IGF

INTERGOVERNMENTAL FORUM
on Mining, Minerals, Metals and
Sustainable Development

ASGM Tailings Management and Reprocessing Governance:

Global trends

Secretariat hosted by

IISD

Secretariat funded by

Canada

Kingdom of the Netherlands

Project funded by

Published by the International Institute for Sustainable Development

The International Institute for Sustainable Development (IISD) is an award-winning independent think tank working to accelerate solutions for a stable climate, sustainable resource management, and fair economies. Our work inspires better decisions and sparks meaningful action to help people and the planet thrive. We shine a light on what can be achieved when governments, businesses, non-profits, and communities come together. IISD's staff of more than 200 experts come from across the globe and from many disciplines. With offices in Winnipeg, Geneva, Ottawa, and Toronto, our work affects lives in nearly 100 countries.

IISD is a registered charitable organization in Canada and has 501(c)(3) status in the United States. IISD receives core operating support from the Province of Manitoba and project funding from governments inside and outside Canada, United Nations agencies, foundations, the private sector, and individuals.

IISD HEAD OFFICE

111 Lombard Avenue
Suite 325
Winnipeg, Manitoba
Canada R3B 0T4

IISD.org
@IISD_news

The Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) supports its more than 80 member countries in advancing their sustainable development goals through effective laws, policies, and regulations for the mining sector. We help governments take action to develop inclusive and gender-equitable practices, optimize financial benefits, support livelihoods, and safeguard the environment. Our work covers the full mining life cycle, from exploration to mine closure, and projects of all sizes, from artisanal mining to large-scale operations. Guided by our members' needs, we provide in-country assessments, capacity building, technical training, publications, and events to advance best practices, peer learning, and engagement with industry and civil society. The International Institute for Sustainable Development has hosted the IGF Secretariat since October 2015. Core funding is provided by the governments of Canada and the Netherlands.

IGFMining.org
@IGFMining

ASGM Tailings Management and Reprocessing Governance: Global trends

May 2024

Written by Nellie Mutemeri, Giorgio de Tomi, Clémence Naré, Grégoire Bellois, Fitsum Weldegiorgis, Jaqueline Taquiri

Contributors: Nydia Ponnan, Giovana Loredo, Ekpen Omonbude, Viola Tarus, Deborah Goldemberg, Thelma Halim, Ege Tekinbas, Marion Provencher Langlois, Andrea Lemus Mesa, Carlos Ortega, Marina Ruete

Experts reviewers: John Tychsen from ASSM Consult, Malgorzata Stylo, Kenneth Davis, from UNEP, Micheal Paterson from IISD Expiremental Lakes Area

Cover photo: Carlos Henrique Xavier Araujo

ACKNOWLEDGMENTS

Thanks to IISD colleagues Emily Kroft, Dihu Wu, and Abas Kinda for assisting with research.

Executive Summary

Artisanal and small-scale gold mining (ASGM) has attracted millions of individuals in Africa, Asia, and Latin America, driven by factors such as rising commodity prices, global consumption demands, unemployment, poverty, and challenges related to climate change, as well as conflicts limiting traditional livelihoods. This sector involves around 20 million people across 80 countries and contributes up to 20% of the world's annual gold supply.

Defining artisanal and small-scale mining (ASM) is complex due to its diversity and the fact that it encompasses a range of activities, from informal artisanal mining to formal small-scale commercial operations. While definitions vary among institutions and national frameworks, ASM generally refers to mining and processing conducted by individuals, groups, families, or cooperatives using manual, traditional, labour-intensive techniques across the mining value chain. Despite being a source of livelihood for many, ASM also generates negative impacts, including environmental issues, such as mercury pollution and deforestation, and socio-economic challenges, such as gender-based violence and child labour.

The handling and disposal of mine waste, or tailings, from ASGM can result in severe adverse impacts. These tailings often contain hazardous materials, including cyanide and mercury, that pose risks such as water pollution, threats to drinking-water sources, agricultural and aquacultural contamination, disruptions to food supplies, and ecological harm. In addition, improper tailings management can endanger human health, particularly affecting women and children involved in ASGM activities, especially through tailings' detrimental effects on women's reproductive health and infant well-being. Therefore, the safe management of tailings, including their disposal, transport, sale, and reprocessing, is a pressing global concern that demands immediate attention.

ASGM is the single largest source of anthropogenic mercury emissions. Since the adoption of the Minamata Convention on Mercury in 2013, the use of mercury in ASGM has received considerable international attention. However, similar attention has not been paid to the regulation of tailings that are often laden with mercury and other toxins.

This research examined the current trends in ASGM ore extraction, processing, and waste management covering the following areas:

- ASGM methods of ore extraction and processing, use of chemicals such as mercury and cyanide, and tailings disposal and reprocessing
- Mercury recovery, management and disposal
- The potential of by-production from ASGM tailings management and reprocessing, especially opportunities for producing critical minerals
- The current state of ASGM tailings governance and legal frameworks at international, regional, and national levels, including:
    - international tailings commitments
    - regional governance of tailings in Africa, Asia, and Latin America
    - national governance of ASGM and tailings disposal and management in 15 different countries
    - the responsibilities and rights surrounding land rights and tailings ownership and permitting

- The ASGM and large-scale mining (LSM) interface as it relates to tailings management, industry knowledge and best practices, and the relationship between ASM and LSM
- Formalization schemes and their alignment with relevant Sustainable Development Goals
- The role of strategic environmental assessments in the successful implementation of environmental and social impact assessments that pertain to ASGM tailings management and reprocessing

The research approach included a detailed literature review of best practices in tailings management and reprocessing; a review of public information on ASGM tailings; interviews, surveys, and inquiries with representatives of mining and environmental agencies of selected countries; and consultations with ASGM specialists and mining experts. The following sections present the key observations and recommendations derived from the research.

Tailings Generation

ASGM operators are using chemicals such as mercury and cyanide indiscriminately to process ore and reprocess tailings without taking the necessary precautions and safeguards. In addition to the health and safety risks facing the operators, unsafe mercury use and cyanide leaching adversely impact the environment and the health of local mining communities. The findings support the following recommendations:

- Sensitization campaigns on the safe use of chemicals and mercury-free techniques should be conducted with ASGM miners and processors.
- Financing options to improve occupational health and safety in ASM should be made available through financial institutions.
- Provisions should be made so that chemicals such as cyanide and mercury are bought only from the government or from government-approved sellers.

Tailings Management

ASGM operators often conduct tailings management activities inadequately due to a lack of know-how and capacity. They believe the residual material does not hold significant value and so dispose of it in the easiest possible way; as a result, they typically dispose of tailings back into the natural environment. They create tailings ponds without the basic containment or proper stabilization measures in place, and these ponds are often filled with tailings from several sites that have been processed using different chemicals and methods. Additionally, ASM operators generally do not or are unable to conduct any restoration or remediation activities and will abandon the mine site and tailings ponds once activities have ceased. The findings support the following recommendations:

- Provisions in legislation and permitting processes need to be developed for ASM operators to provide detailed tailings-management plans.
- Sensitization and awareness campaigns need to be conducted with ASGM miners, processors, and local communities on the safe management of tailings and the risks posed by improper tailings management.

- A remediