, and conservation of the surface and underground water;
3. Construction of tailings dams and ensuring safety in the mine area;
4. Reclamation measures; and
5. Other measures as may be appropriate for the particular mining operation (Minerals Law, Article 39.1.4).

The potential for mining in a watershed should be considered when selecting governance options. If there are mineral resources and mineral concessions within the watershed, provisions should be made to allow for water use by a potential mine. However, mining concessions should only be allowed in those watersheds that have the capacity to accommodate all users, including the potential development of full-scale mines. By allowing mineral concessions in a watershed, it is often implied that water permits could be obtained to support mining.

Cross-border watersheds complicate watershed management. Transboundary agreements should be sought and established between countries sharing a watershed, so that common watershed protection goals can be set, monitored, and administered.

BOX 5. CASE STUDY: CHILE
WATERSHED-BASED GOVERNANCE IN ANTOFAGASTA, CHILE

The water management area of Antofagasta, Chile, covers an area of 127,221 km^2 and includes surface waters and groundwater aquifers that require protection. There are multiple demands for water across the region, including from agriculture, mining, hydroelectric, municipal, and industrial sectors (Arrau Ingeniería E.I.R.L., 2012). The Loa River watershed is the main watershed in the Antofagasta water management zone. The water management planning is headed by the Ministry of Public Works, is well developed, and has evolved over the last couple of decades to be more comprehensive and integrated. The strategic plan for water resources includes all key components of an integrated and comprehensive water management plan, including:

- Identification of water users and demands
- Characterization of surface and groundwater flows and water quality
- Characterization of capacity and risks of existing infrastructure
- Characterization of environmental resources requiring protection
- Institutional and economic constraints
- Analysis of water management tools
- Conservation requirements of non-economic factors
- Public participation
- Strategic environmental assessment
- Identification of gaps and needs
- Conclusions.

The water management program includes a comprehensive environmental assessment and permitting framework and is continually updated with ongoing monitoring and adapted for climate change.

Within this framework, mines like Lomas Bayas (previously owned by Xstrata Copper and now owned by Glencore plc.) can develop their own water management plans that meet the government's clear water protection requirements. Xstrata Copper developed the mine's water management plan with community input and helped improve local water management and agricultural activities (ICMM, 2012).

EFFLUENT CRITERIA: SET EFFLUENT QUALITY AND QUANTITY CRITERIA BASED ON RECEIVING WATER OBJECTIVES AND SITE-SPECIFIC CONDITIONS

Governments must also set mine effluent criteria in consideration of the water quality criteria defined to protect receiving waters at the local and watershed scales. Effluent guidelines for mining are broadly available for governments to draw from, including international guidelines (e.g., IFC EHS Guidelines for Mining, 2007a) and jurisdiction-specific guidelines (e.g., Canada Metal and Diamond Mining Effluent Regulations) (Government of Canada, 2002). These guidelines are usually based on the best available—and most economically viable—water treatment technologies.

Governments should promote water recycling and reuse to minimize treatment requirements, protect the environment, and reduce conflict over competing uses. In addition, governments should encourage investigation into and use of new technologies that reduce the use of water needed for mining. For example, the Vale S11D Eliezer Batista Complex is proposing to use fines dry magnetic separation to extract iron, resulting in a 93% reduction in water use (Gleeson, 2020; Vale, 2020).

Water quality criteria in many jurisdictions are set for the intended water use, which is typically drinking water, livestock, agriculture, and the protection of aquatic biodiversity. Extensive work has been conducted to determine acute and chronic toxicity of water quality parameters and to define water quality guidelines to protect environmental receptors. The U.S. EPA water quality guidelines for aquatic life (U.S. EPA, n.d.a) and for human health (U.S. EPA, n.d.b), for example, incorporate an extensive scientific literature base and are typically set at a level one order of magnitude lower than the chronic toxicity concentration for the most sensitive species. Sometimes criteria are variable based on local conditions and need to be analyzed on a site-by-site basis. Site-specific limits can sometimes be considered by government if the proponent can prove the effluent discharge will still protect downstream resources and water user requirements.

Any mine authorizations or water licences issued by the government should include mine effluent criteria that not only consider the best available treatment technology limits but also protect the downstream water uses. It is up to the mine proponent to provide a water balance and water quality model—and to propose water treatment options—in the ESIA that demonstrate that the proposed effluent will protect downstream water resources. The associated modelling that is done should be completed by competent professionals and should predict long-term water quality, incorporate seasonal and chemical complexities, define uncertainties, and identify contingency requirements.

Water treatment systems often need to be developed to meet project-specific requirements. Mine proponents should be required to provide supporting evidence to prove the proposed water treatment plans and technologies will meet the permitted effluent criteria, including bench-scale and pilot-scale studies. Note that samples of mine water are needed for testing but are not available until after the mine begins operations; therefore, a staged approach should be taken for proving the water treatment flowsheet. In a staged approach, a conceptual treatment process is developed based on detailed water quality predictions based on material sampling and testing, along with known treatment processes for existing mines with similar geology and mineral processing technology. Bench-scale testing may then be completed on samples from the metallurgical and geochemical test work. Depending on the complexity of the process, there may be a need to develop a pilot plant before constructing a full-scale treatment plant. In all cases where a new treatment method is proposed, sufficient testing and research should be provided, with contingency plans, to prevent the risk of the mine being granted a permit despite having untreatable effluent.

Site-specific effluent quality information may be needed in cases where the background receiving water quality is worse than receiving water quality guidelines. It should be the responsibility of the proponent to provide scientifically defensible studies and modelling (including an indication of uncertainties and contingency plans) to prove that the proposed effluent criteria meet the objectives for protecting downstream water uses.

Note that it is not recommended that mines be permitted as no-discharge facilities. At a minimum, an emergency discharge provision should be included in the permit, with associated conditions regarding allowable quantity and quality measures and special circumstances. Excess water destabilizes earth-filled structures such as waste rock dumps, leach piles, mine workings, tailings dams, and tailings piles; therefore, it is important for mines to have the ability to discharge water to maintain the structural stability of all facilities.

WATER PERMITS: CONTROL WATER USE AND DISCHARGES THROUGH SURFACE WATER AND GROUNDWATER PERMITTING

Water rights and use are typically allocated to companies by governments through permits or licences. In addition to the effluent criteria discussed above, mine authorizations and associated water licences should specify the rate of water extraction from surface or groundwater sources and the allowable discharge rates for all potential mine contact water. The flow rates should reflect an allowable volume over a set period of time and should be compatible with flow rate metrics the government uses to manage the water licence and permit allocations in the watershed.

As with water quality criteria, it should be the proponent's responsibility to provide a site-wide mine water balance to detail proposed water extraction requirements and list all proposed effluent discharges in the ESIA. The water extraction proposal should include details on how the mine's infrastructure design will prevent aquatic life from getting accidentally captured or harmed in the water intake.

Allowable extraction flow rates are determined based on an assessment of other water users and of environmental flow requirements: the minimum flows needed to support the aquatic life in the watershed. Flow requirements need to consider requirements for all users in all scenarios (annual variation, and drought and flood conditions) over the life of the mine, and they need to account for climate change. Environmental flows should also maintain enough water to support wetland habitats. It should be part of the proponent's responsibility to do detailed hydrological modelling and the regulator's responsibility to define recurrence rate requirements for design and management.

Mine authorizations and water licences typically specify conditions for point source effluents from the mine; however, there are other non-point sources that can contribute significant amounts of contaminants to the receiving environment, and these should not be overlooked. The legal frameworks should require non-point sources to be collected and controlled so that the source can be monitored for water quality and quantity. Examples include seepage from mine workings, both underground and open pit, as well as tailings and waste rock dumps.

BOX 6. MINE WATER PERMITTING LEGISLATION

Mine water permitting frameworks vary throughout the world. A comparative review of eight jurisdictions with long mining histories (including Australia [Western Australia], Canada [British Columbia], Chile, China, Peru, the Philippines, South Africa, and the United States [Alaska, Arizona, Nevada, and New Mexico]) was completed by Thomashausen et al. (2018). The review identified a variety of approaches that countries have taken to their legal frameworks for mine water permitting:

- Basis of allocation of water: Usually completed through a permit or licence for surface and/or groundwater from the water authority. Chile also has a private market for trading water rights.
- Duration of the water right: Ranges from a defined 5, 10, 30, or 40 years, to the mine life, to in perpetuity provided it is being beneficially used, or simply in perpetuity.
- Basis for regulating a mine discharge: Usually a separate discharge permit administered by the environmental authority.
- Requirement for an impact assessment: Most water permits are linked to the mine development impact assessment.
- Community consultation: Approximately half of the countries surveyed require community consultation on water permitting, usually as part of the impact assessment process.
- Enforcement: The approach varies from one authority responsible for enforcement, to a water or environment authority that can enforce permits, to each authority being responsible for enforcement of their applicable legislation, to public or private enforcement.

WATER MANAGEMENT PLANS: REVIEW AND APPROVE WATER MANAGEMENT PLANS PRIOR TO PERMITTING AND MONITOR THE RESULTS OF IMPLEMENTATION THROUGHOUT ALL MINE PHASES

Governments need to understand the proposed mine water management plan, check that good international practices are employed, and regulate the water discharge quantities to protect the receiving environment. Good international practices should follow the mitigation hierarchy (MH), for example, by avoiding water contact with mining operations using diversions, minimizing water use with recycling, and mitigating effluents with treatment.

The water balance and water quality model, a core component of a water management plan, should be a tool that passes on from the ESIA, is updated over the course of mine operations, and is used to manage and adapt to changes in actual conditions during mining and into closure. Governments should require that water management plans be submitted for review and approval with permit applications. Agencies should review the plans in detail to check that the commitments made in the ESIA and in the project approval are implemented through all mine phases and that there are sufficient mechanisms to check and adapt to changing conditions.

Mine water management guidance can be prepared and published by the government to define the content and structure of the required management plan. This will allow for submitted plans to be in a similar format so they can be reviewed and approved efficiently. Water management plans should be developed by competent professionals and through an engagement process with local stakeholders. The level of stakeholder engagement should be commensurate with the risks to the stakeholders. Key components of a water management plan include the following:

- The site-wide water balance, including all water sources, management structures, and discharge locations.
- A site hydrological model, including storm and drought events with different recurrence rates.
- Detailed predictions of site water quality using acid-base accounting, leach tests, and humidity cells.
- The water quality model, including locations for discharge and for downstream receiving waters compliance and monitoring.
- Effluent discharge criteria.
- Receiving water quality objectives.
- Descriptions of water management facilities and operational objectives, which can include minimizing mine contact water volumes and secondary containment features to manage breakages, upsets, or extreme events.
- Water treatment plant designs, with influent and effluent flow and quality specifications.
- Monitoring and reporting requirements.
- Adaptive management plans, including details on triggers and contingency plans.

BOX 7. MINIMIZE LONG-TERM WATER TREATMENT REQUIREMENTS BY DESIGNING FOR CLOSURE

Water and mine waste management designs and plans should have the fundamental objectives of preventing long-term active treatment and management of water from the mine. The key step in designing for closure is characterizing, segregating, and storing mine waste so it is physically stable and will not leach acid or other harmful constituents to waterways in the future. Designs should also allow for ultimately restoring natural drainages without requiring active pumping or diversions. Constructed wetlands are sometimes planned for long-term passive treatment instead of water treatment plants; however, it should be recognized that constructed wetlands are only semi-passive and will require long-term maintenance. They often require some form of active pre-treatment of water for their effective operation.

TRACK PERFORMANCE: ALLOCATE FINANCIAL AND HUMAN RESOURCES FOR TIMELY AND EFFECTIVE REVIEWS OF MONITORING DATA

Tracking the performance of the water management plans is key to protecting water resources. Conducting the sampling, monitoring, and evaluation for mine water management is the responsibility of the mining company. In many cases, governments request regular submission of water quality and flow data around the mine site and the receiving environment, but the data are only looked at briefly to see if they comply with permits (or worse, the data simply get filed). The reason for monitoring is not just to check compliance but to track trends. Since human and financial resources are often limited in governments, permit conditions should require reported data to be presented in such a manner that trends can be easily seen, such as graphs and summary tables of results. Analyzing trends allows government (and proponents) to identify, take proactive mitigation measures against, and prevent future non-compliance with permit conditions.

Participatory or community water quality monitoring programs can be implemented and financially supported by the mining proponent. Results from these monitoring programs should also be reviewed and evaluated. A feedback mechanism should be implemented to allow community members to notify government of any observed changes in water quality. This is an opportunity for community members to help the government identify water management issues that require addressing while also building the community's trust in government and the mine.

Governments can also promote improvements to monitoring programs in guidance documents. Technologies such as automated and remote sensing methods can be employed to measure water flows and water quality and to track trends in a timely and transparent manner. This technology can improve the timeliness of responses to unexpected events and prevent pollutants from being released from the mine. Online tools should also be promoted to share water data, track regional trends, improve regional planning, and more fully engage communities.

BOX 8. SHARING DATABASES FOR BETTER MANAGEMENT AND DECISIONS

Individuals and companies may prefer to keep water quality data confidential. It is the responsibility of governments to require all water licence and permit holders to provide baseline and monitoring data using standard metrics in a format that is usable by government and other entities in analyzing trends and to efficiently model and manage water for each mine and in the watershed as a whole.

Some mine industry initiatives have been undertaken to promote data sharing through a common database; however, the wide-scale collection of data for a common database has been most effective when these are legal requirements in ESIA submissions and permits.

Real-time water quality and environmental monitoring and data sharing via the Internet, community-level data stations, and easily accessible computers can help maximize community engagement and maintain stakeholder trust. Teck Resources, for example, uses digital sensors to generate real-time data on water and air quality at its sites at Carmen de Andacollo, Chile, and Elk Valley, Canada. The information generated is shared hourly with government and local communities to help them understand the mine's impact and to feel safe (World Economic Forum, 2017).

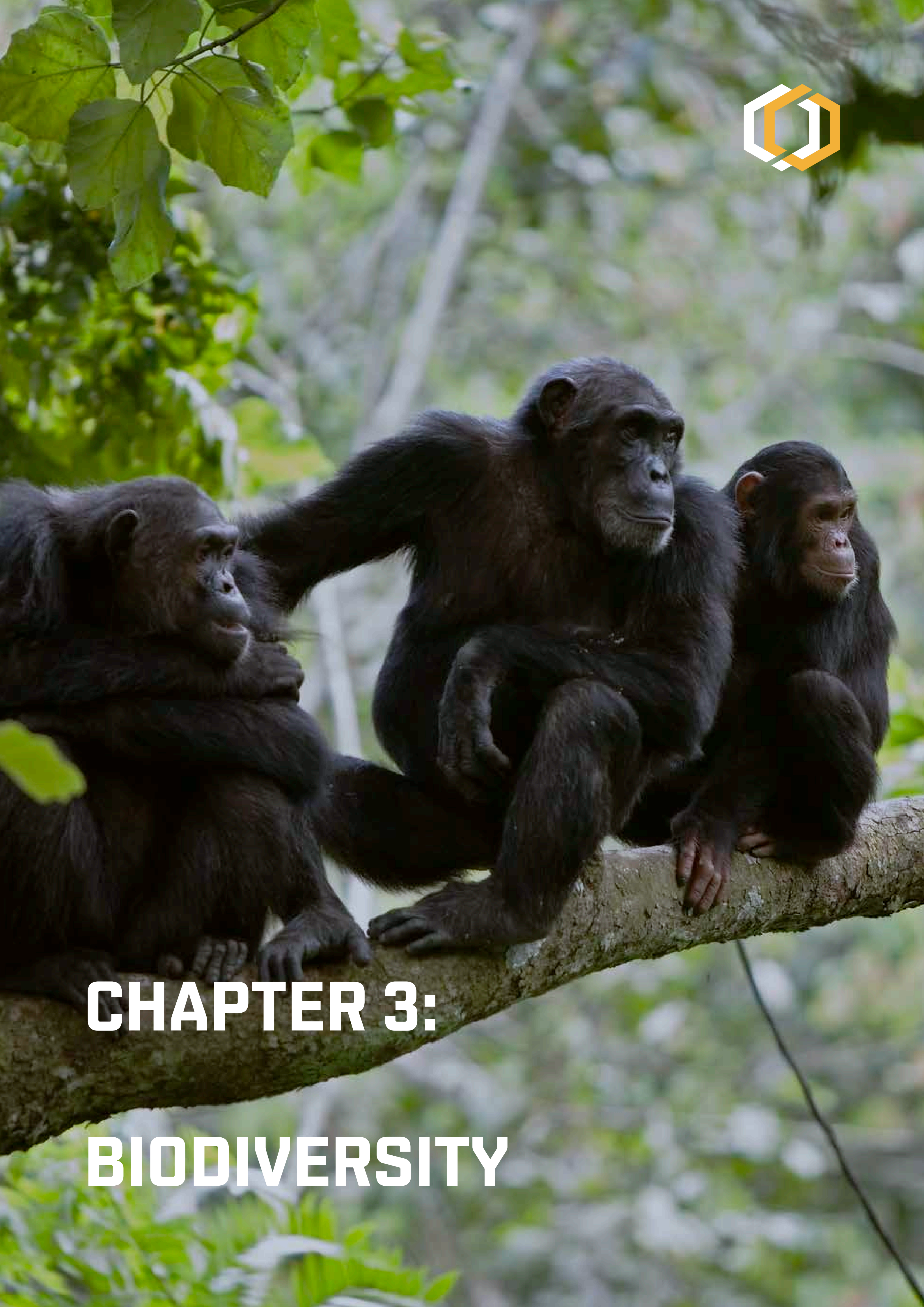
Governments can provide an opportunity for database sharing through their permit reporting requirements. Making data available via a government-managed website portal provides transparency and allows data to be available to a broad array of stakeholders to inform watershed management. In addition, SEAs and cumulative effects assessments will become more accurate and better informed by a large, regional database.

ENFORCEMENT: ENFORCE COMPLIANCE WITH WATER PERMITS

Enforcement is a critical component of the legal framework for the governance of water management. Appropriate consequences must be included in the legislation to manage situations where non-compliance is discovered upon review of the monitoring reports, from inspections, or from upset events. The consequences borne by the proponents should be tied to the level of risk of non-compliance. The enforcement system should be practical and efficient for regulators. It should also be noted that water discharge that is not compliant with the mining authorization or water licence may also be non-compliant with other legislation, such as fish protection and human health protection legislation.

Particularly high risks for non-compliance with mine effluent discharge permits occur during a mine's construction and as new facilities are commissioned, given that the construction of mines involves extensive land clearing over a short period of time. As a result, there is a high risk of sediment release from the erosion of newly exposed soils. Erosion control fences and settling ponds may be in place, but runoff can be challenging to manage, especially during high rainfall events. In addition, commissioning waste management facilities, process plants, and water treatment plants takes time before they are fully effective; there is therefore a risk of non-compliance as the systems are brought to full capacity. A robust water management design that considers site-specific meteorological conditions and erosion potential should be in place before construction to reduce the risk of non-compliant discharges.

Consistent enforcement of minor non-compliance incidents is critical to keeping proponents diligent, maintaining the trust and authority of regulators, and, most importantly, preventing larger incidents. Major incidents are often a result of the failure of many smaller components. Therefore, catching the failures of minor components early can prevent a major failure.



CHAPTER 3: BIODIVERSITY

FIGURE 7. BIODIVERSITY MANAGEMENT

ISSUE: BIODIVERSITY MANAGEMENT

Protect biodiversity, ecosystems and the services they provide

Mining projects can have direct and indirect impacts on biodiversity and ecosystem services, including:

- Habitat loss
- Ecosystem fragmentation and degradation
- Water, air, soil and noise pollution
- Human population growth
- Increased hunting, fishing, gathering and land clearance for agriculture
- Unintentional introduction of invasive species

National governments should enact policies that follow the mitigation hierarchy to avoid and minimize these impacts.

OVERVIEW

When not properly planned, activities across the mine life cycle—from exploration through the post-mining transition—can have significant direct and indirect impacts on the natural world. From land-use change and deforestation to pollution, greenhouse gas emissions, and the unintended introduction of invasive species, there are a host of ways in which mining operations can influence local and national biodiversity and ecosystem services. Many of these impacts are unavoidable but can be minimized or mitigated with good planning; in some ecologically sensitive areas with rich mineral deposits, such as nature reserves, wilderness areas, national parks, and UNESCO World Heritage Sites, the decision may be that these stay in the ground. Communities and governments will have to weigh their development priorities with their conservation needs. However, through collaborative planning, implementation, and monitoring and evaluation, these stakeholders can work with mining companies to ensure that economic value is generated with no net loss to biodiversity. In the best-case scenario, when properly planned and implemented, mining activities could even lead to a net gain for nature over the life of the mine.

Governments have a strong role to play here. According to the MPF, governments—through their legal and policy frameworks—should seek to avoid and minimize potential adverse effects of mining on biodiversity by:

- *Requiring that mining entities submit environmental management programs and updates for approval, during the permitting process and whenever there are significant process or operational changes during the operating life of the mine;*
- *Identifying, monitoring, and addressing potential and actual risks and impacts to biodiversity throughout the mining cycle; and*
- *Requiring that mining entities conduct monitoring on a continuous basis based on national standards and the conditions of the operating permit, compile and submit performance assessments to government, and publish regular reports that are readily accessible to the public.* (IGF, 2013, p. 36).

This chapter provides background information on biodiversity governance in the context of the mine life cycle. It is based on the latest information and trends and presents internationally accepted benchmarks for how to mitigate the biodiversity risks associated with mining. It explores how considerations on biodiversity can be integrated into mining policy and law. Improving the protection and management of biodiversity and ecosystems will help with the achievement of a number of SDGs, including SDG 14 (life below water) and SDG 15 (life on land). It should be noted that the scope of the chapter has largely been limited to large-scale terrestrial mining while acknowledging that offshore, deep-sea, and artisanal mining practices can all have significant impacts on biodiversity. For each of these, adhering to the MH (see below) remains good international practice.

This chapter presents why it is important to:

1. Consider biodiversity and ecosystem services when setting the objectives for mine design, establishing an environmental management system, managing mine closure, and establishing the post-mining transition.
2. Understand the MH and its application by mining companies.
3. Understand how to integrate good practice on biodiversity and mining into relevant mining policies, laws, regulations, and permitting.

KEY ISSUES

BIODIVERSITY AND ECOSYSTEM SERVICES

Biodiversity is, most simply, the variety of life on Earth in all its forms and interactions. At the global level, it is governed in part by the UN's CBD, which defines it as: "the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD, 2020).

There are three principal components of biodiversity (CBD, 2008):

- **Genetic diversity**: The variety of genes within a population, species, variety, or breed. Genetic diversity is crucial to maintaining the health of a population in response to environmental changes.
- **Species diversity**: The number of different species that are represented in each community or location. Globally, it has been estimated that there are 8.7 million species, and as of 2011, only a fraction of those—1.2 million—had been described (Mora et al., 2011).
- **Ecosystem diversity**: The variety of ecosystems that occurs within a larger landscape. This ranges from biome, the largest ecological unit, to microhabitat, the smallest.

Biodiversity and ecosystem services are closely related, though important distinctions should be made between the two. Biodiversity can be thought of as the "stock which sustains human life and livelihoods through the ecosystem services that it provides; that is, the processes through which the environment produces benefits useful to human populations" (CBD, 2008). These services can include clean water, pollination, soil fertility, carbon sequestration, decomposition of waste, and the control of pests and disease. Ecosystem services are often underpinned by biodiversity, and impacts on the latter will likely affect the delivery of the former (IFC, 2012e). This is particularly important in many of the areas home to mining operations, in which adjacent households and communities are typically more dependent on natural resources for their livelihoods, particularly those that more heavily rely on these services for their physical and spiritual well-being, including women and Indigenous groups.

The ecosystem services provided by biodiversity can be split into four main categories: provisioning, regulating, cultural, and supporting (Table 2).

TABLE 2. DESCRIPTION OF THE DIFFERENT TYPES OF ECOSYSTEM SERVICES

TYPE OF ECOSYSTEM SERVICE	DESCRIPTION	EXAMPLE
Provisioning	The goods or products obtained from ecosystems	Food, timber, fibre, medicines, and fresh water
Regulating	The benefits obtained from an ecosystem's control of natural processes	Climate regulation, disease control, water flow regulation, erosion prevention, nutrient cycling, water cycling, and primary production
Cultural	The non-material benefits obtained from ecosystems	Recreation, spiritual attachment, and aesthetic enjoyment
Supporting	The natural processes that maintain the other services	Soil formation, nutrient cycling, and pollination

Source: IFC, 2012a; The Biodiversity Consultancy (TBC), 2018.

Although societies' appreciation and understanding of the value of biodiversity has improved, globally, it continues to decline, and the rates of species extinction and ecosystem deterioration are accelerating (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019). According to the 2019 global assessment by the IPBES, 1 million animal and plant species are now threatened with extinction, many within decades, unless urgent, transformative action is taken. This alarming trend is driven by five key principal anthropogenic factors, each of which is relevant to mining: land- and sea-use change; direct exploitation of natural resources; climate change; pollution; and invasive species. These drivers, when considered in a context of greater demands on ecosystem services and for natural resources from growing populations, mean that avoiding further degradation or loss of biodiversity and ecosystem services by extractive industries is an increasingly important consideration for both governments committed to supporting the well-being of their citizens and companies needing to establish and maintain good relationships with surrounding communities.

BOX 9. GENDER AND BIODIVERSITY

Gender roles highly affect women's relationship with natural resources. According to data from the Food and Agriculture Organization of the United Nations, women comprise 43% of the agricultural labour force globally, and in least developed countries, 64% of women were employed in agriculture. In many African countries, up to 90% of subsistence agriculture is undertaken by women, as food crop production, kitchen gardens, and collection of herbs and vegetables are considered as a primary responsibility for women (Food and Agriculture Organization of the United Nations, 2015). In rural areas of Africa and Asia, women and men are highly dependent on biomass, such as firewood, agricultural crops, wastes, and forest resources, for their energy and livelihoods (Lambrou & Piana, 2006).

As such, women's relationships with ecosystem services and biodiversity are often much more significant than those of men, which can make them critically vulnerable. Loss of biodiversity can perpetuate gender inequalities by increasing the time it takes for women to perform tasks that typically fall to them, like collecting water, food, and fuelwood, reducing the time they have for education and income-generating activities (CBD, 2015). Accordingly, the specific biodiversity needs, constraints, and risks related to women should be integrated into impact assessments and regulations aimed at preserving and protecting biodiversity.

IMPACTS OF MINING ON BIODIVERSITY

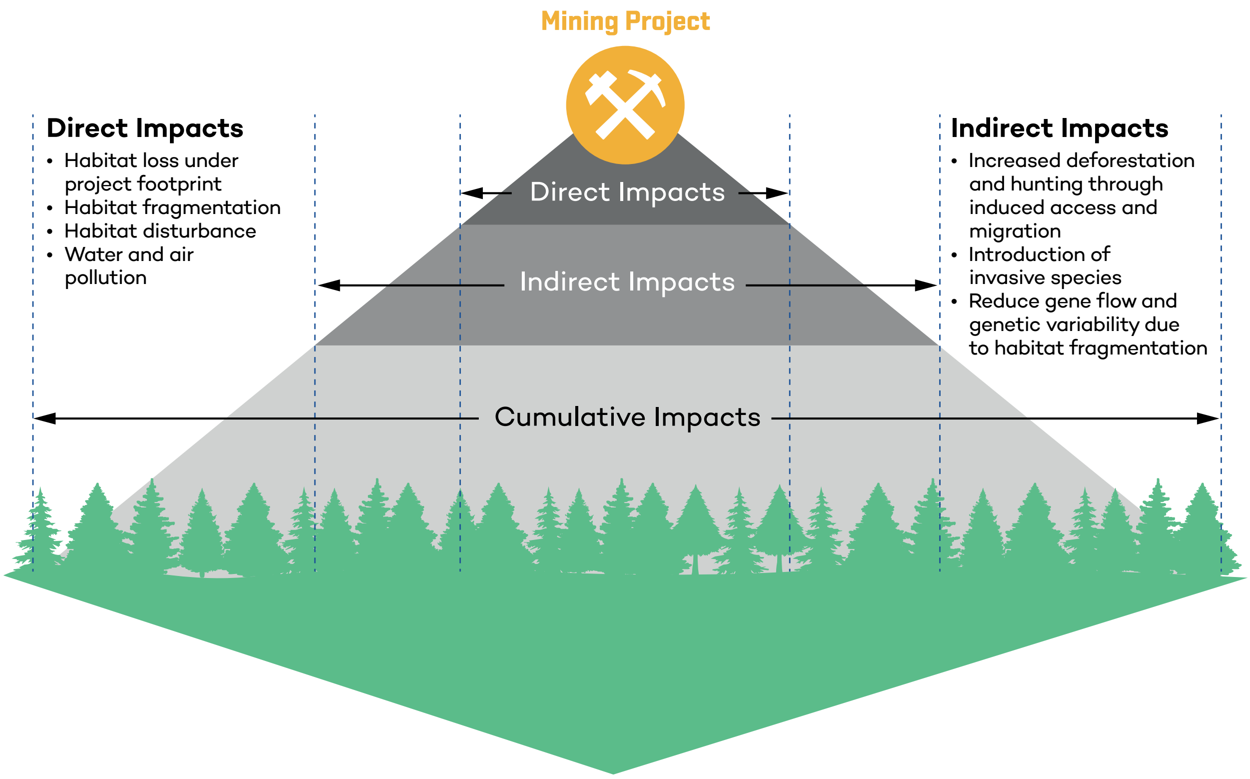
Mining projects have the potential to impact biodiversity and ecosystem services throughout their life cycle in a variety of ways. Understanding how development projects can impact biodiversity is vital to the development of appropriate mitigation measures. Impacts can be grouped into three main categories: direct, indirect, and cumulative (see Figure 8).

- **Direct Impacts**: These are the biodiversity impacts directly related to a mining project's footprint, activities, and decision making. They include habitat loss, fragmentation, and degradation, as well as water, air, soil, and noise pollution. Most direct impacts occur near project activities, either on-site or in a buffer zone; however, some direct impacts—particularly those relating to water pollution—can be felt farther from operations due to downstream transmission. Concrete examples of direct biodiversity impacts include land clearance leading to habitat loss; habitat degradation from acid rock drainage and contamination; species disturbance due to dust, noise, and light pollution; carbon emissions from energy use; and habitat fragmentation and changing wildlife movements resulting from the construction of roads, railways, and power lines (TBC, 2018). With adequate baseline knowledge of the ecosystem and the biodiversity present in the project area, these impacts can be largely predicted based on the location, size, and type of planned mining activities.
- **Indirect Impacts:** These impacts can be thought of as the "by-products" of mining activities. In many countries, they are often—though not exclusively—associated with project-induced human migration to and around the project area. This migration can be driven by the increased economic opportunities associated with the project—

whether real or perceived—and the expanded access to valuable natural resources that follows the creation or improvement of accessible infrastructure (such as roads) by the project. With this in-migration to a mining area comes the construction of settlements to house the growing population; more hunting, fishing, gathering, and land clearance for agriculture in order to sustain this population; and the unintentional introduction of invasive species into an ecosystem (TBC, 2018). All will affect local biodiversity and ecosystem services. Indirect impacts are much more complex and difficult to predict and often have more significant negative consequences for biodiversity than the more spatially restricted direct impacts listed above. Compared to direct impacts, they often also have a larger geographic scope, lower levels of predictability, and unclear boundaries of responsibility.

- **Cumulative Impacts**: These are the successive, incremental, and combined direct and indirect impacts of a mining project's development and implementation. When considered together, small, non-significant impacts can have a substantial negative effect on the ecological integrity of an area over time. When taken more broadly, consideration of cumulative impacts on biodiversity includes the compounding activities of other past, present, and reasonably foreseeable future projects in the area. These impacts will typically be more significantly cumulative in those areas experiencing rapid development, where those designing and managing mining projects fail to consider the additive effects of other projects in the area (IFC, 2013a).

FIGURE 8. DIFFERENT TYPES OF IMPACTS THAT MINING CAN HAVE ON BIODIVERSITY



Continuous and long-term monitoring by stakeholders will help to qualify or quantify actual impacts over time and refine any initial estimates of impacts made as part of ESIAs. Good international practice on biodiversity—both corporate and governmental—promotes no net loss (NNL) to biodiversity and highlights the benefits of a net positive impact (NPI) over the life of the project. To achieve this, projects should be designed and implemented in a way that first attempts to avoid any expected impacts from mining operations on biodiversity and ecosystem services (see below). For those impacts that cannot be avoided, minimization must then be pursued. Should impacts still remain, the proponent must address them through rehabilitation and restoration; any impacts remaining after these mitigation efforts are termed "residual impacts." Some of these can be addressed through offsets. These four actions for addressing the direct, indirect, and cumulative impacts of a mining project on biodiversity and achieving NNL or NPI form the basis of the MH and will be explored in the next section.

It should be noted that if expected residual impacts cannot be offset—because, for example, the area to be affected is unique and irreplaceable from a biodiversity perspective—governments should investigate the potential need to require the proponent to redesign the project or not permit the project to proceed. This could include projects that could result in extinction-level impacts (mining in an Alliance for Zero Extinction site) or in protected areas where the implementation of the project would run counter to the overall conservation objectives of the area.

INTERNATIONAL STANDARDS AND PRACTICE

The integration of biodiversity and ecosystem service protections into mining policy and legislation is fairly new. It has emerged from an increased and expanding understanding—from the public, from governments, and from corporations—of ecological processes and ecosystem services; of the growing economic importance of nature-based tourism; of the close links between environmental health and community support for mining projects; and of the operational and reputational risks that can derive from destroyed, degraded, or disturbed biodiversity, particularly in an era of increased information flow. Mines have been delayed or even temporarily closed due to community protests linked to the loss of ecosystem services or grievances around inadequate financial compensation received for such losses (TBC, 2018). There is also increasing recognition that a failure from mining operations to address the impacts of their operations on biodiversity can undermine critical livelihoods and nutrition, create significant long-term liabilities for developers, contravene human rights, and undermine irreplaceable cultural traditions (International Association for Impact Assessment, 2018). Finally, financial institutions are an important source of capital for mining companies, and approximately 50 international banks provide the majority of these resources (Arcus Foundation, 2014). Many of these banks have performance standards relating to biodiversity—including the IFC's Performance Standards, the European Bank for Reconstruction and Development's (EBRD's) Performance Requirements and the Equator Principles—which companies must adhere to as part of their lending requirements. The result of all of this is that integrating biodiversity considerations into mine design, construction, and operations is increasingly good business.

This section will look at the principal benchmarks guiding the interactions between mining operations and biodiversity/ecosystem services, including NNL/NPI, and the MH, as well as standards that have emerged in the industry and in government.

KEY BENCHMARKS

NO NET LOSS/NET POSITIVE IMPACT

As mentioned, mining companies—and businesses more broadly—are recognizing the need to manage their operational and reputational risks due to major drivers of environmental change, including biodiversity loss. In order to maintain good relationships with mine-adjacent communities, many companies are trying to design, build, operate, and close their mines in a way that results in NNL to biodiversity over the life of the mine, or—more positively—strives for an NPI on biodiversity over time.

NNL/NPI goals are biodiversity targets for development projects (including mining) that call for negative biodiversity impacts caused by the project to be either balanced (for NNL) or outweighed (for NPI) by biodiversity gains through compensation measures implemented in the project region (Alama et al., 2015). To properly measure the success of an NNL/NPI target, a relevant biodiversity baseline must be established prior to the start of a project and any of its impacts. Baselines can consider a number of factors; the EBRD, for example, requires that biodiversity and ecosystem baselines consider loss of habitat, degradation and fragmentation, invasive alien species, overexploitation, migratory corridors, hydrological changes, nutrient loading and pollution, and impacts relevant to climate change and adaptation (EBRD, 2014).

At this stage, the biodiversity and ecosystem services that are considered priorities from a conservation or community perspective should be identified. Once the baseline has been established and biodiversity priorities identified, the company—working with stakeholders—develops, implements, and monitors the progress of mitigation and compensation measures for priority biodiversity. This is measured against the baseline over the project's life cycle to ensure that—at the very least—the project has an overall neutral impact on biodiversity, but in a best-case scenario, that biodiversity improves over time.

The nature of mining guarantees that there will be some disturbance to the natural environment. Committing to NNL/NPI helps companies shift from intending to do less harm to biodiversity to doing overall good for biodiversity. For NNL or NPI to be achieved, it is recommended that a systematic approach to biodiversity management is taken, an approach that is normally referred to as the MH.

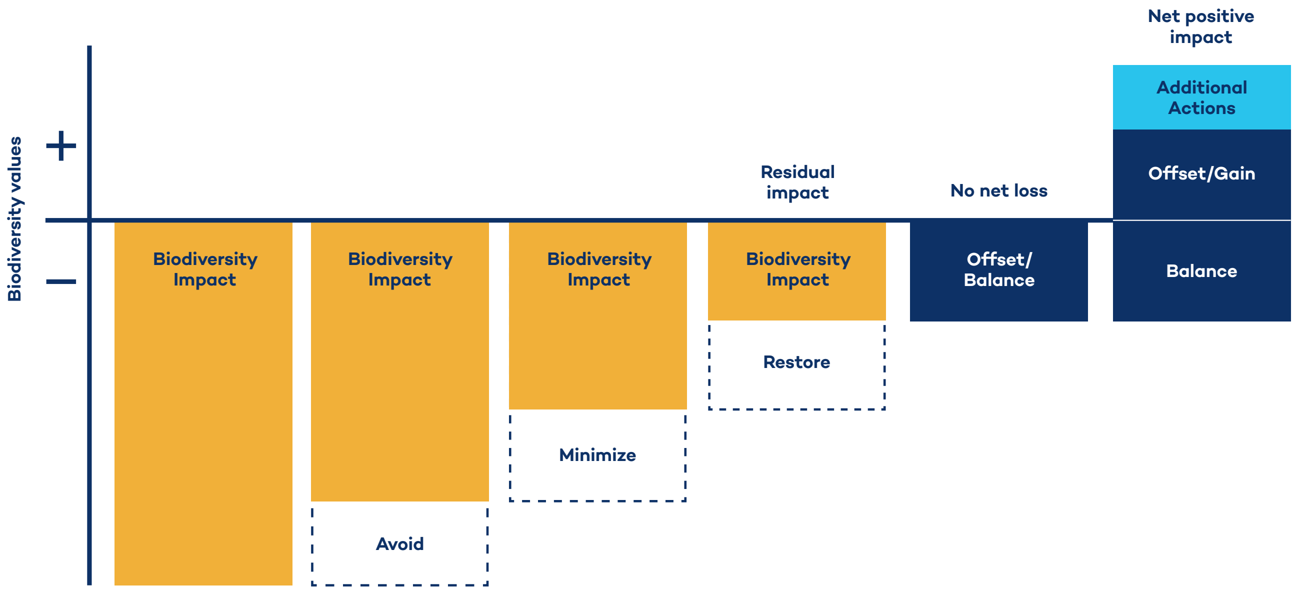
THE MITIGATION HIERARCHY

The mining industry is increasingly using the MH framework (see Figure 9) to guide companies in reducing the negative impacts of operations on priority biodiversity. The focus here is on significant impacts: for example, something threatening, unusual, or highly localized, of major economic or cultural value, or where the impacts severely reduce a species' viability.

The MH is an approach to mitigation planning; it is not a standard or goal in and of itself. It has been in use for several years and is included in the EBRD's Performance Requirement 6 and the IFC's Performance Standard 6 on biodiversity (see below). Application of the MH can help companies establish and maintain their social licence to operate, reduce their impacts and liabilities, and access funding, among other benefits. It is based on the iterative application throughout the project's life cycle of a series of four sequential steps (see, for example, EBRD, 2014; IFC, 2012e; TBC, 2018). These steps are:

1. **Avoidance**: Selecting sites and designing projects that avoid impacts to areas with important biodiversity.
2. **Minimization**: Minimizing unavoidable impacts through siting and operational controls.
3. **Rehabilitation/restoration**: Returning impacted areas to a natural state or to stakeholder-agreed land use.
4. **Offset**: Achieve NNL or achieve gains for habitats and species that still face significant residual impacts.

FIGURE 9. THE MITIGATION HIERARCHY



Source: Adapted from Business and Biodiversity Offsets Programme, 2009.

Avoidance and minimization activities are preventive and can be cheaper, while rehabilitation, restoration, and offsets are focused on remediation and are usually more costly. The former are usually preferable for a number of ecological, financial, and social reasons. As such, it is recommended that companies—and governments—place more emphasis on avoidance and minimization activities, which will reduce the scale and cost of any offset actions that may eventually be required. Preventive measures typically occur primarily—though not exclusively—during the planning cycle, while remediation activities occur later in the project, including throughout operations (TBC, 2015).

More detailed descriptions of all four steps in the MH are found below.

1. **Avoidance**: The first step of the MH is comprised of measures taken to avoid the project having a negative impact on biodiversity from the outset. This can be done through site design and scheduling; while the mineral deposit lies where it is found, proponents can determine: a) whether it is viable to develop, based in part on expected biodiversity impacts, and b) whether mine infrastructure can be designed and located, and activities timed, to avoid these biodiversity impacts. When choosing a site for project infrastructure, proponents should first undertake a landscape (or seascape) screening of biodiversity risks. With an improved understanding of these risks, the proponent can then design the site accordingly, including the infrastructure it requires, its placement, and its mode of operation. A company may, for example, design the placement of its access roads to avoid rare habitats or a key local species' breeding grounds. Scheduling can also help; certain project activities may be reduced or halted during a critical species' breeding or migratory season, for example, or during seasonal changes in the ecosystem.

   Avoidance is applied most rigorously to the highest-priority species. It is often the easiest and most effective way of reducing potential negative impacts, but it requires biodiversity to be considered from the design stage of a project onwards and relies on robust baseline data to be effective. It can be expensive, but these costs are usually upfront, one-off, and typically less than those associated with later steps.

2. **Minimization**: The second step in the MH, minimization, involves those measures taken to reduce the duration, intensity, and/or extent of any impacts on biodiversity that cannot be completely avoided and—when effectively applied—can eliminate some negative impacts. Minimization can be used throughout the project life cycle and can be a core part of ESIA requirements. All mining projects will have some unavoidable impacts on the environment, and most will have an impact on biodiversity; as such, it is recommended that companies get started on minimizing their impacts early in the project life cycle, and that—through risk management, adaptative management, and continuous monitoring—they constantly try to find ways to respond as more data becomes available and baseline conditions change over time (TBC, 2015). In Fiji, during the planning phase of an open-pit/underground mine, processing plant, and waste management facility for copper concentrate, it was found that the project could negatively affect endemic species of flora and fauna in an upland rainforest and cloud forest within the project's area of influence. Application of the MH led to

the development of a biodiversity management plan, which included key minimization activities such as restricted access to mine access infrastructure, mine site design around key species to reduce impacts, and buffer zones established around waterways (TBC, 2018).

There are three main types of minimization actions: physical controls, operational controls, and abatement controls. Physical controls adapt the design of project infrastructure to reduce potential impacts. Operational controls help to manage and regulate the actions of the people involved in the project. Abatement controls are those steps taken to reduce the level of pollutants that could have negative impacts on biodiversity and ecosystem services (TBC, 2015). Minimization activities can also support local content policies for companies and governments, as many are labour intensive and can present an opportunity for local jobs and community involvement.

3. **Rehabilitation/restoration**: Environmental restoration is required and expected on all mine sites and is dependent on the final land-use and post-mining transition plan. For those biodiversity and ecosystem impacts that cannot be avoided or minimized any further, specific rehabilitation and restoration activities are taken on-site to improve degraded or re-establish lost ecosystems. There is an important distinction between the two: restoration has specific ecological goals, often aiming to return an area to a state similar to what the ecosystem was before the project activities started, whereas rehabilitation aims only to restore basic ecological functions and/or ecosystem services (e.g., through planting exotic trees to stabilize bare soil or establishing a lake to provide a recreational facility). Reclamation, another commonly used term in the context of resource and mining impacts, is where the adverse environmental effects of surface mining are minimized, and mined lands are returned to a beneficial end use. Rehabilitation and restoration are frequently needed toward the end of a project's life cycle but may be possible in some areas during operation (e.g., through progressive rehabilitation after temporary borrow pits have fulfilled their use). To increase the chance of restoration success and decrease associated costs, restoration trials will need to be implemented from the early stages of the project onwards.

   Given that the pace of ecological recovery can be slow (restoring an old-growth forest, for example), it is at times hard for proponents to hit their restoration targets within project time scales; typically, these actions are most successful when they use well-tested techniques that have worked in similar contexts, are planned early in the project, and are piloted and implemented as soon as possible (TBC, 2015). Each of these considerations should be integrated into a mine's environmental management plan. Realistic ecological, social, and financial goals should be, too: What is ecologically possible at the site? What is socially acceptable at the site? What is financially realistic for the proponent (TBC, 2015)? Above all, these actions must work within the broader landscape and, through inclusive consultation, must have the buy-in of local communities.

Collectively, avoidance, minimization, and rehabilitation/restoration serve to reduce, as far as possible, the residual impacts that a project has on biodiversity and ecosystem services. Even after their effective application, however, one additional last step will likely be required to achieve NNL or NPI for biodiversity for the project: offsets.

4. **Offset**: These are measures taken off-site to compensate for any residual adverse impacts from mining operations after the previous three steps of the MH have been fully implemented on-site. Offsets are almost always related to conservation interventions related to land, freshwater, or sea management, and while typically away from the site of the direct project impacts, they should still be located in areas that deliver benefits to affected communities. It should be noted once more that not all residual impacts can be offset, particularly if the affected area is unique and irreplaceable in terms of its biodiversity and ecosystems (World Bank, 2017). Useful guiding principles governments can consider for how offsets are designed and implemented in their jurisdiction include equivalence (Is the offset a fair exchange for what is lost?); stakeholder engagement (Are the right stakeholders—particularly the most vulnerable—meaningfully and inclusively involved in the offset program?); additionality (Will the offset provide real, tangible positive changes on the ground?); and longevity (Will the offset impacts last at least as long as the activity impacts?) (TBC, 2015).

   There are two main types of offsets: "restoration offsets," which aim to rehabilitate or restore degraded habitat, and "averted loss offsets," which aim to reduce or stop biodiversity loss (e.g., future habitat degradation) in areas where this is predicted. Both will have to be diligently monitored over time to ensure that they are having the desired impact. Offsets are often complex and expensive, so mining companies are advised to do all they can to avoid and minimize impacts early and throughout the mine life cycle, and to design restoration and rehabilitation activities that are effective, comprehensive, and—where possible—progressive throughout the mine's life. Although not part of the MH calculation toward NNL or NPI, additional conservation actions can help to alleviate residual impacts for local communities where compensation (offsets) is happening in another location.

BOX 10. RESOURCES ON BIODIVERSITY, MINING, AND THE MH

For further information on the MH, please see the following resources:

Business and Biodiversity Offsets Programme. (2018). *Government planning for biodiversity net gain: A roadmap*. https://www.forest-trends.org/wp-content/uploads/2018/11/BBOP-Business-Roadmap-1-11-18.pdf

Cross-Sector Biodiversity Initiative. (2017). *CSBI timeline tool: A tool for aligning timelines for project execution, biodiversity management and financing*. http://www.csbi.org.uk/wp-content/uploads/2017/10/CSBI-timeline-tool.pdf

EBRD. (2014). *EBRD Performance Requirement 6: Biodiversity conservation and sustainable management of living natural resources*. https://www.ebrd.com/documents/environment/performance-requirement-6.pdf

ICMM. (2006). *Good practice guidance for mining and biodiversity*. https://www.icmm.com/en-gb/guidance/environmental-stewardship/good-practice-mining-biodiversity

IFC. (2012). *Performance Standard 6: Biodiversity conservation and sustainable management of living natural resources*. https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/performance-standards/ps6

International Union for Conservation of Nature (IUCN). (2016). *IUCN Policy on Biodiversity Offsets*. https://portals.iucn.org/library/sites/library/files/resrecfiles/WCC_2016_RES_059_EN.pdf

MAC. (2015). *Towards Sustainable Mining: Biodiversity Conservation Management Protocol*. https://mining.ca/wp-content/uploads/2019/02/Biodiversity-Conservation-Management-EN.pdf

Southern African Development Community (SADC). (2015). *Guidelines for mainstreaming biodiversity and ecosystem services in extractive industry*. https://biopama.org/wp-content/uploads/2021/02/SADC-Extractive-Industry-and-Biodiversity-Guidelines-EN-1.pdf

TBC. (2015). *A cross-sector guide for implementing the mitigation hierarchy*. http://www.csbi.org.uk/wp-content/uploads/2017/10/CSBI-Mitigation-Hierarchy-Guide.pdf

There are considerable benefits to adopting and using the MH in the mining sector. Ecologically, a company can protect and conserve biodiversity, maintain ecosystem services, and help sustainably manage living natural resources. This in turn reduces the risk of project activities undermining local livelihoods, human health, and the project itself. From an economic perspective, adherence to the MH can help companies reduce risks, costs, and delays while also helping the company secure easier and less costly access to finance, land, and resources. From a regulatory standpoint, the MH has increasingly been adopted by multilateral and regional development banks, including the IFC (see below), the World Bank, and the EBRD, while governments are now also starting to integrate the MH into laws and directives (see, for example, Australia's Environment Protection and Biodiversity Conservation Act and the European Union's Birds and Habitat Directive) (TBC, 2015). Finally, from a reputational standpoint, transparent and participatory efforts by companies to eliminate and compensate for biodiversity impacts represent an increasingly important part of establishing and maintaining the support of local communities and the government.

THE CONSERVATION HIERARCHY

The conservation hierarchy (CH) presents a newer approach to biodiversity protection for governments that complements and builds upon the MH. In addition to using the MH, governments can also apply the CH to take a broader and more proactive approach to their conservation actions, setting their conservation targets within the four categories of the MH (Sinclair et al., 2019). For example, rather than simply working with mining companies to avoid the impacts of mining on a particular patch of forest, the government can work together with them on actively identifying areas for protected area expansion. Rather than simply trying to reduce pollutant runoff (minimizing), governments can use the CH to collectively manage polluters to prevent habitat degradation (Sinclair et al., 2019). Working at the landscape level will help governments not only collectively manage the biodiversity impacts of all industry stakeholders but will also aid them in meeting their international environmental commitments, including to the CBD and the SDGs (specifically SDG 14: life below water and SDG 15: life on land). SDG 15 is particularly relevant, given that it calls on governments to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (United Nations Department of Social and Economic Affairs, 2015).

KEY STANDARDS

Many standards relating to biodiversity and ecosystem protection and conservation are linked to project financing from lending institutions and are increasingly converging around similar requirements.

IFC PERFORMANCE STANDARD 6

The IFC's Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources (PS6) is a key international standard for the management of biodiversity and ecosystem services by the private sector (IFC, 2012e). The IFC, which is the private sector lending arm of the World Bank Group, is a large source of multilateral private sector funding, and, as part of its lender requirements, it has developed eight performance standards for borrowers, covering a range of environmental and social impacts including gender, labour, Indigenous Peoples, resettlement, and cultural heritage. The objectives of PS6 are to protect and conserve important biodiversity and habitats, encourage the implementation of the MH, and promote sustainable management of living natural resources. PS6 represents good international practice for biodiversity management and has been widely adopted; for example, the Equator Principles Financial Institutions (which, as of April 2020, comprise 105 of the world's major finance institutions) are all signatories to applying PS6, and PS6 requirements feature in many leading government and corporate biodiversity mitigation policies. IFC clients must meet the requirements of PS6 while also complying with international and national laws.

By using the MH, governments can require companies to address a number of key threats across the landscape or seascape, including habitat loss, degradation, and fragmentation;

invasive species; overexploitation; hydrological changes; nutrient loading; and pollution. The basic targets for PS6 are a net gain for critical habitat (areas of the highest importance for biodiversity conservation) and NNL for natural habitat (areas of natural ecosystems). Achieving these targets requires an assessment of the habitat at the beginning of the project and evaluating the presence of critical habitats.[1] Specific requirements are also in place for projects located in internationally recognized and legally protected areas.

In areas that have been defined as critical habitats, projects can still go ahead under PS6 if the following are demonstrated:

- No other viable alternatives exist.
- There are no measurable adverse impacts on the biodiversity values for which the critical habitat was designated.
- No net reduction in global, national, or regional populations of Critically Endangered or Endangered species.
- Inclusion of a biodiversity monitoring and evaluation plan in the developer's management plan.

When these criteria are met, the project's mitigation strategy will need to be described in a biodiversity action plan (BAP). In order to demonstrate that the NNL/NPI has been achieved, long-term monitoring and evaluation of the critical or natural habitat are required, and the approach should be detailed in the biodiversity monitoring and evaluation plan.

EBRD'S PERFORMANCE REQUIREMENT 6

EBRD's PR6 on Biodiversity Conservation and the Sustainable Management of Living Natural Resources is one of 10 performance requirements covering key environmental and social issues that the bank requires the projects it finances to comply with. PR6 recognizes the importance of maintaining the core ecological functions of ecosystems and their biodiversity and requires that projects protect and conserve biodiversity, in part through the adoption of the MH (EBRD, 2014). As described above, this is grounded in risk and impact assessment, as well as the proponent characterizing baseline conditions and assessing the project's anticipated risks and impacts. How it will address these risks and impacts is then described in the project's overall environmental and social management system and project-specific ESMPs, including biodiversity management plans or, where appropriate, a specific BAP (EBRD, 2014). The management of risks through the application of the MH should happen across the project life cycle, which requires that proponents adopt adaptive

[1] Critical habitats are areas with high biodiversity value, including (i) habitats of significant importance to critically endangered and/or endangered species; (ii) habitats of significant importance to endemic and/or restricted-range species; (iii) habitats supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes (IFC, 2012e). Further guidance on how to proceed with a critical habitat assessment, including how to define an area of analysis and assess biodiversity features against thresholds for qualifying as a critical habitat, can be found in the IFC's associated guidance note (see further resources in Box 10).

management practices to ensure that what they are doing responds to changing conditions over time (EBRD, 2014).

EQUATOR PRINCIPLES

The Equator Principles are a risk management framework designed to help financial institutions determine, assess, and manage environmental and social risks in projects (Equator Principles, 2020). To date, 108 financial institutions in 38 countries have officially adopted the Equator Principles, covering the majority of international project finance debt in developing and emerging markets (Equator Principles, 2020). In adopting the principles, financial institutions must assess the potential environmental and social risks associated with a proposed project seeking financing—risks described in the ESIA and including those relating to biodiversity. This due diligence from financial institutions, and the ways in which the proponent plans to address and manage these risks and impacts through its ESMP, will in turn affect lending decisions. Financial institutions should also encourage their clients to share commercially non-sensitive, project-specific biodiversity data with the Global Biodiversity Information Facility, as well as relevant national and global data repositories (Equator Principles, 2020).

OTHER STANDARDS

The multilateral and regional development banks—from EBRD to the Asian Infrastructure Investment Bank to the Inter-American Development Bank to the Asian Development Bank—have now largely adopted NNL/NPI principles, and the requirements are now globally adopted. In addition to the above, there are several other lenders who have performance standards that also provide a good benchmark. The World Bank's Environmental and Social Standard 6 relates to biodiversity conservation and the sustainable management of living natural resources (World Bank, 2017). This standard follows a similar but less detailed framework for biodiversity that encourages the use of the MH and has an NNL target for natural habitats and an NPI target for critical habitats. The Inter-American Development Bank also has guidance for assessing and managing biodiversity impact and risks (Watkins et al., 2015), a detailed document that promotes the use of the MH and also outlines approaches relating to baseline studies, BAPs, and monitoring biodiversity.

In the international community, in 2016 IUCN adopted its *Policy on Biodiversity Offsets*, which provides authoritative, balanced guidance to help conservation organizations, governments, and companies reach common ground on the associated risks and opportunities regarding offsets (IUCN, 2016). The policy also led to the development of the Global Inventory on Biodiversity Offset Policies (GIBOP), which presents an inventory of 198 countries' national laws and legislation on offset provisions. On the industry side, the ICMM published good practice guidance for mining and biodiversity for its members in 2006. The guidance was developed to help members achieve Principle 7 of ICMM's Sustainable Development Framework, in which they have committed to "contribute to the conservation of biodiversity and integrated approaches to land use planning" (ICMM, 2006). It focuses on the integration of biodiversity considerations into all phases of mining (project development, operations, and closure planning and implementation); ESIAs and ESMPs; and stakeholder consultation and engagement. Finally, it offers guidance on mitigation, rehabilitation, and offsets (ICMM, 2006). Biodiversity has also been integrated into MAC's TSM program, with MAC offering both a protocol and framework for biodiversity conservation to its members, most recently updated in 2020 (MAC, 2015). The protocol outlines three indicators that have been established for MAC members to guide their actions with regards to biodiversity conservation. These are the establishment of a corporate commitment to biodiversity conservation with accountability and communications, facility-level biodiversity conservation planning and implementation, and biodiversity conservation reporting (MAC, 2015).

ROLE OF GOVERNMENT

When considering the merits of a proposed mining project, governments have to weigh the economic and development needs of the country and the local community against its conservation and environmental goals. However, active collaboration on biodiversity management and protection among governments, companies, and local communities is increasingly seen as a win–win–win for many of the reasons already mentioned. For governments specifically, working with mining companies to protect biodiversity and ecosystem services can help them achieve their commitments under multilateral environmental agreements, including SDGs 14 and 15, the Aichi Targets of the Convention of Biological Diversity, the Convention on Migratory Species, the Ramsar Convention on Wetlands, and the UN Framework Convention on Climate Change. In addition, biodiversity management activities can provide livelihood options for local communities, improve land-use planning, and support both mitigation and adaptation to climate change.

The draft text of the post-2020 global biodiversity framework produced by the CBD has presented an ambitious global target for biodiversity of NNL by 2030 and NPI by 2050 (CBD, 2020). These targets will almost certainly necessitate the adoption of new national-level legislation on biodiversity for many of the 196 Parties to the convention. As of 2019, more than 100 countries have developed—or are in the process of developing—policies for biodiversity offsets, 37 of which require biodiversity compensation as a prerequisite to project permitting and 64 of which enable voluntary offsetting (GIBOP, 2019). A large majority of the global offsets legislation (85%) is embedded in national ESIA frameworks, though there is only a weak link to the MH in much of this legislation (GIBOP, 2019). According to the GIBOP, as of 2019, only 10 countries globally required a robust application of the MH and guidance according to good international practice principles.

This represents a major weakness in the current national legislative frameworks because, by focusing only on offsets and not the entire MH, the cost for companies to comply with the regulation is likely to be higher, given that this last-step option is typically far costlier than avoidance, minimization, rehabilitation, and restoration. This may discourage or delay investment, and, for those projects going ahead, the risk of a net loss of biodiversity is higher.

There is no one way to integrate biodiversity and ecosystem services considerations into legal and regulatory frameworks; each country has its own economic, social, environmental, legal, and institutional context, and there is no one-size-fits-all solution to balancing national and local development and conservation needs. There are, however, certain good practices that governments can follow as they move toward improving the protection of biodiversity and ecosystem services.

POLICY DEVELOPMENT: DEVELOP AND ADOPT A NATIONAL POLICY ON BIODIVERSITY

The MPF recommends that governments develop, adopt, and implement laws, policies, and regulations to protect biodiversity and ecosystem services (IGF, 2013). The first step for a government aiming to improve biodiversity protection in the mining sector—and across all industries—is to set an explicit policy goal for biodiversity. This might mean stating that the government intends to move from cumulative loss of biodiversity to NNL to NPI by a set future date. The policy should also include a commitment to the entire MH and not just offsets. When setting the national objective on biodiversity, it is important to be realistic; it is better to achieve a lesser but viable target in the short term than to commit to an ambitious but unrealistic goal (Business and Biodiversity Offsets Programme, 2018). The policy should also be aligned with regional biodiversity initiatives and plans, recognizing the transboundary nature of many biodiversity and ecosystem issues.

With a policy goal established, the government can move toward implementation. This might entail the development of a new policy on biodiversity or the improved integration of biodiversity considerations into existing sectoral policies (including mining) through the country's National Biodiversity Strategies and Action Plans under the CBD. If a specific policy goal on biodiversity is not possible in the short term, the government could explore options for integrating the MH and NNL/NPI objectives into the ESIA process in the interim. Either way, the approach taken must be aligned with the country's development path and priorities as well as its international commitments (including the CBD and SDGs). The work on biodiversity policy should be consultative, involving relevant government departments and agencies, the private sector, and civil society, in order to ensure inclusivity and broad support.

LEGAL FRAMEWORKS: INTEGRATE THE MH INTO NATIONAL LEGISLATION AND REGULATIONS

Once the biodiversity policy, policy modifications, or national action plans or strategies are in place, the government must work to complete the roadmap: developing, for example, the necessary laws, rules, regulations, and standards required to implement the policy; establishing the institutions required to carry out the policy; securing and allocating the resources needed to implement and enforce the policy; and developing the guidelines that spell out the policy and its regulations to relevant stakeholders.

Robust laws, regulations, and guidelines covering the entire MH are essential for the implementation of biodiversity practices relating to NNL/NPI targets. Governments must first review and, as appropriate, revise their legal frameworks to include the protection of biodiversity and ecosystem services. National legislation needs to be clear on the scope, permitting requirements, and processes to be followed and the objectives that need to be met. Legislation or guidance that is not consistent across different sectors and could give rise to conflict should be aligned (SADC, 2015).

Some key considerations for the integration of biodiversity in national legal frameworks, as aligned with the MPF, include:

- Require that proponents conduct a systematic review with affected communities to identify priority ecosystem services (for both the operations and for affected stakeholders), taking into account the different values assigned to biodiversity and ecosystem services by affected stakeholders, including women, Indigenous persons, and other groups where appropriate.
- Provide guidance on acceptable metrics for measuring biodiversity loss and gain.
- Require that mining entities identify potential and actual risks and impacts to biodiversity before, during, and after mining as part of the ESIA process and based on national standards and the conditions of the operating permit.
- Explore opportunities for integrating biodiversity management plans, biodiversity monitoring and evaluation plans, and BAPs into ESMPs, and ensure that these are updated whenever there are significant process or operational changes during the operating life of the mine.
- Compile and submit performance assessments to government and publish regular reports that are readily accessible to the public.
- Clarify no-go scenarios, locations, and situations in which negative biodiversity impacts are not permitted in the most sensitive areas, including protected areas, UNESCO World Heritage Sites (Natural and Mixed), and Alliance for Zero Extinction sites.
- Develop and distribute guidance on the set of activities that can deliver the secure and additional long-term gains needed to offset any residual impacts, the exchange rules outlining which types of impacts on biodiversity can be offset by which type of gains (for example, like for like or better), and the areas suitable for offsets (and those to be avoided).

As noted above, the MH can be usefully integrated as a risk assessment and management tool in the ESIA process or regulations and into ESMPs. By integrating the MH into the ESIA process, governments can help ensure that biodiversity considerations are included in the permitting and licensing system for major projects involving significant land-use decisions, including mining projects. As part of the screening or scoping phase of the project, and prior to the ESIA, the MH can be used to assess the magnitude of biodiversity and ecosystem services risks: for example, the feasibility of mitigating impacts at the site or whether the site can be restored (Cross-Sector Biodiversity Initiative, 2015). During the ESIA process, the MH can serve as the principal organizing framework for biodiversity and ecosystem services considerations within the process, guiding associated planning and communications. Finally, once the ESIA has been submitted and construction and operations are underway at the mine site, the MH can be used as an adaptive management framework for practitioners, an audit tool for regulators and financial institutions, and a tool for offset design (Cross-Sector Biodiversity Initiative, 2015). Governments will have to set and communicate approval conditions for the biodiversity components of ESIAs and ESMPs and can require that adequate biodiversity impact assessment reports are publicly available and are integrated into the baseline data for future environmental management programs.

BOX 11. CASE STUDY: ECUADOR – COMMUNITY ACCESS TO CLEAN WATER AND BIODIVERSITY CONSERVATION IS ENSHRINED IN THE CONSTITUTION

The 2008 Constitution of the Republic of Ecuador, as amended at the Referendum of February 4, 2018, states that basic principles of the state include, "Planning national development, eliminating poverty, and promoting sustainable development and the equitable redistribution of resources and wealth to enable the realization of good living" (Republic of Ecuador, Article 3(5)). The literal term for "good living" is "*sumak kawsay*," an Indigenous term that refers to living in harmony with community and the environment (Berros, 2015).

The constitution assures that, in order to protect and manage biodiversity and the natural environment, "the State shall establish and implement programs with the participation of the community to ensure the conservation and sustainable use of biodiversity" (Article 57(8)). In particular, the constitution aims to protect "the biodiversity of the Amazon ecosystem," requiring the central government and decentralized governments to adopt sustainable development practices (Article 259).

The constitution further aims "to foster participation and social monitoring, acknowledging the diverse identities and promoting their equitable representation, at all stages of governance," (Article 276(and "to restore and conserve nature and maintain a healthy and sustainable environment ensuring for persons and communities equitable, permanent and quality access to water, air and land, and to the benefits of natural resources and natural assets" (Article 315).

INSTITUTIONAL ARRANGEMENTS: ESTABLISH AND MAINTAIN ADEQUATE INSTITUTIONS FOR BIODIVERSITY PROTECTION

As with water, waste, and emergency preparedness, governments must also ensure that the institutional arrangements required to implement and enforce its policies and regulations on biodiversity protection are in place to ensure strong and transparent governance of MH-related activities. Assigning a lead department or agency, or a task force within that department or agency, will help ensure that there is ownership for the policy's implementation and that there is a clear structure in place for communication, monitoring, evaluation, and adaptive management. Building and maintaining high-level, cross-ministerial support for the policy will be important for its successful implementation. It will also be critical to recognize that this can be difficult to achieve given the competing priorities across ministries.

One early task for such a group will be to establish a coordination mechanism for different relevant branches of government and to review relevant ministerial policies on biodiversity to ensure that it can identify and remove any contradicting policy signals coming from the government. This could include integrating biodiversity considerations—and NNL or NPI objectives—into land- and sea-use planning; clarifying which institutions will play a role in the generation and communication of environmental data and information; assigning roles in the review of biodiversity assessments and management plans; and assessing how individual projects and their cumulative progress are helping the government achieve its overall biodiversity goals. While coordination is required across ministries, departments, and agencies, the lead agency must also define and communicate the role of subnational and local levels of government in the delivery of national biodiversity targets. The government must also clearly outline who is responsible for enforcement and ensure that the institutional arrangements are in place to follow up on any breaches or non-compliance.

GUIDELINES: ESTABLISH CLEAR GUIDELINES ON BIODIVERSITY OFFSETS

The government will have to ensure that clear, consistent guidance is developed for the use of biodiversity offsets, that it is available to potential buyers and sellers of offsets, and that these stakeholders are connected. These guidelines should be developed in consultation with mining companies, but also with conservation organizations to ensure that they result in meaningful, effective offsets. A global inventory outlining the scale, scope, and implementation status of biodiversity offset policies is available through the IUCN and its partners at the GIBOP. For situations in which larger offsets are required, governments can consider making allowances for larger, aggregated offsets with multiple mine developers in a mining district or establishing new reserves or protected areas in the portion of a large mining concession not needed for mining. Governments will need to provide mechanisms for big offset options for mining if they are to meet their biodiversity conservation and protection goals.

COLLABORATION: ESTABLISH MECHANISMS, PLATFORMS, AND REQUIREMENTS FOR INFORMATION SHARING AND REPORTING

Companies and local communities will need reliable, timely, and robust data, maps, and information on local development and local biodiversity and ecosystem services to establish baselines and metrics. They will need to design effective and realistic biodiversity and ecosystem management systems for their mine plans. The government should work with communities and civil society to establish mechanisms that allow them to provide this information in an open and accessible way and in a standardized format that is easily understood and used by stakeholders—including those with limited or no literacy or access to information technologies. Governments can also provide a platform where mining entities are able to engage with each other on landscape-level biodiversity issues, in part to promote more attention to cumulative impacts of operations and integrated offsets. This information can then form the basis for landscape-level planning, baselines, and metrics to calculate the impacts of the mining operation and the potential gains associated with the mining company's biodiversity and ecosystem conservation activities. One existing external source of such information is the Global Biodiversity Information Facility, which is an international network and research infrastructure that aims to provide open access to data about all types of life on the planet. Once provided, the information should be regularly updated to reflect changing ecological conditions and—hopefully—the positive results of the company's conservation activities at the project and landscape levels.

Once the mine's conservation activities are developed and planned with inputs from all stakeholders, but before they are underway, proponents should be obliged to publicly disclose how they were developed and their progress on the implementation of these measures using indicators (originally outlined in the monitoring plans). The same transparency should be required of offset providers and managers; they should also publicly disclose how offsets are designed and how they are being implemented. This will allow the public, and particularly the affected local community, to monitor progress over time and for the government to assess broader progress toward its biodiversity policy goals.

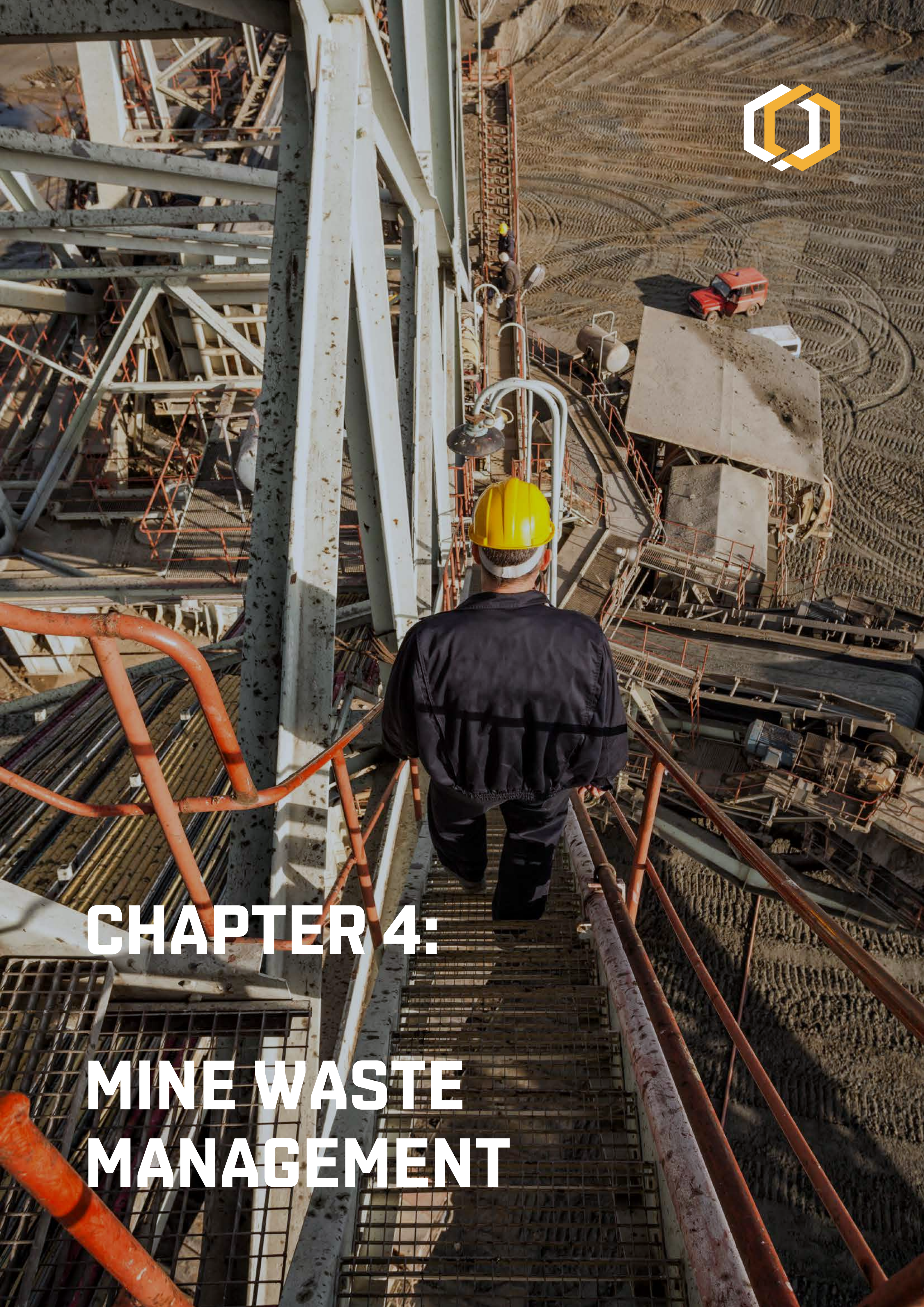
ENFORCEMENT: ALLOCATE ADEQUATE FUNDING TO SUPPORT IMPLEMENTATION AND ENFORCEMENT

Finally, adequate resources will need to be allocated to the protection and strengthening of biodiversity and ecosystems. This includes funding to cover the monitoring and enforcement of the biodiversity components of the legal framework for mining, including those activities that take place after mine closure. The government must require that sufficient financial assurance is in place for long-term risks to ecosystem restoration success and that sustainable financing is in place if needed to meet the long-term requirements of NNL and NPI.

Governments can also consider engaging independent panels of experts or review boards for those complex projects with significant impacts on biodiversity. This could include formal review boards like the Mackenzie Valley Review Board, which was established to conduct fair and timely environmental impact assessments in the Mackenzie Valley of the Northwest Territories in Canada. It can also include more project- or topic-specific panels, such as the one set up by the IUCN to provide objective guidance on the environmental and socio-economic restoration efforts that are underway in the Rio Doce watershed in Brazil, following the Fundão tailings dam breach at the Samarco mine in 2015 (IUCN, 2017).

Beyond the mining sector specifically, this includes not only sufficient funding for a country's protected areas but also ensuring that relevant government staff have the time, skills, and resources needed to work on the implementation of the country's biodiversity policy and enforcement of its regulations. This will require adequate training for staff in biodiversity and ecosystem services impacts in the concepts of NNL and NPI, and in the application of the MH. Government staff will also have to be capacitated to review and approve ESIA and biodiversity management plans.

Capacities must extend beyond government staff to independent external experts with strong regional experience; these individuals can assist in the development of an MH for a proposed project (SADC, 2015). Local knowledge is important here; identifying the beneficiaries of ecosystem services requires sociological, gender, and anthropological expertise and stakeholder consultation. These independent experts can also assist in the preparation of conservation plans, baseline studies, impact assessments, loss–gain calculations, and the design of feasible offset activities and management plans (Business and Biodiversity Offsets Programme, 2018). Domestic capacities should also be built for offset providers and brokers to generate and maintain long-term gains in biodiversity and ecosystem services.



CHAPTER 4:

MINE WASTE MANAGEMENT

FIGURE 10. MINE WASTE

ISSUE: MINE WASTE

Ensure the long-term physical and chemical stability of all mine waste, including:

- Waste rock
- Tailings and related facilities
- Spent heap leach pads and facilities
- Sludges and precipitates from water treatment or minerals recovery
- Dust

Waste systems and facilities must be engineered to eliminate the risk of failure and minimize the risk and exposure to people, land, agriculture, vegetation, and animals.

OVERVIEW

Mining typically moves and processes large amounts of materials to extract the target commodity. The excess material is known as mine waste. Mine waste can have some mineralization that may be reactive or that could be released from the rock when it is mined, crushed, exposed, and dispersed in air and water. As a result of having large amounts of waste material coming out of their operations, mining companies need to spend a lot of time and energy on managing these wastes effectively (e.g., waste rock piles, tailings management facilities, spent heap leach facilities, overburden, etc.). Mine waste management facilities are typically permanent structures; therefore, they need to be designed for closure from the planning stage. Consequently, the closure plan needs to be periodically updated as mine plans are revised through construction and operation.

Given the potentially significant environmental and social impacts that poorly managed mine waste can have on operations, communities, and ecosystems, governments have a central role to play in ensuring that these by-products of the mining sector are effectively managed. According to the MPF, governments will achieve this by:

- *Ensuring that structures such as waste dumps and tailing storage facilities are planned early, designed, and operated such that geotechnical risks and environmental and social impacts are appropriately assessed and managed throughout the entire mine life cycle and after mine closure;*
- *Requiring that mining entities design, operate, and maintain mine waste structures according to internationally recognized standards; and*

- *Requiring that mining entities commission independent expert reviews and report to governments prior to development approval, when changes in design are proposed, and at regular intervals during the operating phase*. (IGF, 2013, p. 36)

This chapter provides an overview of critical mine waste management issues and applicable good international standards and practices. It then provides more detailed guidance on the role of government in supporting sound mine waste management. Mine waste in this chapter includes waste rock, tailings, spent leach pads, mine water treatment sludges, and dust. For the purposes of this report, mine waste does not include general industrial and municipal wastes such as hazardous waste, non-hazardous waste, gaseous emissions, recyclables, hydrocarbons, sewage, and putrescible wastes. There is already guidance in place for the governance of these general wastes, and controls for these wastes are typically integrated into permit conditions.

The overall objectives of mine waste management are to first minimize the volume of waste produced and then to ensure the physical and chemical stability of all mine waste management facilities for the long term. Minimizing the volume of mine wastes should consider innovation, reprocessing, repurposing, and liability reduction. These objectives support the UN SDGs (specifically goals 6, 8, 13, 14, and 15) in that small, stable mine waste facilities will protect water resources, life below water, and life on land while still supporting the mining needed in many areas for local economic prosperity.

As with many aspects of environmental management in mining, waste management should follow a risk-based framework to determine priorities. Waste management in mining is complex and incorporates a range of disciplines, including geology, geochemistry, hydrology, hydrogeology, environmental engineering, civil engineering, and geotechnical engineering. In addition, engineered facilities need to incorporate site-specific design criteria for seismic conditions, for the local climate, and to accommodate climate change scenarios. As a result, the best mine waste management option will vary from site to site based on the local conditions. It is important for governments to have an overall understanding of the potential issues and what affects them and to obtain expert advice and assistance where and as needed for effective control and governance through all mine phases. This includes once mining has finished and the mine has been closed and rehabilitated, if and when responsibility for long-term management of facilities reverts to government. For example, a national seismic risk map should be used as a guide for foundation design and slope stability, but detailed assessment and modelling are required for waste deposition and storage facility design for specific seismic zoning, bedrock, and hydraulic conditions. Similarly, climatic conditions and the impact of climate change on engineered structures and their systems are required in consideration of various operating and post-mining transition and closure conditions.

This chapter presents why it is important to:

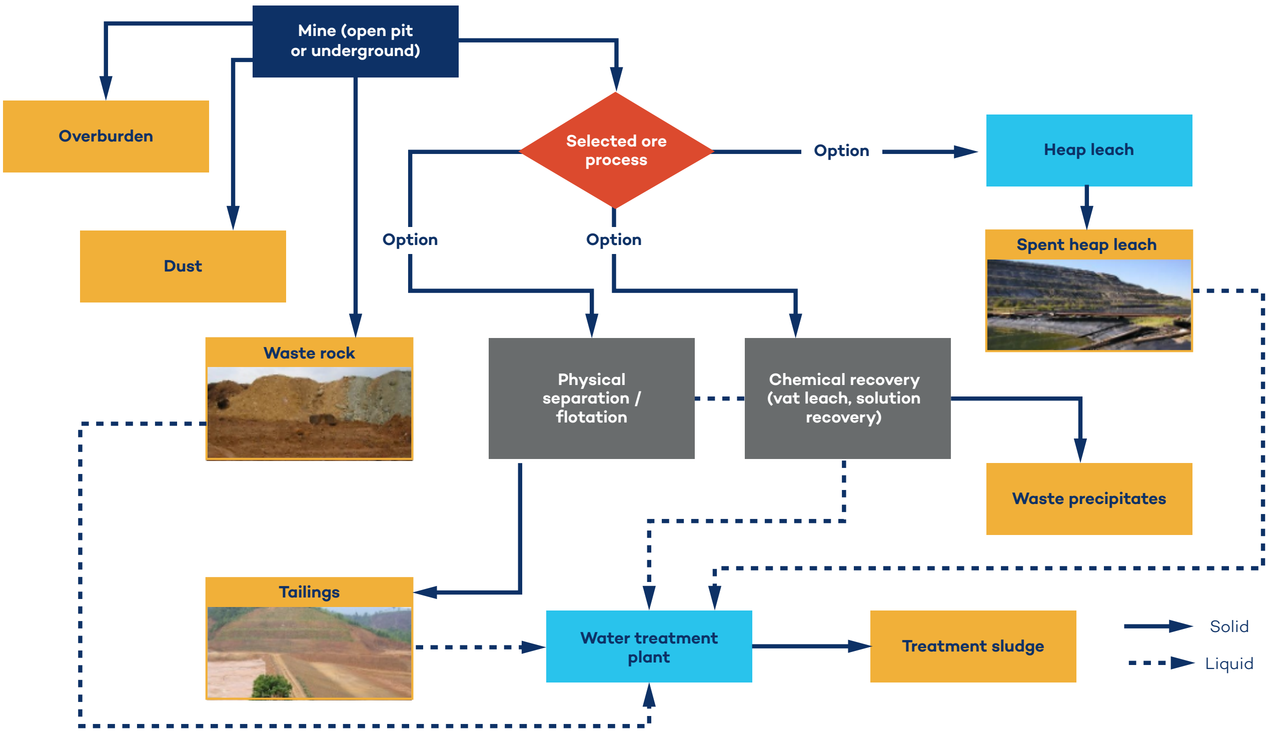
1. Set clear standards and codes for good mine waste management based on site-specific risks.
2. Set quality requirements for tailings facility stability and establish requirements for independent tailings review panels based on site-specific risks.
3. Require accountability to reinforce good corporate management.
4. Review mine waste management designs, risk assessments, and plans prior to project approvals and permitting.
5. Consider financial mechanisms to manage facility risks in the long term.
6. Allocate financial and human resources for timely and effective reviews of monitoring data.
7. Enforce compliance with mine permits.

KEY ISSUES

Typically, the extraction of mineral-bearing ore requires the mine operator to first remove non-economic waste rock surrounding the ore body. The ore is then processed to recover the economic minerals. An exception is in situ leaching or solution mining, where solutions are pumped into an orebody that dissolves the economic minerals into a solution, which is then extracted in liquid form and further processed (e.g., some gold, copper, and uranium mining). Managing these waste materials safely and effectively will be critical to ensuring the safety of staff, the surrounding communities, the broader ecosystem, and the continuing operation. A consultation process should be in place with potentially affected peoples during the alternatives assessment in the planning phase for high-risk waste management facilities.

Mine wastes can comprise a major proportion of the total material managed in mining—typically much larger by volume than the ore. The strip or waste-to-ore ratio defines how much waste rock there is compared to ore and can range from less than one-part waste to one-part ore to more than 10-parts waste to one-part ore. From 1 tonne of ore, the amount of economic mineral is recorded in grams per tonne for precious metals or in small percentages for other ores, leaving the remaining non-economic minerals in the ore to be managed and stored. In addition, as the rock is blasted and removed from the ground, it increases in volume and is less dense than when it was intact in the ground, which is often termed as the “swell factor.” Innovations and opportunities should be considered to find value in mine wastes in support of a circular economy and to minimize risks. Figure 11 illustrates the sources of mine waste from mine operations, each of which is discussed below.

FIGURE 11. SOURCES OF MINE WASTES FROM THE MAIN MINE COMPONENTS



BOX 12. PROMOTING A CIRCULAR ECONOMY WITH MINE WASTES

An important goal for sustainable mining is minimizing waste by finding its value in contributing to a circular economy. The Brazilian government is engaging with the public to find better ways to use and manage tailings in mining and open opportunities for small-scale miners. The National Mining Agency of Brazil (Agência Nacional de Mineração, 2020) opened a public comment period in late 2020 to solicit contributions from society on the use of waste.

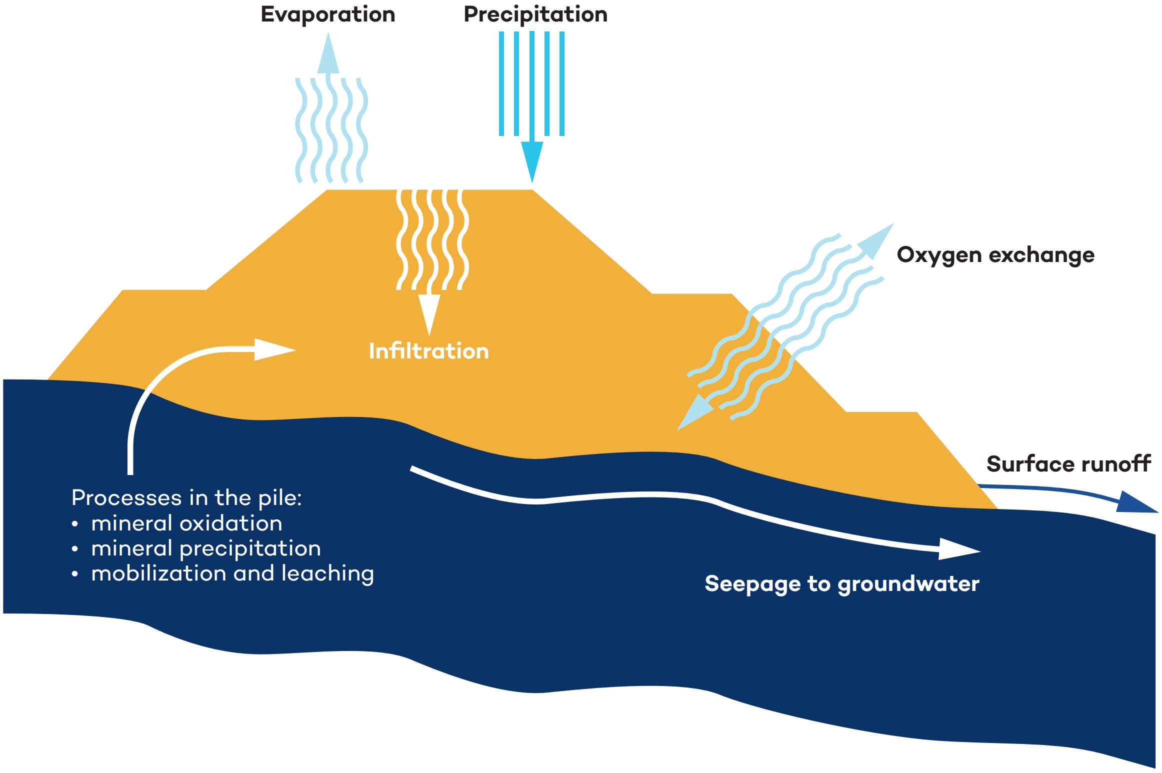
BOX 13. MINE WASTE AND GENDER

Although men and women are exposed to identical methods of absorbing chemical substances in mining, the respective accumulation zones of the toxic molecules and the affected or damaged organs may not be the same; this may result in different health consequences. Women's specific physiologies at different life stages (childhood growth, menstruation, pregnancy, lactation, and menopause), along with their physical percentage of body fat, weight, and ability to absorb and retain nutrients, affect their susceptibility to disease (CCSG Associates, 2004). In addition, gender division of labour results in women—and also children—being in more direct contact with potential sources of contamination (such as polluted water sources or land polluted with dust) and experiencing more severe forms of disease, such as hypertensive disease, ischemic heart disease, stroke, anxiety, and depression (Hendryx & Inness-Wimsatt, 2013). Pollution also adds to women's double burden, as they tend to care for sick children who are unable to go to school and must stay home due to contamination-related symptoms, including air pollution (Montt, 2018).

WASTE ROCK

Waste rock (and overburden) storage facilities, leach pads, and tailings storage facilities are large structures that must be carefully engineered to ensure they are physically and chemically stable in the long term (i.e., the slopes will not fail or excessively erode and deposit material downstream). These structures must be designed to be physically and chemically stable to ensure the safety of workers and the public, given the characteristics of the stored material; the climatic, geotechnical foundations; and the seismic characteristics of the mine site. The design must also account for how these factors might change over time. The chemical stability of these facilities is also critical since they can be the source of long-term pollutants leaching into the receiving environment. For example, waste rock (and potentially overburden) can be the source of acid generation and/or metal leaching for centuries if stored incorrectly. Special considerations will be required for radioactive mine wastes from uranium and rare earth mining due to the inclusion of uranium and thorium in the waste rock. Conversely, in some deposits, some waste rock does not contain harmful minerals, is considered "clean," and can be used for construction. For example, the uranium mining company Cameco uses clean waste rock as aggregate for maintaining site roads and in concrete mixtures at most of its mines (Cameco, 2016). Many mines, including the Kumtor gold mine in Kyrgyzstan, use their clean waste rock for downstream tailings dam and buttress construction. Figure 12 illustrates the geochemical and hydrometeorological processes in a typical waste rock facility.

FIGURE 12. WASTE ROCK STORAGE FACILITY PROCESSES



Source: Adapted from Garbarino et al., 2018.

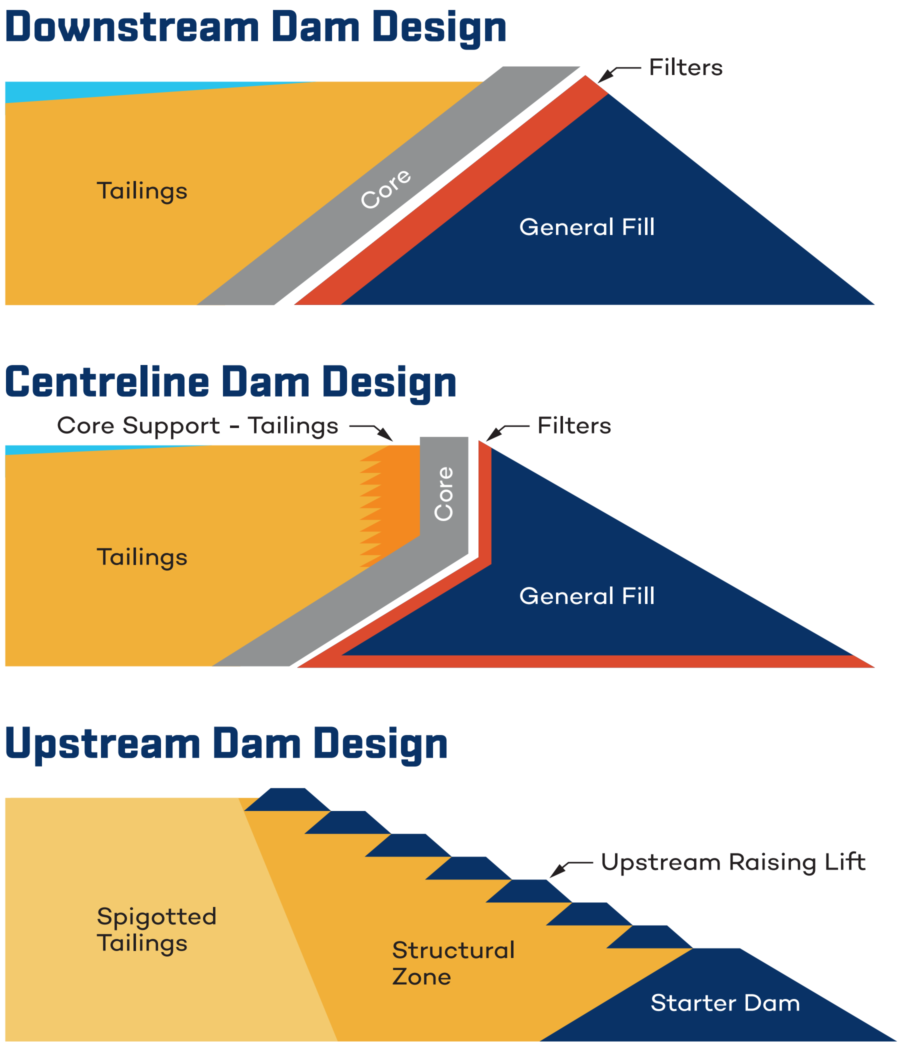
TAILINGS MANAGEMENT

Tailings are a residual material from mineral processing and can include fine material such as sand, silt, clay-sized materials, and varying amounts of water. A process flowsheet developed to recover the minerals for a specific mine is needed to determine the types of tailings that will be produced and managed by the mine. Tailings will vary depending on site-specific conditions and processing, as will the tailings facility design specifications. They can be chemically benign, potentially acid generating, and/or leach salts, metals, or other constituents. They are often in a slurry form at the end of mineral processing, at which point they can then be dried, thickened, or left in slurry form. Once ready, they may be stored on-site in dammed facilities, dry stacked, in open pits, backfilled underground, or occasionally (in <1% of facilities [Kwong, 2019]) disposed of in rivers, lakes, or the ocean (e.g., Batu Hijau mine in Indonesia, and Lahir, Ramu, and Simberi mines in Papua New Guinea [Kwong, 2019]). However, unconfined tailings disposal is challenged as acceptable practice and must be proven to be physically and chemically stable and minimize environmental impacts to socially acceptable levels.

Tailings storage needs to be carefully planned, designed, and managed (from construction through post-closure) to ensure that the foundations and dam slopes are geotechnically stable, that any dams will remain in perpetuity, and that the tailings are chemically stable for the long term. Liquefaction of the tailings and/or tailings dam before or during a potential dam breach is a critical risk and must be considered in the design, construction, operation, and maintenance of the tailings impoundment; the same is true of how the dam withstands potential flooding events. Figure 13 illustrates three approaches to conventional tailings dam design (downstream, centreline, and upstream) for slurry tailings storage. Note that the dam designs below do not apply to all tailings storage options, and the best design options depend on site-specific conditions and tailings characteristics. The upstream configuration uses the least fill material, may be a higher-risk design, and—considering the recent Brumadinho tailings facility failure—is no longer a permissible design in Brazil (National Mining Agency of Brazil, 2019). Dry stack tailings are often used in more arid environments and are becoming more prevalent in other environments as well.

FIGURE 13. TAILINGS DAM DESIGN TYPES FOR SLURRY TAILINGS STORAGE

Source: Adapted from McLeod & Bjelkevik, 2017.



A key component of effective tailings management is the importance of the accountability of engineers and companies for the sound design, construction, operation, and closure of the facilities. The tailings facility management should also include preparation and coordination with governments and communities for potential emergencies. Information disclosure is an important component of accountability and emergency response (UNEP et al., 2020).

SPENT HEAP LEACH CLOSURE

Heap leach facilities recover metals through leaching, that is, running a dissolving solution through the heaped pile of ore. The dissolving solution will differ according to the ore: a cyanide solution is used to recover gold and precious metals, for example, and a sulphuric acid solution is used to recover copper, nickel, and uranium. Once the available metals are recovered, a leach pad where the material is left on the pad must be rinsed during decommissioning to dilute and neutralize residual cyanide or acid to levels that are not harmful in the long term. Heap rinsing can take considerable time and must be accounted for in closure planning.

A key design feature of heap leach facilities is the foundation liner and leachate collection system, which protects the surrounding ecosystem and water sources from contamination. The liner system is linked to water management in the waste management design, illustrating the importance of an integrated approach to mine waste and water management and governance.

PRECIPITATES FROM WATER TREATMENT AND CHEMICAL RECOVERY PROCESSES

Mine water treatment and chemical recovery processes also produce residual wastes, such as metal sludges, that need to be managed in a manner that ensures the long-term stability of wastes and prevents future mobilization of contaminants. Generally, there are only small quantities of residuals; however, prediction of future potential volumes and disposal plans need to be made, especially if the closure plan includes water treatment in perpetuity.

AIRBORNE PARTICULATES

Airborne particulates can be generated from blasting, waste rock, tailings, and heap leach piles, as well as mine site roads and cleared areas. As a result, the particulates may contain constituents from the mined materials that are potentially harmful to humans (through respiratory diseases, for example), plants, and wildlife. These dusts can also contain sulphides or metals that can leach out and impact the surface water or groundwater. Dust minimization is best achieved through the inclusion of dust filtration and containment structures at ore transport and transfer points in project design (e.g., baghouses), progressive reclamation to minimize exposed materials, and dust-suppression measures, including the use of watering or non-toxic dust-suppression chemicals.

INTERNATIONAL STANDARDS AND PRACTICES

Many good international standards and practice guidelines are available for governments to draw from when designing their requirements for mine waste management. As outlined below, most of these standards and practices are technical in nature and share the underlying goal of managing mine wastes to prevent pollution in the long term.

BOX 14. RESOURCES ON MINE WASTE MANAGEMENT

For further information on mine waste management, please see the following resources:

Australian National Committee on Large Dams (ANCOLD). (2012). *Guidelines on tailings dams, planning, design, construction, operation, and closure*. https://www.resolutionmineeis.us/documents/ancold-2012 Revised in 2019: https://www.ancold.org.au/?product=guidelines-on-tailings-dams-planning-design-construction-operation-and-closure-may-2012

Canadian Dam Association. (2013 revision). *Dam safety guidelines*. https://www.cda.ca/EN/Publications_Pages/Dam_Safety_Publications.aspx

Eco Efficiency Consulting and Engineering Ltd. (2019). *Development of a guidance document on best practices in the extractive waste management plans: Circular economy action*. https://op.europa.eu/en/publication-detail/-/publication/f18472f8-36aa-11e9-8d04-01aa75ed71a1/language-en/format-PDF/source-87989698

EU. (n.d.). *Water protection and management*. https://www.europarl.europa.eu/factsheets/en/sheet/74/water-protection-and-management

Garbarino et al. (2018). *Best available techniques reference document for the management of waste from extractive industries*. https://publications.jrc.ec.europa.eu/repository/handle/JRC109657

ICMM. (2019). *Integrated mine closure: Good practice guide* (2nd ed). https://www.icmm.com/website/publications/pdfs/environmental-stewardship/2019/guidance_integrated-mine-closure.pdf

UNEP et al. (2020). *Global industry standard on tailings management*. https://globaltailingsreview.org/global-industry-standard/

International Commission on Large Dams (ICOLD). (2019). *World declaration on dam safety*. https://www.ussdams.org/wp-content/uploads/2020/01/World-Declaration-on-Dam-Safety_final.pdf

ICOLD. (2020). *Bulletin 181 on tailings dam design – Technology update*. https://www.icold-cigb.org/GB/publications/bulletins.asp

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IFC PERFORMANCE STANDARDS AND ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINES

The IFC Environmental and Social Performance Standards provide guidance on waste management in *Performance Standard 3: Resource Efficiency and Pollution Prevention*. The requirement is to minimize the waste generated during mining and to dispose of the waste that is generated in a manner that does not harm people or the environment (IFC, 2012c).

The IFC's *Environmental Health and Safety Guidelines for Mining* also provide recommendations on how mines should manage waste rock, tailings, and leach pad waste (IFC, 2007a, 2007b). The guidelines require the geochemical characterization of ore and waste, and the development of appropriate segregation and storage plans to minimize the threats of acid rock drainage and metal leaching.

GEOCHEMICAL CHARACTERIZATION OF MINE WASTES

Geochemical characterization of all mine wastes prior to construction and ongoing through operations is good international practice. This type of analysis provides an understanding of the geochemical characteristics of all materials that will be mined and processed, allowing for a more accurate prediction of how the materials will perform in the conditions where they are stored (i.e., taking into consideration climate, any material blending, water covers, and air circulation). The *Global Acid Rock Drainage (GARD) Guide* provides good international practices for sampling, analyzing, and predicting acid generation, and determining metal leaching potential of mine waste materials (INAP, 2014).

MINE WASTE PLANNING AND DESIGN

The European Commission's *Best Available Techniques Reference Document for the Management of Waste from Extractive Industries* and the guidance on *Development of a Guidance Document on Best Practices in the Extractive Waste Management Plans: Circular Economy Action* both provide best practice guidance on how to characterize materials and plan mine material management from exploration through design and closure (Eco Efficiency Consulting and Engineering Ltd., 2019; Garbarino et al., 2018). ICMM's (2019b)

Integrated Mine Closure: Good Practice Guide provides additional background on how mines should be designed for closure.

Canada's *Mine Environment Neutral Drainage* (MEND) program is linked to the INAP and has supported research and provided guidance on mine waste management, from prediction through prevention and controls, treatment, and monitoring. It also publishes extensive research on the newest innovations and technologies in mine waste management.

TAILINGS MANAGEMENT

Tailings facilities have been given special attention in setting standards for mine waste management. Many tailings facilities have failed over the years, with a range of undesirable consequences, and tailings facilities are typically one of the highest-risk facilities on a mine site. As a result, tailings management and standards have developed and strengthened over time.

The *Global Industry Standard on Tailings Management* by UNEP, ICMM, and Principles for Responsible Investment was released in August 2020. The latest standards present clear principles and requirements for strict controls in tailings management and address six key areas: knowledge base; affected communities; design, construction, operations, and monitoring; management and governance; emergency response and long-term recovery; and public disclosure and access to information. A requirement for an independent tailings review board is becoming a new international standard. This provides for a multidisciplinary team of experts to further check the design, construction, operation, and closure of each tailings facility.

In addition, a new *World Declaration on Dam Safety* was published in 2019 that outlines the key pillars for dam safety, including tailings dams (ICOLD, 2019). The member countries of the ICOLD (101 by the end of 2019) were consulted on the Declaration. The Declaration is discussed further in the section on the role of government.

ROLE OF GOVERNMENT

Given the key issues related to mine waste presented above and the good international standards and practices that are being used across the sector, there are key actions that governments should take to ensure the effective and safe management of mine waste. The key actions are broadly aligned with the MPF and are presented in a sequence related to policy development and the mine life cycle. Specifically, governments should:

1. Prior to mine permitting, develop mine waste management standards based on site-specific risk.
2. Prior to mine permitting, set specific standards for tailings facilities based on site-specific risk.

3. Require accountability to promote good corporate governance
4. Through the ESIA review and mine permitting process, review and approve the mine waste management plans.
5. Through the ESIA review and mine permitting process, require financial sureties for waste management facilities to manage government risks if the mining company cannot meet its obligations.
6. During construction, operation, and closure, monitor and evaluate mine waste management performance.
7. During construction, operation, and closure, enforce compliance to protect land and water resources, as well as worker and community safety.

MINE WASTE MANAGEMENT STANDARDS: SET CLEAR STANDARDS AND CODES FOR GOOD MINE WASTE MANAGEMENT BASED ON SITE-SPECIFIC RISK

Standards for mine waste management should be set clearly by governments in their legal frameworks. The development of standards and codes takes time. Governments may be able to institute interim policies requiring companies to meet international or other jurisdictions' standards while their standards are developed.

In many jurisdictions, legislation has been developed and revised as a result of mine waste facility failures. For example, the European Union's Mine Waste Directive 2006/21/EC was developed recognizing the dam and heap failures at Aberfan (United Kingdom, 1966), and Stava (Italy, 1985), and as a result of dam failures near Aznalcōllar (Spain, 1998), and at Baia More and Baia Borsa (European Commission, n.d.; Romania, 2000). British Columbia, Canada, now has the most comprehensive regulations for tailings storage facilities in the world as a result of the Mount Polley tailings dam failure in 2014.

Based on various legal frameworks and industry experience, mine waste management standards should consider covering the following:

- Overarching objectives of sound mine waste management
- Any unacceptable or banned mine waste designs or management practices
- Requirements for third-party and independent reviews of designs and plans
- Required analyses to assess and manage risk, such as:
    - Alternatives analysis
    - Slope stability
    - Waste, overburden, and construction materials characterization
    - Foundation studies
    - Groundwater and seepage analysis
    - Failure modes and effects analysis
    - Dam breach and inundation analysis

- Engineered designs, including specified design criteria
- Management and monitoring plan requirements, such as:
    - Construction quality assurance and quality control plan
    - Waste segregation plan
    - Operation, surveillance, monitoring, and maintenance plan
    - Reclamation and closure plan
    - Community emergency response plan
- Closure and post-closure plans

In addition, governments should set mandatory standards for minimum design criteria, such as slopes, factors of safety, hydrometeorological events, and seismic events, within development or mining policy and in mining legislation. Standards for mine waste facilities should be set, taking into consideration local conditions, such as existing facilities, meteorological and geotechnical conditions, engineering capacity, and emergency response capacity in the country within regulations or legislative guidelines.

Jurisdictions where uranium and rare earth deposits occur typically have additional legislation and administrative authorities specific to these mines. Residual wastes from uranium and rare earth mining contain radioactive materials, which require additional controls such as ventilation, respirators, gamma radiation monitors, and material-specific training. Therefore, worker and public health and safety must be considered in the characterization of the waste, as well as the design, operation, and closure of waste storage facilities. For example, a process hazard analysis is a required component for uranium mining in Canada (Government of Canada, 2000). Process hazard analysis is typically required by safety authorities "for any industrial process that makes use of hazardous chemicals. It identifies and analyzes data to provide information that will assist employers and employees in making decisions for improving safety and reducing the consequences of unwanted or unplanned releases of hazardous chemicals" (Occupational Health and Safety Academy Training, n.d.).

There may be overlap between mine waste management legislation and other pieces of legislation—such as those governing contaminated sites, air quality, and hazardous materials—and possibly between national, regional, and local legislation. It is important to ensure that legislation is consistent and aligned, and guidance materials should be published to provide clarity for any overlaps.

The legal framework should include mechanisms for consultation and participation of affected communities. Communities should be involved in the planning stage to meaningfully participate in the selection of waste management alternatives for waste storage facilities that could affect them.

BOX 15. THE SULLIVAN MINE AND LESSONS LEARNED FROM A REACTIVE WASTE ROCK FACILITY

The Sullivan mine is a lead, zinc, and silver underground mine in British Columbia, Canada, that closed in 2001. The waste rock facility contained an estimated 1 million m^3 of acid-generating rock. Acidic runoff from the waste rock pile was collected from a toe drain at the facility and treated with lime. The chemical oxidation of sulphides in the waste rock consumes oxygen, resulting in anoxic conditions within the toe drain. Tragically, four fatalities occurred in 2006 as a result of anoxic conditions in the confined sampling housing at the toe drain. Investigations arising from the facilities led to a greater understanding of airflow patterns within chemically reactive waste rock dumps. With daily temperature variations outside the dump and heat-generating chemical reactions in the dump, large air flows result through the entire dump. The airflows continue to replenish the sulphides with oxygen resulting in continued chemical reactions and production of acid mine drainage.

This case study illustrates the importance of investigative testing and modelling to predict the physical and chemical behaviour of waste rock facilities. It is important that this information is used to improve waste rock facility design (Sullivan Mine Incident Technical Panel, 2010). To assist companies and mines in conducting risk assessments specifically for this type of risk, the British Columbia Workers' Compensation Board, with WorkSafe BC and the Workers' Compensation Board of Nova Scotia, funded the development of an atmospheric conditions risk assessment tool for companies in 2011.

TAILINGS FACILITY REQUIREMENTS: SET QUALITY STANDARDS FOR TAILINGS FACILITY STABILITY AND ESTABLISH REQUIREMENTS FOR INDEPENDENT TAILINGS REVIEW BOARDS BASED ON SITE-SPECIFIC RISK

A government's legal framework on mine waste management should include standards for tailings facilities design, construction, and management that are consistent with good international standards and practices. This process may take time. In the interim, governments could require operators to conform to international standards (e.g., UNEP et al.'s 2014 *Global Industry Standard on Tailings Management*) while their standards are developed.

For consistency with current good international practice, an independent tailings review board should be legally required to periodically review the design, construction, operation, and closure of high-risk tailings storage facilities. High-risk tailings storage facilities include, but may not be limited to, facilities with a large dam that is defined by ICOLD as greater than 15 metres or a dam between 5 and 15 metres impounding more than 3 million m^3 of material.[2]

The overriding objectives in legislation regarding tailings facility stability should be ensuring the long-term physical and chemical stability of the tailings facility to protect the

[2] ICOLD definition of a large dam: https://www.icold-cigb.org/GB/dams/definition_of_a_large_dam.asp

surrounding environment and communities for the full life of the facility. The legal framework should also include:

- Requirements for the design and study details, including emergency response and closure plans, to be included and reviewed by government and stakeholders in the ESIA.
- Inclusion of community engagement in the development of tailings management plans and emergency response planning and implementation.
- Engineer and proponent responsibilities defined for the life of the facility.
- Monitoring and reporting requirements during construction and operation.
- Inspection requirements by government and independent experts.
- Closure and long-term post-closure reclamation, monitoring and reporting requirements.
- Designation of financial responsibilities for technical reviews, inspections, and monitoring.
- Potential requirements for financial securities or insurance for emergencies.
- Enforcement measures.

Tailings facility design depends on the geophysical and geochemical properties of the tailings and the meteorological, hydrological, physiographic, social, and environmental context. Extensive testing on the tailings and surficial geology of the foundation conditions is needed, in addition to designs by experienced geotechnical engineers. A comprehensive alternatives assessment is usually completed for tailings facilities to assess alternative technologies, locations, and designs. A risk-based analysis, such as a failure modes and effects analysis, is also usually completed for a comprehensive design.

BOX 16. STANDARDS RESULTING FROM THE MOUNT POLLEY TAILINGS FACILITY FAILURE

The Mount Polley tailings facility failed on August 4, 2014, in British Columbia, Canada, releasing millions of cubic metres of tailings and water to downstream Polley Lake, Hazeltine Creek, and Quesnel Lake. Several standards were written into the Health, Safety and Reclamation Code of British Columbia (Ministry of Energy and Mines, 2017) as a result of the Independent Review Panel report (Independent Expert Engineering Investigation and Review Panel, 2015). Some key changes to the code included the following:

- An independent tailings review board and an engineer of record must be designated for all tailings facilities.
- The mine manager is responsible for the safety of all tailings facilities on the site and for designating a qualified person for the tailings storage facility.
- Physical stability is included in the code as the primary objective; all available technologies (such as dry-capped tailings) should be considered in the designing phase; and water should be removed from tailings. The alternatives assessment needs to include environmental, societal, and economic considerations in addition to technical considerations.
- Risk assessments and a breach and inundation study must be completed for proposed tailings storage facilities.

ACCOUNTABILITY: REQUIRE ACCOUNTABILITY TO PROMOTE GOOD CORPORATE GOVERNANCE

Safe waste management facilities (and tailings facilities in particular) require good corporate management, as indicated in the Global Industry Standard on Tailings Management (UNEP et al., 2020). Mining companies use a variety of management systems that function well but depend on the workings of the company, which makes a management system difficult to regulate and enforce. However, a legal framework can promote effective management systems, protect communities and the environment, and simplify enforcement by setting requirements for accountability and responsibility for key corporate, management, and engineering positions. The onus for performance and cost of the facility is on the company promoting the development of an effective corporate management system.

BOX 17. A LEGAL DIRECTIVE THAT PROMOTES GOOD CORPORATE GOVERNANCE THROUGH REQUIRING ACCOUNTABILITY

Pertaining to the governance of dams, the Alberta Dam and Canal Safety Directive (Alberta Government, 2018) sets responsibilities for the following key positions:

1.1(2)(c) "accountable executive" means an individual who:

> *(i) is employed or retained by a dam/canal owner; and*
>
> *(ii) has overall authority, including financial authority, for the safety management of the dam or canal;*

1.1(2)(h) "designer-of-record" means a qualified professional who:

> *(i) possesses the requisite knowledge and skills and has at least 15 years of appropriate*
>
> *experience in design, construction, performance analysis and operations of dam and*
>
> *canal structures;*
>
> *(ii) is retained by a dam/canal owner; and*
>
> *(iii) is responsible for the overall design of the structures in a dam or canal…*

1.1(2)(j) "engineer-of-record" means a qualified professional who:

> *(i) possesses the requisite knowledge and skills and has at least 15 years of appropriate experience in design, construction, performance analysis and operations of dam and canal structures;*
>
> *(ii) is employed or retained by a dam/canal owner; and*
>
> *(iii) is responsible to provide technical direction regarding the safety of a dam or canal…*

1.1(2)(r) "operations manager" means a qualified individual who

> *(i) is employed or retained by a dam/canal owner;*
>
> *(ii) is responsible for the safe operation, maintenance and surveillance of a dam or canal..*
>
> *(iii) possesses the requisite knowledge and skills to perform their responsibilities and has*
>
> *at least 10 years of related experience*

1.1(2)(w) "safety manager" means a qualified professional who:

> *(i) is retained by a dam/canal owner;*
>
> *(ii) is responsible for oversight of safety management of a dam or canal…*
>
> *(iii) possesses the requisite knowledge and skills to perform their responsibilities and has at least 15 years of related experience.*

The directive is linked to the Water Act and the Water (Ministerial) Regulation (AR 205/98). Within the regulation, accountability is set for the person or entity who is "to be the dam/canal owner responsible for all aspects of compliance with the Act and this Regulation or any portion of that legislation." The penalties are set out in the Water Act, depend on the severity of the contravention, and can include fines and potentially imprisonment.

MINE WASTE MANAGEMENT PLANS: REVIEW MINE WASTE MANAGEMENT DESIGNS AND PLANS PRIOR TO PROJECT APPROVALS AND PERMITTING

Mine waste management facility designs and plans should be scoped into and defined in the terms of reference in the ESIA review phase for proposed mine development. This should include conceptual closure plans. The level of design required to be presented for review in the ESIA should be commensurate with the level of risk for the proposed facilities, with engineered designs required to be submitted for the environmental assessment and for permitting. In general, a pre-feasibility-level design should be expected for the ESIA and feasibility-level design for permits.

Technical experts should be contracted by the government as necessary for technical reviews, especially for high-risk facilities. Governments can also look to good international standards and practice guides, as well as other organizations, for assistance with capacity building.

The ESIA legal framework should include inclusive stakeholder consultation. Stakeholder consultation is imperative if the mine plan includes any high-risk mine waste storage facilities that have the potential to directly impact communities or any water and land resources used by the community. Community members downstream of any mine waste storage facilities must be involved in the development of community emergency response plans.

Detailed engineering designs for high-risk structures should be required to be submitted to the mining and environmental authorities and inspectors in advance of construction and with enough time for the relevant authorities and inspectors (or their designated technical expert) to review and approve plans prior to construction. Designs should also be required to be submitted for review and approval prior to any significant new phases to be constructed and prior to any significant changes in the facility. Design changes may require permit amendments. A new ESIA review process may be triggered if the facility design changes would alter the footprint or waste and water management plans to a point where there are potentially significant new impacts.

The legal framework should require that all engineered designs for the life of the facility be signed off by qualified and competent professional engineers, and legislation should be in place that includes a mechanism for registering and guaranteeing the competencies of these professional engineers. Alternatively, the legal framework should define the competencies and acceptable professional engineer qualifications, responsibilities, and obligations for mine facility designs.

The Mining Act (1995) of the Philippines (Republic of the Philippine, 1995), for example, requires every contractor to undertake an environmental protection and enhancement program covering the period of the mineral agreement or permit (Section 69). This program must be incorporated into the work program the contractor or permittee submits when applying for a mineral agreement or permit. The work program must include not only plans relative to mining operations but also to "rehabilitation, regeneration, revegetation and reforestation of mineralized areas, slope stabilization of mined-out and tailings covered areas, aquaculture, watershed development and water conservation; and socioeconomic development" (Republic of the Philippines, 1995, Section 69).

BOX 18. OTHER ALTERNATIVES: ENSURE DESIGN IS APPROPRIATE FOR THE SITE-SPECIFIC CONDITIONS AND IS SUPPORTED BY FIELD STUDIES AND TESTING

Alternative options and new technologies are needed to address the long-standing challenges of the physical and chemical stability of mine waste storage. Considerable research has been completed and continues to be needed to better minimize the long-term risks of mine wastes. The INAP[3] is a global alliance of groups conducting this research and sharing knowledge for better mine waste management. Examples of alternatives that are in use and continue to be researched include the following:

- Cyclone sand – a method used to separate coarse material from tailings that can be used for structural earthworks where borrow materials are limited or can be used to minimize the disturbance footprint.
- High-density thickened/paste tailings – a tailings dewatering method that reduces the water management requirements at the storage facility.
- Dry stack tailings – a tailings dewatering and storage method that reduces the volume of tailings and reduces—or in some cases, eliminates—dam requirements.
- Waste rock dry covers – a method used to reduce water infiltration into potentially acid-generating waste rock or tailings. Research has looked at cover thickness, permeability, and effects on performance with vegetation, with varying degrees of success in application.
- Co-placement – a method where tailings are thickened or filtered and blended (mixed) with waste rock, at an appropriate ratio, to maintain the geotechnical safety of the waste rock dump and potentially mitigate acid generation.
- Blending – a method where acid-generating and acid-neutralizing waste rock are blended before placement in the storage facility to neutralize any acidic drainage generated. Research and application have had varying levels of success.
- Segregation and encapsulation – a storage method where acid-generating mine waste is separated from non-acid-generating waste and stored within a specified zone in the storage facility where air and/or water flow through are minimized to prevent acid drainage release. The success of application depends on the site and the design.
- Air reduction in waste rock storage facilities – using bottom-up construction in small lifts with fine, compacted material between lifts, this design limits the liberation of contaminants from the waste rock by limiting oxidation and improves the opportunity for progressive reclamation as the facility is constructed (Meiers et al., 2018).

Governments should require proponents to provide the research and evidence to support any proposed new technologies. Site-specific bench-scale or pilot-scale studies should also be provided that prove that the proposed technology will work for the proposed project since each mine has unique characteristics of mineralization and site conditions.

[3] See the INAP website and access its partners' websites via https://www.inap.com.au/.

FINANCIAL MECHANISMS FOR WASTE MANAGEMENT: CONSIDER FINANCIAL MECHANISMS TO MANAGE FACILITY RISKS IN THE LONG TERM

Financial mechanisms should be required to fund closure and reclamation of the entire mine project, and these should be based on detailed cost estimates commensurate with the level of design and with appropriate contingencies. Within the closure and reclamation cost estimate, mine waste facilities costs should include (as applicable):

- Rinsing of heap leach pads
- Construction of closure features, such as a final spillway
- Re-contouring
- Capping and revegetation
- Instrumentation and long-term geotechnical monitoring
- Associated hydrogeological, hydrological, and water quality monitoring along with water treatment costs for the long term
- Ongoing maintenance

Note that costs should include mobilization, demobilization, equipment, and contractor costs to account for a scenario when the mine proponent is bankrupt and the government becomes responsible for closure and reclamation. In some jurisdictions (e.g., European Union Environmental Liability Directive 2004/35/EC), the responsibility of existing and future damages on the property remains with the owner following the "polluter pays principle." However, a secure financial mechanism should be in place to protect the government from future costs when this type of framework is not in place and there are risks of the future solvency of an owner.

The financial mechanism should be calculated and posted prior to construction and updated as the project advances. Financial sureties (or a portion of the sureties) are returned to the proponent following the end of the post-closure period if there are no outstanding liabilities and/or risks. An appropriate final financial mechanism should be maintained after post-closure and structured into a sustainable finance mechanism to pay for the long-term monitoring and management of any high-risk mine waste facilities in perpetuity. As recommended in the World Bank mine financial surety guidance, there are many ways to structure financial regulations; however, the best structures are led by one agency, are simple and clear, and take into account the jurisdiction's structure and capacity (Sassoon, 2009). Note that there are other financial mechanisms that can be considered if structured correctly (e.g., bank guarantees, insurance, cash, pledge of assets, etc.).

Financial sureties do not usually cover upset conditions or failures. Governments may consider requiring companies to carry insurance on the facilities (Squillace, 2020). Another option is through charges per tonne of waste stored and fines such as in the Philippines's Implementing Rules and Regulations of RA No. 7942 under the Philippine Mining Act of 1995 (Republic of the Philippines, 1995).

BOX 19. MANAGING ABANDONED MINES

Many members have identified the challenge of managing existing damages from abandoned mines. Abandoned mines programs provide a framework for funding and coordination. Examples include:

- Canada's National Orphaned/Abandoned Mines Initiative (NOAMI), organized by the national, provincial, and territorial mines ministers and directed by the National Advisory Committee.
- Chile began an abandoned mines inventory program through the National Geology and Mining Service (SERNAGEOMIN).
- The Sub-Saharan African abandoned mines program, Environmental and Health Impacts of Abandoned Mines in Sub-Saharan African Countries, funded by the Swedish International Development Cooperation Agency (SIDA) and built from the UNESCO-IUGS International Geoscience Programme (IGCP).
- United States Department of the Interior, Office of Surface Mining Reclamation and Enforcement has an Abandoned Mine Land Program for coal mines initially funded through a fee per tonne of coal produced.
- West Australia's Abandoned Mines Program, coordinated through the Department of Mines, Industry Regulation and Safety.

TRACKING PERFORMANCE: ALLOCATE FINANCIAL AND HUMAN RESOURCES FOR TIMELY AND EFFECTIVE REVIEWS OF MONITORING DATA

Tracking the performance of mine waste management facilities has similar requirements as those discussed for water management in Chapter 2. Monitoring and reporting requirements for mine waste management should be specified in permit conditions, and guidance and standard templates (or tables of contents) should be provided to mining proponents so that the information submitted is in a standard format that allows for efficient review.

Regular inspections of mine waste storage facilities should also be conducted. Inspections should be followed up with a report of any non-compliances and work to be completed, plus a required time frame for the mine proponent to report on follow-up. Follow-up inspections may need to be conducted for any major non-compliance that cannot wait until the next government inspection.

Government staff completing the inspections should have the necessary technical competencies for the type of facility and for conducting inspections. It is preferable that the staff reviewing the monitoring reports are the same people conducting inspections. Governments should contract inspection services to external experts (especially for high-risk facilities) if their staff do not have the key competencies required to adequately complete the task.

Finally, government should plan and allocate appropriate financial and human resources to complete monitoring report reviews, inspections, follow-up, staff training, and enforcement.

ENFORCEMENT: ENFORCE COMPLIANCE WITH MINE PERMITS

A key component of the legal framework for the governance of mine waste management is enforcement. Appropriate consequences must be included in the legislation to manage situations where there are instances of non-compliance discovered from reviews of the monitoring reports, from inspections, or in response to incidents. The consequences should be tied to the level of risk of the non-compliance. Enforcement should consider compliance with the implementation of progressive reclamation and updates of closure plans to minimize long-term risks.

Failure of mine waste management facilities may result in non-compliance with other legislation or standards. For example, an incident with the tailings impoundment may be non-compliant with the approved design in the mining permit but may also result in the release of tailings materials that could result in non-compliance with water or fish legislation and could even result in criminal charges.

Major incidents are often a result of the failure of many smaller components, and therefore the consistent enforcement of minor non-compliance is critical to keep proponents diligent, maintain the trust and authority of regulators and communities, and—most importantly—to prevent larger incidents. Catching failures of minor components early can help prevent a major failure.

BOX 20. CASE STUDY: CONSEQUENCES OF TAILINGS FACILITY FAILURES IN BRAZIL

The most recent catastrophic failures in Brazil include BHP Billiton and Vale's Fundão tailings facility in 2015, which killed 17 people and polluted 663 km of the Rio Doce, and Vale's Corrego do Feijão mine tailings facility on January 25, 2019, which resulted in 259 deaths.

Following the Fundão tailings facility failure, criminal charges were laid by the Brazilian government against 22 people, and a civil claim settlement of USD 5 billion was made for environmental remediation. Another claim for USD 5 billion was filed against BHP in May 2019 in England on behalf of 235,000 Brazilian individuals, companies, and Indigenous tribes (Ridley & Lewis, 2019).

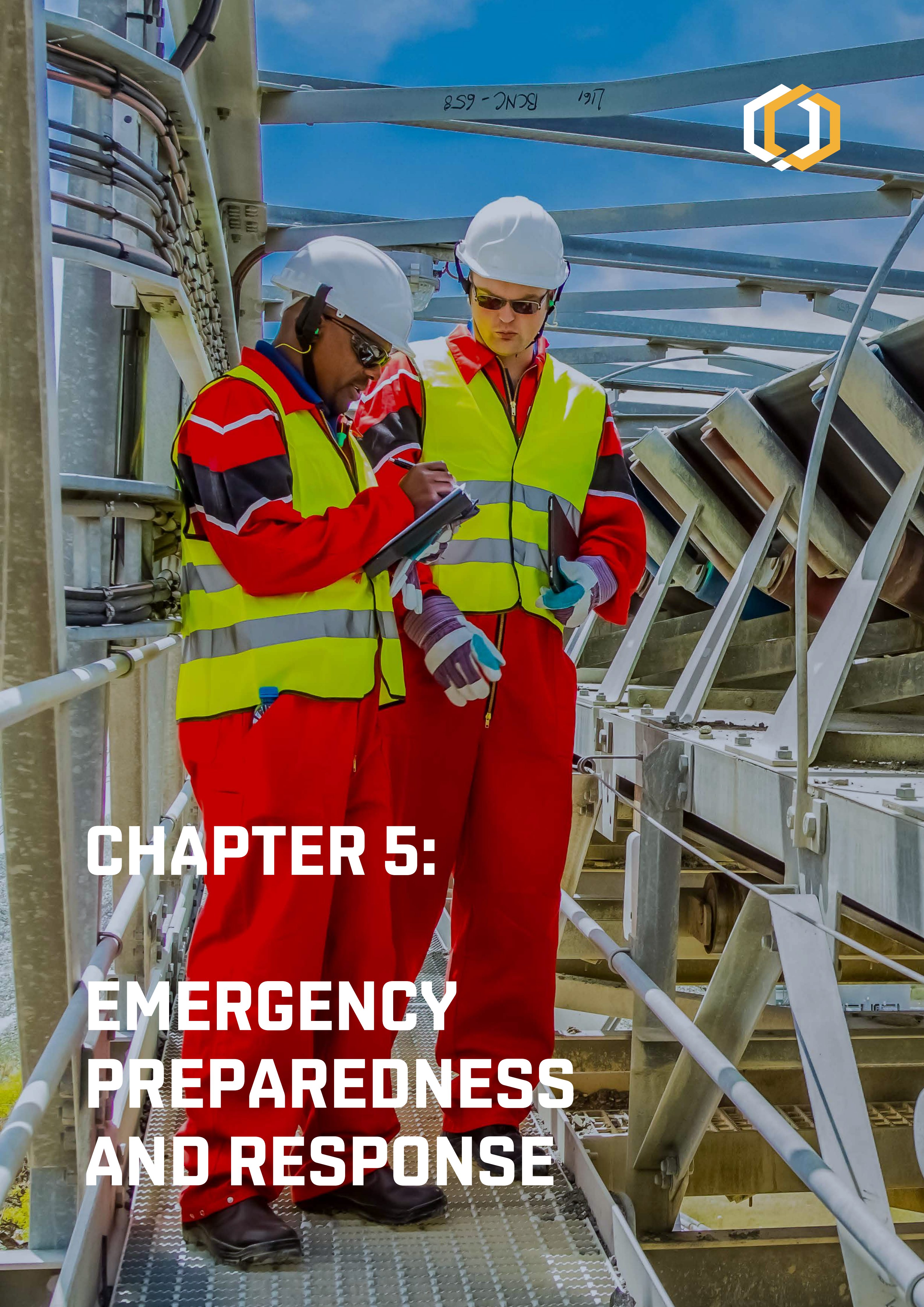
Following the Corrego do Feijão tailings dam failure, criminal charges were laid against 16 people, including company executives and engineering consultants (Phillips, 2020).

Vale and BHP are working to compensate for social impacts and repair environmental damages. The work being completed is communicated through Vale's company website and BHP's Renova Foundation website.[4]

As a result of these incidents, Brazil revised its legislation to prohibit tailings dams using an upstream construction method (National Mining Agency of Brazil, 2019). In addition, the National Mining Agency of Brazil ordered stability reviews of all tailings dams in Brazil and stopped 47 mine operations in April 2020 where dam stability could not be certified (Reuters, 2020). The outcomes of these tragedies are still being realized. The Brazilian government must ensure the enforcement measures are appropriate for the damages and also need to work with the companies to support their efforts to compensate for and repair damages.

Internationally, tailings facility standards have become more stringent as a result of these incidents, and the mining industry and governments need to continue to improve governance of mine waste management to ensure a sustainable future for mining.

[4] Vale's repair and development website is http://www.vale.com/brasil/EN/aboutvale/reports/atualizacoes_brumadinho/Pages/default.aspx, and BHP's Renova Foundation website is http://www.vale.com/esg/en/Pages/RenovaFoundation.aspx



CHAPTER 5:

EMERGENCY PREPAREDNESS AND RESPONSE

FIGURE 14. EMERGENCY PREPAREDNESS AND RESPONSE

ISSUE: EMERGENCY PREPAREDNESS & RESPONSE

Ensure that all stakeholders are well prepared to prevent, address, respond to and recover from emergencies.

National governments must ensure that all potentially affected stakeholders identify and understand potential risks across the mine life cycle, and that they are well prepared to address and respond to them. Emergency preparedness and response programs should include:

- Risk assessment
- Preparedness and prevention plans
- Response plans
- Recovery plans
- Crises communications plans

OVERVIEW

Emergency preparedness, management, communications, response, and recovery are increasingly important in the mining sector. Emergencies, including both internal mine site accidents and external natural and social hazards, can affect operations, workers, and communities, and the impacts can extend well beyond the boundaries of a mine to the communities, rivers, wetlands, farms, and infrastructure that surround the site. Emergency events can also affect operations and communities across the mine life cycle, with the risks extending from construction and operations through mine closure to the post-mining phase. Governments must have emergency response plans in place and must communicate and coordinate these plans with potentially affected stakeholders, including companies, communities, and all levels of relevant authorities. They must ensure that all potentially affected stakeholders identify and understand potential emergency situations and that they are well prepared to address and respond to them in an aligned manner. This extends beyond those crises that may impact operating mines to the accidents and emergencies that can equally affect the closed facilities and waste storage infrastructure that are left to the community after mining ceases.

A strong culture of safety starts from the top down in an organization, whether it be a government or a mining company. For a country, a safe culture starts with the government setting a strong example of safe practices and establishing expectations for safety throughout its legal framework. Emergency preparedness and response for mining are not just about what the mining companies put in place; they must be an extension of the regional and national emergency preparedness and response network. Governments must be collaborative partners in emergency preparedness, developing and communicating their own risk assessments and crisis preparedness plans, to ensure that stakeholder responses are coordinated if and when an emergency takes place. Putting in place a strong national culture of safety will not only support community health and well-being (SDG 3) but also will help to attract mining companies and investors, as it reduces their risks and liabilities and helps protect their staff and assets.

Preparing for emergencies through formal programs—whether within a mining company, government, or community—is above all else about prevention and working to protect populations and ecosystems. A series of high-profile accidents in the sector, including the Brumadinho tailings dam failure in Brazil and the jade mine collapse in Myanmar, combined with the increasing impacts of a changing climate, have underscored the need for national and local governments, mining companies, workers, and communities to work together to identify possible emergency situations and develop, test, implement, and improve emergency preparedness before, during, and after mining.

To this end, the MPF recommends that governments require that mining companies operating in their jurisdiction develop and implement an emergency preparedness program. This should include:

- *Requiring all mining operations to have an emergency preparedness and response program in place prior to commencement of operations, and ensuring that the program is comprehensive, meets current best practice standards, and is reviewed, tested, and updated on a regular basis;*
- *Basing all elements of the emergency preparedness program on ongoing, inclusive consultation and cooperation with local communities and other stakeholders and government.*
- *Ensuring that monitoring of the effectiveness and responsiveness of the emergency preparedness program is conducted by companies in cooperation and in an inclusive manner with communities and all levels of government.* (IGF, 2013, p. 37)

The following chapter outlines key concepts in emergency preparedness, the benchmarks and standards most commonly applied in the sector, and the role of governments in ensuring that mining companies, staff, and communities are fully prepared for emergency situations. Please note that the chapter will primarily focus on emergencies at large-scale underground and open-pit mines and not offshore or small and artisanal operations; however, many of the concepts can be adapted to other environments and scales.

This chapter presents why it is important to:

1. Ensure companies develop comprehensive emergency preparedness and response plans grounded in risk assessment prior to the granting of mining permits.
2. Require that the development, implementation, testing, and monitoring of emergency preparedness and response plans are consultative and inclusive.
3. Mandate that emergency preparedness and response plans cover the entire mine life cycle.
4. Regularly test, review, and update emergency preparedness and response plans to reflect the changing context.
5. Coordinate and align government and mine emergency response plans.

KEY ISSUES

Emergency preparedness and response require both governments and mining companies to understand exposure and vulnerability to potential emergencies through a risk assessment. Response measures must be designed to prevent and minimize vulnerabilities to the greatest extent possible through consultation with relevant stakeholders in planning, training, and response, effectively communicating preparedness and response to and with partners. The plan should be continuously tested, trained, and improved based on experience, changing contexts, and evolving best practice.

An emergency, in the context of mining, is a sudden event that can significantly affect the ability of a mining company to carry out its business (MAC, 2018a). As mentioned, emergencies can happen across the mine life cycle, including—where applicable—in the post-mining transition. Emergencies can include (MAC, 2018a):

- Industrial emergencies, including those involving critical injuries, property damage, fire, building collapse, vehicle and aircraft accidents, derailment, mine structural failures, flooding, explosions, power failure, freeze-up, and loss of water.
- Natural and climate-related disasters that jeopardize staff, community safety, and commercial operations, including flooding, mudslides and landslides, tsunamis, tornadoes, hurricanes, earthquakes, wildfires, and volcanic eruptions.
- Health emergencies, including an epidemic, a pandemic, or medical emergencies on sites where access to quality medical care is limited or lacking.
- The accidental release of materials into the environment, such as through tailings facility failures or major chemical spills.
- Missing persons relating to criminal or non-criminal circumstances.
- Political and security risks, such as kidnapping, extortion, bomb threats, bombings, political or civil unrest, illegal detention, and insurgent or guerrilla activities.

Emergencies and hazards such as those listed above can have a number of consequences and impacts for staff and operations, for the health and well-being of local and regional communities, for biodiversity and ecosystems, for critical infrastructure, and for critical economic sectors like water, agriculture, transport, forestry, and tourism. These consequences can be expressed in several ways: according to their social, gender, or human impacts; in operational or technical terms; or in terms of their monetary implications.

BOX 21. THE GENDERED IMPACT OF EMERGENCIES

Crises and disasters have different impacts on women, girls, boys, and men. People have different risk levels based on many identity factors, including their age, gender, disability, ethnicity, Indigenous status, or others, all of which may factor in their vulnerability in the face of crises. Globally, natural disasters have a greater negative impact on the life expectancy of women than men; on average, natural disasters (and their subsequent impacts) kill more women than men and kill women at an earlier age than men (Neumayer & Plumper, 2006).

There are many resources available for analyzing the gendered impacts of emergencies, including on women and girls' limited or lack of access to life-saving information, such as emergency alerts and measures; the gendered share of humanitarian aid; and preferential treatment in rescue efforts. In addition, women and girls are more likely to be impacted by political and security risks associated with emergencies, which can easily put their physical security and integrity in jeopardy. A gender-responsive emergency preparedness response must take such differences, as well as inter-community relations including the gendered division of labour, into account for not only correctly analyzing risks exacerbated for certain groups but also for being able to offer a plan that is equally responsive to these respective risks.

EMERGENCY PREPAREDNESS

Emergency preparedness and response programs should cover all foreseeable emergency scenarios. As a first step, this will require looking at historical hazards, emergency events, and future climate projections in a given area to assess what risk scenarios might exist for a site and the possible scale and duration of these events. This kind of risk assessment should form the basis of government and company emergency preparedness plans.

For companies, risk assessments should be performed before mining starts, preferably as part of the ESIA process, then be repeated across the mine life cycle at any time substantial changes are made to the operation (DMIRS, 2018). In a risk assessment, the risk level of an event is determined by the likelihood of occurrence multiplied by the potential consequences. Site-wide risk assessments should identify all major foreseeable emergency events that could affect a mining operation and its personnel. Those conducting the assessment need to perform a detailed analysis and answer many questions, including the following (DMIRS, 2018):

- What emergencies could happen at the site?
- How could these emergencies occur?
- When, where, and why could it happen, and to whom?
- What is the likelihood of occurrence?
- What are the potential consequences?

Once the company has worked with other affected parties to answer these questions and complete its risk assessment, it can think about the actions (or controls) that are available to it to reduce risk, prevent emergencies and their consequences, and identify any possible hazards that might be associated with the proposed responses. It should also share the risk assessment with the government and engage with emergency responders—fire, police, medical—to ensure everyone understands what must happen if and when an emergency situation occurs.

EMERGENCY RESPONSE

For identified risks, companies—working with their community and government partners—should then develop a list of appropriate response measures for each possible emergency. These should be aligned with government response plans where possible. Within large mining companies, site-specific emergency preparedness and response programs are prepared and aligned with a company's overall risk management approach across its operations. Site-specific response measures to be adopted should be considered, from most reliable and protective to least. The Government of Western Australia, for example, asks that these control measures be presented in a hierarchy, from the most appealing option to the least: elimination of the risk; substitution of the risk; isolation or segregation of the risk; development of engineering solutions to the risk; development of administrative procedures for handling the risk; and the use of personal protective equipment (DMIRS, 2018). Response measures will form the basis of the emergency preparedness and response programs, but these programs should be robust and adaptable enough to respond to unforeseen events. Response planning should also not detract from the preeminent goal of accident prevention and should not focus solely on operating mines, given the permanent nature of many sites and the potential for post-closure accidents (UNEP, 2001).

Companies should try to implement response measures that avoid emergency risks by deciding not to start or continue with the activity (for example, shutting down operations due to a storm or increase in seismic activity); removing the source of the risk if possible (a hazardous chemical, for example); changing the likelihood of the risk occurring; or changing the consequences (DMIRS, 2018). Mines in Chile, for example, are built to withstand large earthquakes, a response to the high frequency and scale of seismic activity in that country. As a result, large lithium and copper mines in the north of the country were unaffected in June 2020 by a magnitude 6.8 earthquake that struck nearby San Pedro de Atacama (Patnaik & Cambero, 2020).

CONSULTATION

To be effective, emergency preparedness and response activities—from risk assessment through planning and design to testing, implementation, and monitoring and evaluation—should be inclusive, involving not just mine managers but also staff, communities, local authorities, and national governments. Consultation should be a formalized process that includes open, inclusive, and transparent dialogue among stakeholders about possible hazards and emergency response procedures, and how responses will be sequenced and organized to optimize their effectiveness. This dialogue must ensure equal and meaningful participation of groups and individuals that are at risk of increased potential impact from crisis and emergencies—such as women, Indigenous Peoples, disabled persons, and certain castes, ethnicities, and races, as well as their cross-cutting identities. Stakeholder input can help inform response procedures that consider the local culture and tie into existing community communication, notification, and response networks. This will serve to not only increase the effectiveness of planning and response actions but can increase community awareness of mining operations and emergency risks, as well as build trust among stakeholder groups.

Consultation and coordination are particularly important given that a key challenge in emergency response for mines is that the effectiveness of responses is often predicated on the availability and quality of regional and national emergency response infrastructure and resources. For example, a response to a serious medical emergency at a mine may require evacuation to a local hospital if facilities are available, or it may require evacuation to a hospital in a nearby country if local facilities are not available. The time required to get medical attention increases the risk. Governments must be collaborative partners in emergency response planning: the consequences of an emergency can be reduced if the government has strong fire, medical, and response equipment, services, and facilities along with a well-established communication network.

COMMUNICATIONS

Crisis communications are also important. Effective, structured crisis communications—and the systems and institutions required to support them—will help a government, company, and community work together to reduce confusion at the onset of an emergency and resolve an issue more quickly (MAC, 2018a; UNEP, 2001). Companies—through one-on-one discussions, group meetings, workshops, or other means—should provide information to local authorities and community members on the hazards involved in the mining operation and on the measures the company is taking to reduce these risks. Governments must also communicate their risk assessment for the site, as well as their preparedness and response plans and capacities. This information should be accessible to all members of the affected communities, and the communication plan should have specific measures to reach out to people and groups with increased vulnerabilities to emergencies. Both governments and companies must also communicate continuously during a crisis on how they are managing and resolving the situation in order to coordinate actions, and so that messaging to responders and communities from the company and government is consistent to avoid confusion. Strong, coordinated communications will also help maintain and build confidence in the company and government during a critical time (MAC, 2018a). Doing this effectively takes considerable planning, organization, and practice long before an unwanted event occurs.

MONITORING

The finalization of the emergency preparedness and response plan is not the end of this process: the plans must be continuously tested and improved across the life of the mine to ensure that it reflects the operating realities and footprint of the mine site, that it integrates changes in the broader operating context (including regulatory changes), that it reflects the mining company's organizational approach to emergencies, that it integrates evolving best practice, and that it incorporates experiences and lessons learned from its application over time. Staff and partner training must also be continuous to ensure that capacities to respond are in place and not lost to time or staff turnover.

A well-planned and coordinated approach to emergency preparedness and response—based on gender-responsive risk assessment and supported by open and effective communications, rigorous testing, continuous improvement, and comprehensive training for staff and outside partners—will ensure that an organized and sequential set of response activities is in place to guide emergency responders should an emergency occur. This will strengthen a mining company's capacity to prevent, protect against, respond to, and recover from incidents and emergencies during and after mining and to avoid the cascading losses that can occur. Good planning also allows for fast, effective response, and organizations have recognized that rapid assessment and notification in the initial moments of an adverse event can make a significant difference in the mitigation of the situation.

BOX 22. MINING DURING A CYCLONE

The Moma titanium project, located near the Mozambican coast, is prone to severe weather damage. The mine is operated by Kenmare, and the approach of Cyclone Idai in March 2019 triggered the on-site emergency management team to activate the mine's cyclone preparedness plan. This was done to protect the company's staff and assets and included the suspension of product-loading activities and shipping (due to rough seas). The storm eventually made landfall to the southwest of Moma, near the town of Beira and caused untold suffering and damage to those living in the region. The mine's distance from the storm's path saved it from the cyclone's worst impacts; however, the initiation of preplanned mitigation measures prior to landfall ensured that mine managers could reduce the threat to both personnel and operations (Mining Review Africa, 2019).

INTERNATIONAL STANDARDS AND PRACTICE

Comprehensive emergency preparedness planning begins at the outset of mine design and planning and should continue throughout the mine life cycle. The focus within these plans should be on prevention above all else, but mitigation and recovery must also be addressed in the event of an emergency. Mining companies, governments, and communities can draw on several international, regional, and corporate benchmarks and standards in the development of their emergency preparedness and response plans. These benchmarks and standards cover several of the key issues outlined above, and they overlap in a number of ways. Complementary aspects of each are highlighted below.

INTERNATIONAL GUIDELINES

International guidelines on emergency preparedness and response have been developed by several organizations, including the UNEP, the World Bank/IFC, and the European Union. These guidelines collectively stress that the process of planning for and responding to emergencies should be initiated prior to permitting, applied throughout the mine life cycle, inclusive and consultative, and grounded in risk assessment.

UNEP'S AWARENESS AND PREPAREDNESS FOR EMERGENCIES AT THE LOCAL LEVEL (APELL)

UNEP's APELL guidelines were developed for the mining sector in 2001, in collaboration with ICMM. The guidance takes users through the steps they must follow from the outset to ensure that their operations reduce emergency risks; prepare and plan for unwanted emergency situations; and have the systems, procedures, and mechanisms in place to ensure that a company can manage, communicate, and recover from emergency situations (UNEP, 2001). The overall goal of applying the guidance is to prevent loss of life or damage to health and social well-being, to avoid property damage, and to ensure environmental safety at the site, in the local community and—where relevant—in the broader environment. It applies across the mine life cycle, including in the post-mining phase. The APELL guidelines, while nearly 20 years old, are still referred to in guidance on emergency preparedness by MAC and ICMM. Further good practice in emergency preparedness and response was elaborated by ICMM and UNEP (2005).

UNEP outlines 10 key steps for achieving emergency preparedness (see Box 23). In addition to adhering to these steps, the APELL guidance also recommends that stakeholders developing emergency preparedness and response efforts consider integrating the mine's emergency preparedness plans into broader plans in the area: those for local communities and those for other businesses operating nearby. This will allow all stakeholders to consolidate their plans into an overall emergency preparedness plan for the region and to coordinate planning, testing, implementation, and response actions. Such cooperation will serve to strengthen the ability of all stakeholders to respond to and recover from emergency situations.

BOX 23. THE 10 STEPS OF APELL

STEP 1: Identify the emergency response participants and establish their roles, resources, and concerns.

STEP 2: Evaluate the risks and hazards that may result in emergency situations in the community and define options for risk reduction.

STEP 3: Have participants review their own emergency plan for adequacy relative to a coordinated response, including the adequacy of communication plans.

STEP 4: Identify the required response tasks not covered by the existing plans.

STEP 5: Match these tasks to the resources available from the identified participants.

STEP 6: Make the changes necessary to improve existing plans, integrate them into an overall emergency response and communication plan, and gain agreement.

STEP 7: Commit the integrated plan to writing and obtain approvals from local governments.

STEP 8: Communicate the integrated plan to participating groups and ensure that all emergency responders are trained.

STEP 9: Establish procedures for periodic testing, review, and updating of the plan.

STEP 10: Communicate the integrated plan to the general community.

Source: UNEP, 2001.

IFC PERFORMANCE STANDARD 4: COMMUNITY HEALTH, SAFETY, AND SECURITY

Emergency preparedness is covered under the IFC's PS1 (Assessment and Management of Environmental and Social Risks and Impacts) and PS4 (Community Health, Safety, and Security) (IFC, 2012b). Clients of the IFC are required to apply these PSs in order to manage and mitigate the environmental and social risks and impacts of their operations to ensure that they contribute positively to sustainable development. PS4, which builds on the World Bank's Environmental, Health and Safety Guidelines, recognizes that project activities can increase community exposure to risks and impacts and that companies have a significant role to play in preventing or minimizing these threats to health, safety, and security (IFC, 2012b). Measures that are proposed to mitigate emergency risks should favour avoidance over minimization. Risks and impacts should first be identified early in the mine life cycle (and prior to permitting) during the ESIA process, with initial preparedness plans then included as a central component to a company's environmental and social management system (IFC, 2012b). This risk assessment, covered in PS1, along with the identification of mitigation measures, should be done in close collaboration with affected communities, local authorities, and other relevant parties, and preparedness plans should be documented and shared with all relevant stakeholders. Preparing for emergencies should include identifying mine site areas where emergency situations may occur, communities and individuals that may be affected, response procedures, required equipment and resources to implement the preparedness plan, roles and responsibilities for staff, communications procedures, and periodic training to ensure effective response (IFC, 2012a).

EUROPEAN UNION

The EU issued guidance on major accident prevention and information in 2006 as part of its directive on the management of waste from extractive industries (Directive 2006/21/EC). The directive notes that member states must ensure that major accident hazards are identified and incorporated into the design, construction, operation, and maintenance of waste facilities, including through closure and the post-mining transition. Operators are required to prepare a major accident prevention policy, specifically for extractive wastes, and put into effect a safety management system to implement it under the guidance of a safety manager. Plans should cover both on-site and off-site responses to any accident, including the rehabilitation, restoration, and clean-up of the environment, and must be developed prior to the granting of a permit. As with other jurisdictions, the development of emergency plans must be consultative, involving the potentially affected public in both the development of the plan and its review prior to finalization. Once an acceptable plan is approved and in place, the directive requires that it be made public and free of charge and that it be reviewed every three years for updates, as necessary (EU, 2006).

GOVERNMENTAL GUIDELINES

Subnational governments in both Australia and Canada have developed regulations and codes of practice on emergency preparedness for those mining companies operating within their state or provincial borders. While echoing much of what appears in the international guidance listed above, these subnational governments also stress the importance of carefully considered response measures, as well as regular testing and review.

GOVERNMENT OF WESTERN AUSTRALIA

In Western Australia, mining companies are required by the government to have three kinds of plans in place to prepare for, manage, and recover from emergency situations: an emergency plan, a crisis management plan, and an emergency response plan (DMIRS, 2018). An emergency plan is an overall preparedness plan for the site, which includes the identification of hazards and a risk assessment. A crisis management plan is designed for the overall management of an emergency; it is designed for managing external stakeholders in an emergency situation and not for managing the company's response activities. Finally, emergency response plans are procedures that assign responsibility and tasks for responding to a specific event and implementing specific contingency plans (DMIRS, 2018).

GOVERNMENT OF BRITISH COLUMBIA

In the Canadian Province of British Columbia, regulations require that companies develop a Mine Emergency Response Plan and—as in many jurisdictions—that the plan outlines the response procedures and preventive measures that are essential for effective and timely management of an emergency (Ministry of Energy Mines and Petroleum Resources, 2017). For British Columbia, regular reviews and revisions of plans are required, as they are seen as necessary to assess a company's level of readiness for emergencies by identifying how conditions have changed over time and where areas of improvement lie. Based on these regular reviews, it is expected that the emergency management team can adapt the plan over time to reflect changing risks and circumstances.

INDUSTRY

Finally, international and national mining associations have also developed principles and protocols for their members to follow in order to ensure that operations, personnel, and communities are prepared for and can safely respond to emergencies and crises. While similarly echoing the benchmarks and standards outlined by the international and governmental sources listed above, both ICMM and MAC reiterate the importance of collaboration and consultation with affected stakeholders, as well as the crucial role that effective communications can play in the speed and efficacy of emergency response measures.

INTERNATIONAL COUNCIL ON MINING AND METALS

ICMM members have committed themselves to implementing 10 Mining Principles and measuring their performance against them. Emergency preparedness is covered by a few of these principles, which stress the importance of collaboration and consultation. The fourth principle, on risk management, refers to the need to "inform potentially affected parties of significant risks from mining, minerals and metals operations and of the measures that will be taken to manage the potential risks effectively" and to "develop, maintain and test effective emergency response procedures in collaboration with potentially affected parties" (ICMM, n.d.b.). Where the risks to external stakeholders are significant, the principles note that the development, implementation, and testing of plans should take place in collaboration with potentially affected stakeholders and be consistent with established industry good practice. Other supporting principles include the fifth, on Health and Safety, which requires a commitment to "seek continual improvement of our health and safety performance," and the 10th, on stakeholder engagement, which includes a commitment to "engage with and respond to stakeholders through open consultation processes" (ICMM, n.d.b.).

TOWARDS SUSTAINABLE MINING

MAC provides protocols to its members on emergency communications as part of its TSM initiative. MAC recognizes that for a mining company to successfully resolve a crisis and limit long-term reputational damage, structures and protocols must be in place internally to ensure proactive crisis management and clear, effective communication with affected stakeholders (MAC, 2016; MAC, 2018a). Members are asked to carefully develop a crisis management and communications plan and continuously scrutinize and modify the plan over the mine life cycle. This communications plan should be in place before an emergency occurs, and it should be updated with lessons learned after each crisis. As part of a company's pre-incident preparation, the plan should identify, prioritize, and prepare contact sheets for key stakeholders to ensure that, in the event of an emergency, no one is missed. The company's emergency response team should also meet regularly or annually with their counterparts within the local authority. Finally, the protocols point out that—as part of preparedness testing—crisis simulation exercises should be carried out regularly by the company. These can include management training exercises, table-top discussions, semi-active sessions, and full crisis simulation. The various types of simulation provide users with information about the planned response activities, allow key stakeholders to practice procedures and decision making during an event, and bring together the key participants to establish and maintain engagement and teamwork (MAC, 2018a).

ROLE OF GOVERNMENT

National governments have a major role to play in emergency preparedness and in ensuring that, should a crisis occur, responses are swift, organized, and coordinated, and that all relevant stakeholders, from local communities and emergency responders to mine staff, are safe and protected.

First and foremost, governments themselves have a crucial role to play in planning for, managing and recovering from emergency situations. They must identify which parts of government will be responsible for emergency risk assessment, prevention and preparedness plans, response plans, recovery plans, and communications with affected stakeholders—including mining companies, local communities, emergency responders and the general public. They must have plans in place for mobilizing resources (e.g., human, financial) in the event of a crisis to protect communities, mine staff, the environment, and critical infrastructure. All of this work must be coordinated with communities and companies to succeed.

Through legislative, policy, and regulatory frameworks and instruments, governments should also mandate that emergency preparedness and response plans are prepared by proponents and that they cover the entire mine life cycle. These plans should:

1. Ensure companies develop comprehensive emergency preparedness and response plans grounded in risk assessment prior to the granting of mining permits.
2. Require that the development, implementation, testing, and monitoring of emergency preparedness and response plans are consultative, inclusive, and reflective of the risks borne by the most vulnerable stakeholders, including women, children, and Indigenous persons.
3. Necessitate that companies regularly test, review, and update emergency preparedness and response plans to reflect the changing context.

PLANNING: ENSURE COMPANIES DEVELOP COMPREHENSIVE EMERGENCY PREPAREDNESS AND RESPONSE PLANS GROUNDED IN RISK ASSESSMENT PRIOR TO THE GRANTING OF MINING PERMITS

First, governments should require all mining operations to have a formal and written emergency preparedness and response program in place prior to the granting of permits or licences and the start of operations. These programs should be formally documented, accurately and comprehensively reflect the risks associated with the company's operations and the mine's location, be publicly accessible, and meet current good international standards and practices. They should form part of a mine's ESMP. Emergency preparedness and response plans should include five principal components: risk assessment, prevention and preparedness, response, recovery, and crisis communications.

FIGURE 15. THE PRINCIPAL COMPONENTS OF EMERGENCY PREPAREDNESS AND RESPONSE

RISK ASSESSMENT

should serve as the foundation of the plan: identification of possible crises that could occur at the site before, during, and after mining and the potential severity of the associated impacts.

PREVENTION AND PREPAREDNESS

are managed once major foreseeable emergency events and their impacts have been identified. Preparedness plans can outline the control measures that will be implemented to prevent, minimize, and mitigate these risks as well as any hazards that might be associated with these responses (DMIRS, 2018). As mentioned throughout this guidance note, a mine life-cycle approach should be taken to emergency preparedness, including the closure and post-closure phases, and control measures should be developed in collaboration with affected stakeholders.

RESPONSE PLANS

include plans for the overall management of an emergency, including the management of external stakeholders in an emergency situation and plans for managing the company's response activities. They outline the procedures that assign responsibility and tasks for responding to a specific event and implementing specific contingency plans (DMIRS, 2018).

RECOVERY PLANS

detail those activities that will commence or continue beyond the emergency in order to restore community safety, ecosystem health, and mining operations.

CRISIS COMMUNICATION PLANS

include protocols for both internal and external communications of the preparedness and response plan to ensure that affected staff and stakeholders are aware of risks and response measures. They outline the lines of communication in the event of an emergency to ensure that emergency response and recovery actions are clear and coordinated. Communications must be tailored to the needs of all stakeholder groups, including those with limited literacy or access to information technologies.

These plans should be developed and submitted before mining starts to ensure that they are in place should an emergency occur.

Governments can formalize these requirements in legislation, such as a Mine Safety and Inspection Act or Emergency Management Act (as in Western Australia, for example). They can also regulate it: given the strong focus of emergency preparedness on risk assessment, it makes sense for governments to integrate emergency preparedness into the ESIA process and to require that these plans be included as part of the conditions for the granting of mine leases and permits. These conditions should include not only that the preparedness plan is established prior to the granting of a permit but also that the plans are developed collaboratively with potentially affected stakeholders and that they are periodically reviewed and adjusted over time to reflect changes in the mine's operations or context.

In order to support mining companies and communities in their efforts to plan for emergencies, national and subnational governments can consider endorsing and promoting good international practices in this area, such as UNEP's APELL process. The application of these kinds of guidelines will help to better coordinate emergency preparedness between mining entities, local authorities, and local populations. To complement good international practice, governments can also develop a national code of practice around emergency management for surface and underground mining and quarries, which could include both mandatory and voluntary actions. Mandatory actions could include the establishment, training, and resourcing of a site-specific crisis management team; the launch of a well-equipped crisis control centre; and the hiring and training of crisis communications specialists.

Governments can also develop codes and standards for mining companies that consider country-specific risks; these risks can be identified through a national or regional risk assessment process. For example, codes and standards might focus on emergency preparedness and response for cyanide spills if there is gold mining in the country, security requirements if there is potential for local civil unrest, and building standards and underground support guidance in areas with high seismic risks.

COLLABORATION: REQUIRE THAT THE DEVELOPMENT, IMPLEMENTATION, TESTING, AND MONITORING OF EMERGENCY PREPAREDNESS AND RESPONSE PLANS ARE CONSULTATIVE AND INCLUSIVE

Promoting and facilitating collaboration and cooperation on emergency preparedness among key stakeholder groups is another central function of the national government.

First, mining ministries should work to ensure that all appropriate government ministries, departments, and agencies at the national, district, and local levels are aware of emergency risks and planning processes and are ready to cooperate with mining companies, both during the planning phase and—crucially—in response to a crisis occurring. The Pilbara Ports Authority in northwest Australia, for example, worked with mining companies to shut down the region's ports in advance of Cyclone Veronica in March 2019 to minimize the Category 5 storm's threat to mining assets and infrastructure (Mining Technology, 2019). Throughout the mine life cycle, mining ministries should also transmit information and data on potential natural and social risks for the mine site and surrounding communities to stakeholder groups, including seismic, climatic, and topographical information. Some of these risks will change over time, and governments should establish appropriate channels or platforms for knowledge exchange to make sure the information gets to those that need it during mining and that it arrives in a format they can understand and use.

During the planning phase, companies should be required by governments to consult and cooperate with local, district, national and—as appropriate—transboundary stakeholders in the development of emergency preparedness programs. This includes jointly conducting risk assessments, developing site-specific response measures, and specifying communication systems and chains of command. A consultative process will help to ensure the plans are comprehensive, that they reflect local needs and perceptions of risk, and that response strategies are widely understood, locally appropriate, feasible, and effective. Beyond the planning phase, communications and consultation must continue; this can take the form of regular meetings between the mine's crisis management team and the local emergency response authorities, organizing and delivering training programs together, and cooperating on both testing and auditing.

One particular form of coordination that can be promoted by governments is the alignment and integration of company preparedness plans into local emergency response plans, resulting in one overall plan for the community—including the mine—to use in the event of a crisis (UNEP, 2001). Having an integrated plan prior to mining will allow for the development of formalized processes within the program that will facilitate communications between communities and the mine's crisis management team. It will improve—through coordination—the efficiency and feasibility of both preventive and response measures. Further, the collaborative and transparent development of integrated preparedness plans will help to establish and foster trust among stakeholders, while all parties will be able to leverage the knowledge, capacities, and resources of their partners for gains that would not be achieved were they acting alone.

MONITORING AND EVALUATION: NECESSITATE THAT COMPANIES REGULARLY TEST, REVIEW, AND UPDATE EMERGENCY PREPAREDNESS AND RESPONSE PLANS TO REFLECT THE CHANGING CONTEXT

A mining company's exposure to emergency hazards and risks will change over time, both as the operation progresses through the mine life cycle and as the wider context within which the mine is located changes—including local demographics, politics, and climate change. Governments have to ensure that emergency preparedness programs are reviewed, tested, and updated on a regular basis during mining to ensure that these programs remain feasible, effective, and responsive in light of the current context. The regular monitoring and evaluating of preparedness plans should be done by companies in cooperation with communities, local authorities, and the national government.

The periodic review of emergency preparedness and response plans will help to make sure not only that the plans reflect the changing risks faced by a company's operations but also that they consider changes in the company's needs, the operational realities of the mine (e.g., current staff numbers, the footprint of the mine, the technologies employed at the mine site, and so on), and good international practices drawn from the standards discussed above. The good international practices of industries where similar hazards and emergency situations can arise—such as the petroleum sector—should also be reviewed.

A comprehensive review and evaluation of preparedness plans and response procedures should look at:

- Hazard identification and scenario analysis procedures
- Preparedness plans and contingency plans
- Organizational structure, roles, and responsibilities for preventive and response activities
- Training and competency of those involved in the response activities
- Equipment and resourcing
- Internal and external communications structures and procedures.

External audits of emergency preparedness and response plans can provide a strong mechanism for evaluating the adequacy and effectiveness of company plans and for identifying and implementing any needed corrective actions. Audits are typically undertaken by people that are not involved in the activity or program being audited; this independence can help provide assurance on the adequacy and effectiveness of the review. Based on the results of audits and reviews, the company's crisis management team can then develop specific goals to improve the program or adapt it to the changed circumstances (Ministry of Energy Mines and Petroleum Resources, 2017).

In addition to periodic reviews during mining, governments can also require that companies undertake regular testing of their plans to gauge their effectiveness and to ensure that all staff understand their role in both emergency prevention and response. Testing can take a number of forms across the mine life cycle (from management training exercises and table-top discussions to semi-active sessions and full crisis simulations [MAC, 2018a]) and will help to ensure that, despite the staff turnover that mining companies habitually deal with, staff knowledge and capacities are continually in place to implement the plan. Annual testing of emergency preparedness and response plans is good practice, and the frequency of testing should be laid out in the plans.

Should an emergency occur and the company's response plan be implemented, companies should work with emergency responders and affected stakeholders to document any lessons learned from the experience and integrate these into emergency preparedness going forward. This should include the collection and analysis of data segregated by gender and any other critical identity factors. In addition to reviewing the overall response, this exercise should include identifying what worked well and what did not with regard to internal and external communications, notification activities, equipment and capacity constraints, roles and responsibilities, response sequencing, and coordination among affected stakeholders. The organization needs to perform this lessons learned analysis with responders, stakeholders, and staff to scrutinize, update, and strengthen the plans with a focus on improvement and not blame or fault.

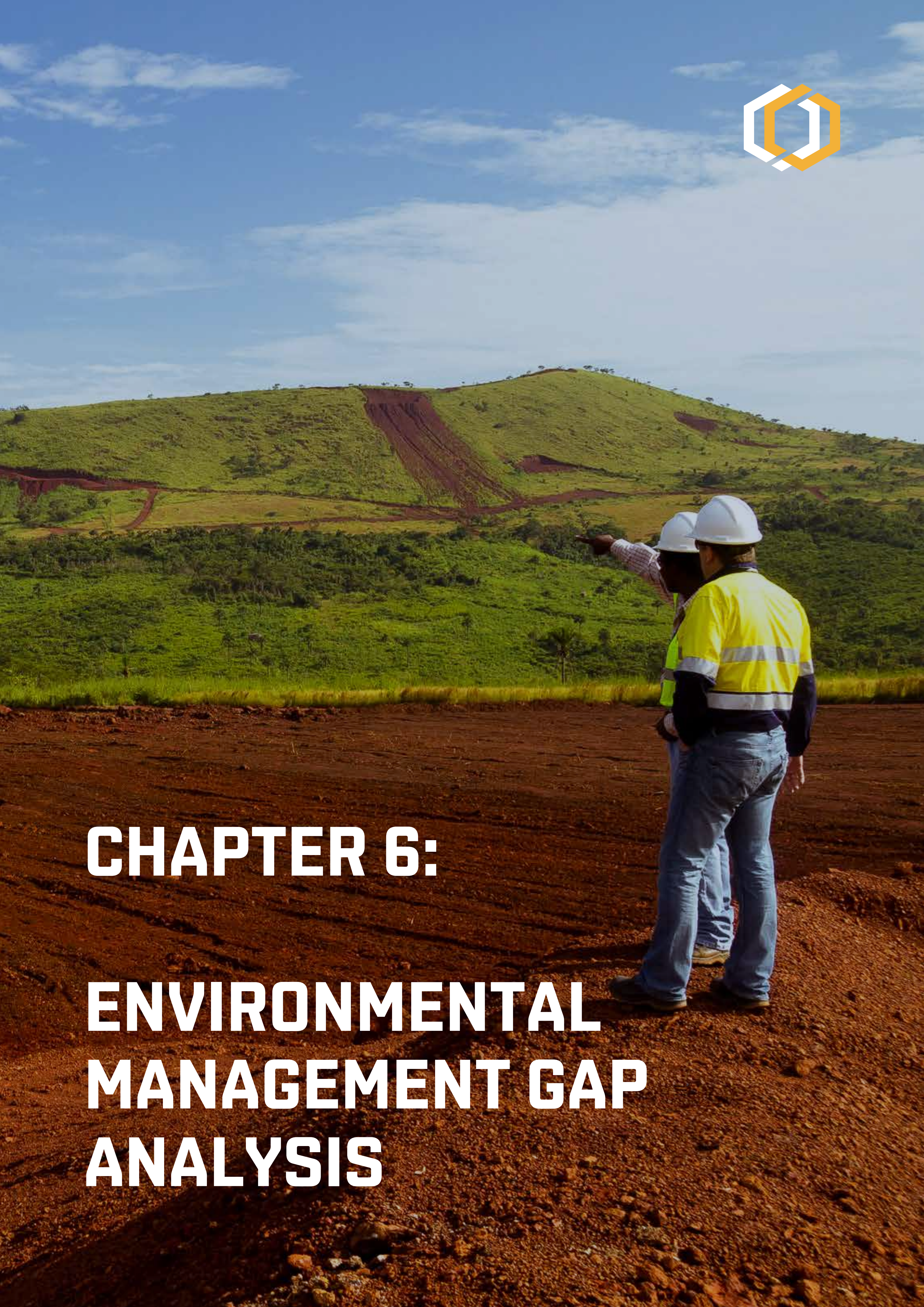
Testing, reviewing and updating emergency preparedness and response plans will require resources, and companies must allocate adequate funding to the implementation and upkeep of these plans. That extends beyond the mine's closure; for the long-term risks that a company cannot eliminate, governments should require that sufficient financial assurances are in place to respond to future risks.

BOX 24. CASE STUDY: TESTING EMERGENCY PREPAREDNESS IN QUEENSLAND, AUSTRALIA

In response to an explosion at the Moura 2 mine in 1994, the state government of Queensland in Australia launched an inquiry that, when completed, recommended that exercises testing emergency procedures should be carried out at all mines on an annual basis (DMIRS, 2018). The government followed this up with standards on running emergency procedure exercises in 1996 and further updated in 2009. As part of the standard, mines are required to test their emergency procedures on an annual basis.

For the emergency simulation exercise conducted at Grosvenor coal mine in July 2018, a broad team of assessors was involved, including representatives from Grosvenor, the union, other mines in the state, and across the government, from inspections and health and safety to the mine rescue services. The simulation exercise tested the protocols and procedures that would be used in the event of an explosion at the mine, as well as the need to ensure the explosion was contained and that staff were safely evacuated from the site.

This exercise points to a strong standard for emergency preparedness and response planning in which legislative requirements mean that annual testing of emergency plans is mandatory and that these tests are undertaken with government oversight and the participation of government assessors. The government also writes the report evaluating the exercise and the mine's ability to plan for and respond to an emergency (DMIRS, 2018).



CHAPTER 6:

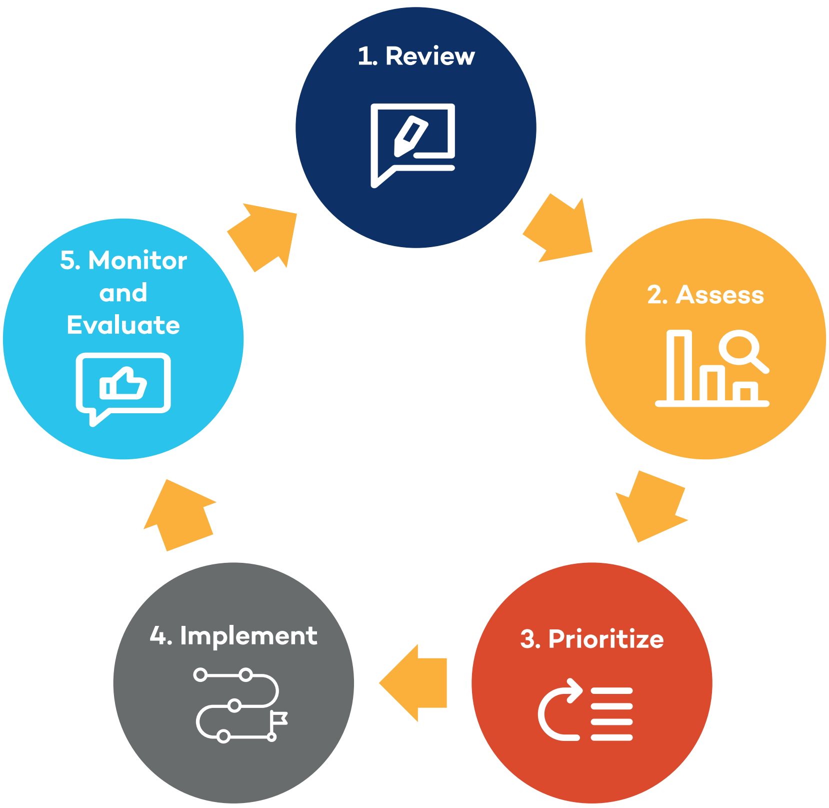
ENVIRONMENTAL MANAGEMENT GAP ANALYSIS

The guidance presented in the previous chapters describes good international practices and key government actions for environmental management of the mining sector. But how does your government begin to assess what changes are needed, given your current legal and regulatory framework? Where do you begin to actually incorporate this guidance to make sure that your policies and legal frameworks protect the environment while optimizing the social and economic benefits of the mining sector? And how do you do this across the mine life cycle?

There are several things that governments must do before, during, and after mining to ensure that those mining companies operating in their jurisdiction effectively manage water resources, protect biodiversity and ecosystems, properly store and dispose of waste materials, and prepare for and respond to emergencies. Using the legislative, regulatory, and policy tools at their disposal, governments can design, implement, and enforce a regulatory framework that supports responsible and effective environmental management in mining that protects communities, supports the private sector, and helps with the achievement of national environmental objectives and the 2030 Agenda for Sustainable Development.

Conducting a gap analysis based on the information presented in this guidance document is an effective way for governments to identify their strengths, gaps, and opportunities in environmental management for mining and to develop a path forward for achieving their environmental objectives. It is a five-step process: review, assess, prioritize, implement, and monitor and evaluate (see Figure 16).

FIGURE 16. KEY STEPS FOR ENVIRONMENTAL MANAGEMENT



1. REVIEW THE EXISTING LEGAL AND REGULATORY FRAMEWORKS

As a first step, governments should conduct a review of their existing legal and regulatory frameworks to understand what they are currently doing or requiring on all four aspects of environmental management across the mine life cycle, including in their ESIAs and ESMP requirements. This information can be presented in a table listing, for example, everything that the government requires of proponents on water management before, during, and after mining, and so on, as well as the ministry, department, or agency responsible for that requirement or standard. While the review will be the responsibility of a core team within one ministry, such as the ministry of mining or environment, it should be coordinated with all relevant ministries and departments (e.g., lands, forestry, gender and so on), as well as civil society and private sector actors, to ensure a holistic understanding of the legal frameworks governing environmental management in mining.

2. ASSESS STRENGTHS, GAPS, AND OPPORTUNITIES IN LEGAL FRAMEWORKS

A government can use the review from the previous step as the basis for assessing their legal frameworks, comparing their progress on environmental governance with good international practice. This will help the government see how their legal frameworks on water, waste, biodiversity, and emergency preparedness measure up against international standards and benchmarks and will allow them to identify an initial list of their strengths, gaps, and opportunities for improving legal frameworks on environmental management. It may be, for example, that their requirements on water management before mining commences are largely in line with international standards but that there are opportunities for further strengthening the laws, policies, and regulations that govern water during mining and after mine closure.

The assessment should be carried out by a dedicated individual or team, preferably one involved in the initial document review. It will require not only a careful reading of existing laws, policies, and regulations but also a good understanding of their implementation and enforcement. The analysis also cannot be simply conducted behind a desk; it must involve meaningful consultation with key stakeholders from across government, civil society, and the private sector to ensure that each understands the exercise and sees their perspectives reflected in it. Efforts should also be made to ensure that these consultations are inclusive and gender responsive.

Table 3 provides a framework that governments can use for assessing the strengths or gaps they have in their laws, policies, and regulations governing environmental management. General guidance, drawn from the document above, is provided, which describes what progress on good practice should look like for each thematic area. The assessment team can then measure progress for the key standards their legal frameworks should be supporting: from a low level of progress, through medium progress, to a high level of progress toward achieving good international practice. A brief description is provided in the table for each possible score to provide guidance to the assessment team about criteria that might result in that score—for example, "no law exists" = low; "a law exists, but it is not implemented" = medium; or "a law exists and it is consistently implemented and enforced" = high.

TABLE 3. ASSESSING STRENGTHS AND GAPS IN ENVIRONMENTAL GOVERNANCE FRAMEWORKS

THEMATIC AREA	STANDARD	GUIDANCE	PROGRESS	LOW	MEDIUM	HIGH
Water						
Water standards	Appropriate environmental management standards for the use of surface water and groundwater are in place and are strictly monitored and enforced through appropriate penalties.	Government ensures that mining entities adhere to appropriate environmental management standards for water management and takes an integrated watershed management approach to ensuring water quality and quantity. Government has established regulations and/or permitting processes for the use of surface water and groundwater that involve strict monitoring and enforcement through appropriate penalties. This applies to the mine life cycle, and governments should ensure that sufficient financial assurance is in place to manage any post-mining water treatment requirements and risks.		Environmental management standards for the use of surface water and groundwater are not appropriate, nor are they strictly monitored and enforced through appropriate penalties.	Environmental management standards for the use of surface water and groundwater are sometimes, but not always, appropriate, and/or are not always strictly monitored and enforced through appropriate penalties.	Environmental management standards for the use of surface water and groundwater are appropriate and are strictly monitored and enforced through appropriate penalties.
Effluent discharge	Require that mining entities ensure that quality and quantity of mine effluent streams discharged to the environment—including stormwater, leach pad drainage, process effluents, and mine works drainage—are managed and treated to meet established effluent discharge guideline values.	Government has established and closely monitors effluent discharge levels. Improper discharge, especially in the form of acid mine drainage, is very difficult and costly to stop and clean up. Issues can be identified through careful monitoring before they become catastrophic. The requirement for ongoing monitoring can be mandated through water or environmental protection legislation and/or as part of the mine permitting process, and must include discharge standards, effluent quality limits, and surface water and groundwater quality guidelines.		Mining entities are not required to ensure that the quality and quantity of mine effluent discharged into the environment are managed and treated to meet established effluent discharge criteria.	Mining entities are sometimes, but not always, required to ensure that the quality and quantity of mine effluent discharged into the environment are managed and treated to meet established effluent discharge criteria.	Mining entities are consistently required to ensure that the quality and quantity of mine effluent discharged into the environment are managed and treated to meet established effluent discharge criteria.

THEMATIC AREA	STANDARD	GUIDANCE	PROGRESS	LOW	MEDIUM	HIGH
Contaminant protection	Require that mining entities ensure that water-leaching or percolating waste dumps, tailings storage areas, and leach pads have equivalent protection.	The stability of waste dumps is particularly important in areas that are prone to severe weather events and significant rainfall. Protective measures must take into consideration climate change impacts, which are expected to include more severe and frequent severe weather events, flooding, and drought. Acid mine drainage and contaminant leaching are common problems with waste dumps and should be modelled and closely monitored. The structural integrity of all dumps and storage areas should be closely monitored and protected, including in the long term after mine closure. Government action in this critical area will ensure progress toward minimizing pollution and treating as needed to minimize the release of constituents at harmful concentrations.		Mining entities are not required to ensure that water-and waste leaching, or percolating from waste dumps, tailings storage areas, and leach pads have equivalent protection.	Mining entities are sometimes, but not always, required to ensure that water and waste-leaching or percolating from waste dumps, tailings storage areas, and leach pads have equivalent protection.	Mining entities are consistently required to ensure that water and waste-leaching or percolating from waste dumps, tailings storage areas, and leach pads have equivalent protection.
Off-site water risk management	Require that mining entities have in place practices and plans that minimize the likelihood of impacts beyond the mining site, particularly potential transboundary impacts.	The government, through ESIA requirements, ensures that companies have appropriate and comprehensive plans in place to minimize adverse water impacts beyond the mining site, including transboundary impacts. Mine-related exploration, construction, production, processing, and transport may potentially impact communities and environments beyond the mine footprint. Impacts can include contamination along roadways, travel ways and loading areas, and pollution of national and transboundary waterways. Appropriate requirements are important for integrated water resources management and transboundary cooperation.		Mining entities are not required to have in place practices and plans that minimize the likelihood of impacts beyond the mining site, particularly potential transboundary impacts.	Mining entities are sometimes, but not always, required to have in place practices and plans that minimize the likelihood of impacts beyond the mining site, particularly potential transboundary impacts.	Mining entities are consistently required to have in place practices and plans that minimize the likelihood of impacts beyond the mining site, particularly potential transboundary impacts.

THEMATIC AREA	STANDARD	GUIDANCE	PROGRESS	LOW	MEDIUM	HIGH
Biodiversity						
Biodiversity risk assessment	Avoid and minimize potential adverse effects on biodiversity by requiring that mining entities submit environmental management programs and updates for approval during the permitting process and whenever there are significant process or operational changes during the operating life of the mine.	Government should ensure their legal framework includes protection of biodiversity and alignment with the international CBD. It should also develop policies and programs for biodiversity conservation, including guidance for mining companies to follow the MH and strive toward NNI/NPI. Biodiversity considerations should be integrated into ESIAs prior to permitting and should be revised when significant changes to the mine are planned (including major technological changes, processing changes and changes in the expected life of the mine, footprint of the mine, and environmental impact of the mine). Biodiversity should be fully integrated into environmental management plans prior to permitting or in separate supplementary biodiversity management plans, with efforts focused on (in order): impact avoidance, minimization, rehabilitation, and finally, offsetting. All actions should be based around baseline biodiversity assessments as part of the ESIA.		Mining entities are not required to submit environmental management programs and updates that incorporate biodiversity considerations for approval during the permitting process or when there are significant changes during the operating life of the mine.	Mining entities are sometimes, but not always, required to submit environmental management programs and updates that incorporate biodiversity considerations for approval during the permitting process and when there are significant changes during the operating life of the mine.	Mining entities are consistently required to submit environmental management programs and updates that incorporate biodiversity considerations for approval during the permitting process and when there are significant changes during the operating life of the mine.
Biodiversity risk management	Identify, monitor, and address potential and actual risks and impacts to biodiversity throughout the mining cycle through the use of the MH.	Government requires ESIAs that assess, among other factors, baseline levels of biodiversity and critical ecosystem services within the mine's footprint, potential project impacts on biodiversity and ecosystem services, and, through stakeholder participation in ESIAs, the level of community and Indigenous knowledge and value of biodiversity. ESIAs are important tools for ensuring that biodiversity considerations are fully integrated into the mining project, baseline assessments, and monitoring mechanisms throughout the life of the mine and through closure and the post-mining transition. Environmental management plans (or supplementary biodiversity management plans) should be used to specify how the mining entity plans to avoid, minimize, rehabilitate, and offset negative project impacts on biodiversity. Government should ensure that sufficient financial assurance is left in place for the long-term risks to restoration success and any sustainable finance mechanisms are in place if needed to meet long-term objectives of NNL/NPI.		Government does not require that mining entities identify, monitor, or address potential and actual risks and impacts to biodiversity throughout the mining cycle.	Government inconsistently or inadequately requires that entities identify, monitor, or address potential and actual risks and impacts to biodiversity throughout the mining cycle.	Government comprehensively requires that entities identify, monitor, and address potential and actual risks and impacts to biodiversity throughout the mining cycle.

THEMATIC AREA	STANDARD	GUIDANCE	PROGRESS	LOW	MEDIUM	HIGH
Biodiversity risk monitoring	Require that mining entities conduct biodiversity and ecosystem monitoring on a continuous basis based on national and international standards and the conditions of the operating permit; require that they compile and submit performance assessments to government and publish regular reports that are readily accessible to the public.	A biodiversity monitoring plan is required as a condition for obtaining an operating permit and as a criterion for maintaining the permit. The plan must be presented as part of the ESIA. Monitoring involves local communities; this can include participatory monitoring as well as gathering geo-referenced data from communities, researchers, and other organizations via accessible technologies (such as smart phone, drone, and satellite technology). Third-party monitoring or verification is encouraged. Reports on the implementation of biodiversity monitoring and management plans, including efforts to apply the MH, are made public through user-friendly and freely accessible websites, as well as through local community communications mechanisms established by the government and company.		Mining companies are not required to conduct monitoring based on national and international standards and the conditions of the operating permit, nor are performance assessments and regular, publicly accessible reports required.	Mining companies are sometimes required to conduct monitoring based on national and international standards and the conditions of the operating permit, and/or to submit performance assessments and regular, publicly accessible reports.	Mining companies are required to conduct monitoring based on national and international standards and the conditions of the operating permit; performance assessments and regular, publicly accessible reports are required.
Mine waste						
Integrating risk in waste structures across the mine life cycle	Ensure structures (waste dumps, tailings storage facilities, etc.) are planned, designed, and operated so as to appropriately assess and manage physical and chemical risks and environmental impacts through the entire mine life cycle and after mine closure.	Decisions regarding the types of structures built to contain mining waste and their location are considered very carefully and discussed with stakeholders, designed for closure, and take into consideration site-specific conditions. These early decisions regarding waste disposal are in many respects irreversible, and thus should be considered with particular care. Responsible and ongoing management of physical and chemical risks and environmental impacts related to waste management structures is extremely important. Design standards are required and carefully reviewed by government in the mine permitting process. Mining waste storage design and location take into consideration existing and potential climate change impacts, mine expansion forecasts, and other environmental and social risk factors. Mining waste structures are managed and monitored throughout the life of the mine and after mine closure. Governments should ensure that sufficient financial assurance is in place to manage any post-mining physical and chemical stability risks from mine waste facilities.		Structures are not planned, designed, or operated to appropriately assess and manage physical and chemical stability risks and environmental impacts throughout the mine cycle and after mine closure.	Structures are sometimes, but not always, planned, designed, and operated to appropriately assess and manage physical and chemical stability risks and environmental impacts throughout the mine cycle and after mine closure.	Structures are consistently and comprehensively planned, designed, and operated to appropriately assess and manage physical and chemical stability risks and environmental impacts throughout the mine cycle and after mine closure.

THEMATIC AREA	STANDARD	GUIDANCE	PROGRESS	LOW	MEDIUM	HIGH
Adoption of international standards	Require that mining entities design, operate, maintain, and close mine waste structures according to internationally recognized standards.	Government ensures that mine waste facilities are designed, operated, and closed following good international practices, taking into consideration site-specific conditions and risks. Waste structures are designed to respond to emergencies such as power outages, seismic events, and major weather events (e.g., emergency and flood overflow spillways and channels). Government requires accountability for the design and management of mine waste facilities. Government requires quality assurance and control to ensure proper construction of waste structures, effective maintenance to ensure proper operation, regular monitoring to ensure proper function, regular executive review, public environmental reporting, full closure, and post-closure monitoring.		Mining entities are not required to design, operate, maintain, or close mine waste facilities according to internationally recognized standards.	Mining entities are, in some ways but not consistently, required to design, operate, maintain, and close mine waste facilities according to internationally recognized standards.	Mining entities are regularly and comprehensively required to design, operate, maintain, and close mine waste facilities according to internationally recognized standards.
Independent reviews and reports	Require that mining entities commission independent expert reviews and report to governments prior to development approval, when changes in design are proposed, and at regular intervals during the operating phase.	Government requires reviews of mine waste facilities by independent experts—a very important component to building trust among the public and stakeholders in the credibility of reported information. Independent reviews of waste management facilities are required not only in the permitting phase but also at periodic intervals throughout the life of the mine when major changes to the project are proposed and as part of mine closure, post-closure, and potentially relinquishment (i.e., if and when granting an exit ticket or closure certificate).		Mining entities are not required to commission independent expert reviews or to report to governments prior to development approval, when changes in design are proposed, and at regular intervals during operating and closure phases.	Mining entities are sometimes, but not always, required to commission independent expert reviews and report to governments prior to development approval, when changes in design are proposed, and at regular intervals during operating and closure phases.	Mining entities are consistently required to commission independent expert reviews and report to governments prior to development approval, when changes in design are proposed, and at regular intervals during operating and closure phases.

THEMATIC AREA	STANDARD	GUIDANCE	PROGRESS	LOW	MEDIUM	HIGH
Emergency preparedness and response						
Emergency preparedness and response plans within government	The government develops and implements its own emergency preparedness and response plans based on good international practice and through consultation with affected stakeholders.	The government should develop its own emergency preparedness and response plans, which should include a risk assessment; emergency management, response and recovery plans; and crisis communications strategies. These plans should be developed in collaboration with and communicated to potentially affected stakeholders from communities and mining companies to ensure that, in the event of an emergency situation, responses are coordinated across all stakeholders. Government plans should be accompanied by adequate resourcing and capacity building for responsible staff; periodically reviewed, tested, and revised to reflect the changing context; and continuously communicated to the public. The government has put into place a system that coordinates emergency preparedness between mining entities, local authorities, and local populations.		The government does not have an emergency preparedness and response plan in place.	The government does have an emergency preparedness and response plan in place, but the plan was not developed in coordination with affected stakeholders, is not adequately resourced or communicated with the public, and is not reviewed and revised on a regular basis.	The government has an emergency preparedness and response plan in place, which was developed with inputs from affected stakeholders, is well resourced and communicated, and is periodically tested and revised to reflect changing circumstances.
Emergency preparedness and response plans within mining entities	Require all mining operations to have an emergency preparedness and response plan prior to commencing operations, and ensure that the plan is reviewed, tested, and updated regularly.	Government requires all mining operations to have an emergency preparedness and response plan prior to commencing operations. Plans should include risk assessment; emergency management, response, and recovery plans; and crisis communications strategies. Government requires emergency programs to be reviewed, tested, and updated regularly and has a system in place to ensure that operations can respond to the types of emergencies that are common locally and regionally. Response plans should cover the entire mine life cycle and should prioritize the elimination and minimization of risks.		Government does not require all mining operations to have an emergency preparedness and response plan prior to commencing operations, nor does it ensure that the plan is reviewed, tested, and updated regularly.	Government at times, but inconsistently, requires mining operations to have an emergency preparedness and response plan prior to commencing operations, and/ or the government does not consistently ensure that the plan is reviewed, tested, and updated regularly.	Government consistently and comprehensively requires all mining operations to have an emergency preparedness and response plan prior to commencing operations and ensures that the plan is reviewed, tested, and updated regularly.

THEMATIC AREA	STANDARD	GUIDANCE	PROGRESS	LOW	MEDIUM	HIGH
Local consultation and cooperation	Base all elements of the emergency preparedness plan on ongoing consultations and cooperation with local and other stakeholders and government.	Government ensures that emergency response plans are tested regularly and developed in collaboration with local, regional, and national governments; local emergency responders; and local communities, including artisanal and small-scale miners when present—particularly if they are located on lands that are unstable, subject to frequent weather events, or otherwise high risk. This helps increase institutional transparency, ensuring public access to information and promoting inclusive, participatory decision making.		Emergency preparedness programs are not based on ongoing consultation and cooperation with local and other stakeholders and governments.	Emergency preparedness programs are sometimes based on ongoing consultations and cooperation with local and other stakeholders and governments.	All elements of emergency preparedness programs are based on ongoing consultation and cooperation with local and other stakeholders and governments.
Participative monitoring, testing, and evaluation	Ensure that monitoring of the effectiveness and responsiveness of the emergency preparedness plan is conducted by companies in cooperation with communities and all levels of government.	Government puts into place a framework to ensure that local communities; mine employees; and local, regional, and national governments (i) participate in developing and monitoring emergency preparedness programs and (ii) are aware of when and where to access reports that result from implementing monitoring and evaluation programs.		Government does not ensure that monitoring of the effectiveness and responsiveness of the emergency preparedness plan is conducted by companies in cooperation with communities and all levels of government.	Government, to some extent, ensures that monitoring of the effectiveness and responsiveness of the emergency preparedness plan is conducted by companies in cooperation with communities and all levels of government.	Government consistently and comprehensively ensures that monitoring of the effectiveness and responsiveness of the emergency preparedness plan is conducted by companies in cooperation with communities and all levels of government.

3. PRIORITIZE ACTIONS AND REFORMS

Having assessed the government's legal framework across each of the standards outlined above and assigned a level of progress to each, the government can now prioritize those actions that must be taken to improve environmental management in the mining sector. For those standards where progress is lowest, the government should identify the social, economic, and environmental risks associated with inaction and the benefits of reform, and subsequently prioritize those actions it must take to minimize any risks, maximize any benefits, and strengthen its legal frameworks for environmental management.

The prioritization exercise will, of course, be context specific and will reflect a number of enabling factors, including available resources for carrying out reforms and political will. A government may choose to focus on those areas where progress is weakest or where the impacts of action (or inaction) are greatest; it may start with the most straightforward—those reforms most easily and inexpensively undertaken; it may take action in those areas for which funding has been allocated or can be accessed; or it may prioritize changes that support its national policy objectives or international commitments. It may also require sequencing; some reforms will necessarily have to be undertaken prior to others.

If, for example, the gap analysis reveals that there is a significant risk to local communities as a result of inadequate requirements for developing emergency preparedness and response plans prior to permitting, governments may prioritize addressing this in the legal framework reform process. Risks and benefits should be analyzed through a gender lens that lays out the gendered impacts of mining, as well as associated risks and opportunities, to ensure that reforms address differentiated risks and vulnerabilities across stakeholder groups. In some jurisdictions, such as Canada, gender has been integrated into environmental assessment legislation to help ensure that social, cultural, and economic contexts are fully understood and accounted for prior to permitting (Status of Women Canada, 2020). And finally, prioritized actions must be feasible and well communicated; it is better to build, convey, and deliver on realistic expectations for environmental governance reform than to overpromise and leave communities and stakeholder groups disappointed.

4. IMPLEMENT ACTIONS FOR IMPROVED GOVERNANCE OF ENVIRONMENTAL MANAGEMENT

With a list of priorities prepared, the government can next develop a roadmap for how it will adjust or reform its legal and regulatory frameworks on environmental management to achieve its policy objectives and meet its international commitments. In this roadmap, the government will outline where changes in policy, law, institutions, capacities, and resourcing will be needed; the best legal instruments for making positive change; the steps that the government will follow to revise the legal framework; how changes will be staffed and paid for; and a time frame for the process (changes to be made in the next 5–10 years, for example). This roadmap will help the government articulate how they will get from where they currently are to where they need to be. This roadmap should be developed in a participative and inclusive way to ensure that it reflects a variety of diverse stakeholder perspectives and has their support, including the voices of women, Indigenous Peoples, and marginalized communities.

The roadmap should reflect the roles and responsibilities of those that will implement it. As mentioned, it should also be feasible; the roadmap should adequately and realistically reflect the time, resources, and capacities needed from the government for this work and not be so ambitious that it ceases to be implementable. Once a realistic roadmap has been developed and adopted, the relevant parties can set about implementing it. This will likely require considerable resources and the participation of several different ministries, departments, and agencies, as well as the participation of outside, relevant stakeholders.

5. MONITORING AND EVALUATION

The government should establish systems and capacities to continuously monitor and evaluate its legal and regulatory frameworks on environmental management to ensure that it continues to meet international standards and benchmarks. Ongoing monitoring and evaluation efforts will allow the government to manage change and adjust frameworks as needed over time to reflect changing practices and evolving knowledge. Adaptive management will help to ensure that the learnings from monitoring are incorporated into future mine practice. These efforts should include communities with an emphasis on vulnerable groups.

GLOSSARY

Adaptive Management – "A structured, iterative process of robust decision-making with the aim of reducing uncertainty over time via system monitoring. It includes the implementation of mitigation and management measures that are responsive to changing conditions, including those related to climate change, and the results of monitoring throughout the tailings facility lifecycle. The approach supports alignment on decisions about the tailings facility with the changing social, environmental and economic context and enhances opportunities to develop resilience to climate change in the short and long term" (UNEP et al., 2020).

Best Available Techniques (BATs) – "The most effective and advanced stage in the development of activities and their methods of operation, indicating the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where this is not practicable, to reduce emissions and the impact on the environment as a whole." [Further:]

- "'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;
- 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator; and
- 'best' means most effective in achieving a high general level of protection of the environment as a whole." (EU, 2010 in OECD, 2020)

Best Practice – "A procedure that has been shown by research and experience to produce optimal results and that is established or proposed as a standard suitable for widespread adoption" (UNEP et al., 2020).

Biodiversity – "'Biological diversity' means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD, 1992).

Contaminant – "Introduced species, substance or material which was either not previously present or was present in a lesser amount, and that may have a harmful effect on air, water or soil" (Indian and Northern Affairs Canada, n.d.).

Cumulative Impacts – These are the successive, incremental, and combined direct and indirect impacts of a mining project's development and implementation. When considered together, small, non-significant impacts can have a substantial negative effect on the ecological integrity of an area over time. When taken more broadly, consideration of cumulative impacts includes the compounding activities of other past, present, and reasonably foreseeable future projects in the area (IFC, 2013a).

Ecosystem – "'Ecosystem' means a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit" (Convention on Biological Diversity, 1992).

Emergency – "A non-routine situation that necessitates prompt action, primarily to mitigate a hazard or adverse consequences for human life and health, property and the environment" (International Atomic Energy Agency, 2016).

First responders – "The first members of an emergency service to respond at the scene of an emergency" (International Atomic Energy Agency, 2016).

Geotechnical – "Dealing with soils beneath the surface of the ground" (Earth Tech, n.d.).

Good International Practice – In this report, good international practice can be applied under the same or similar circumstances globally or regionally. It refers to efficient techniques, methods, processes, or technologies that keep people safe and protect the environment.

Governance – "The process of regulating human behavior in accordance with shared objectives. The term includes both governmental and nongovernmental mechanisms" (Millennium Ecosystem Assessment, 2005). In this document, governance refers to governmental mechanisms unless specified as corporate governance.

Mine – In this report, "mine" refers to the open pit or underground workings, process facilities, storage facilities, and associated infrastructure and ancillary facilities (e.g., maintenance shops, water treatment plant, loadout infrastructure, fuelling areas, administration facilities, camp, borrows, quarries, material storage areas, site power plants, powerlines, site roads).

Mine Life Cycle – In this report, the mine life cycle refers to all mine phases: exploration, planning, construction, operation, closure, and post-closure.

Operator (of a tailings facility) – "An entity that singly, or jointly with other entities, exercises ultimate control of a tailings facility. This may include a corporation, partnership, owner, affiliate, subsidiary, joint venture, or other entity, including any State agency, that controls a tailings facility" (UNEP et al., 2020).

Operator (of a mine) – "An operator of a mine is a person or company that has the right to win minerals from the mine, including the owner, lessee, licensee, tenant or others. The operator of a mine refers to both current and past operators of mines" (Government of British Columbia, n.d.).

Overburden – "Layers of soil and rock covering a mineral deposit. Overburden is removed prior to surface mining and replaced after the mineral is taken from the seam. [...] The waste material that must be removed to uncover ore. Overburden can be subdivided into various categories; and also as 'weathered', 'oxidised' and so on. A more generic term for overburden is 'waste'. [...] Distance between the surface level and the target deposit" (RPM Global, n.d.).

Proponent – A person or entity that proposes a project or activity.

Stakeholder – "Persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, positively or negatively. Stakeholders may include workers, trade unions, project-affected people or communities and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organisations and groups with special interests, the academic community, or other businesses. Different stakeholders will often have divergent views, both within and across stakeholder groupings" (UNEP et al., 2020).

Sustainability – "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

Tailings – "A by-product of mining, consisting of the processed rock or soil left over from the separation of the commodities of value from the rock or soil within which they occur" (UNEP et al., 2020).

Waste Rock – "That rock or mineral that must be removed from a mine to keep the mining scheme practical, but which has no value" (RPM Global, n.d.).

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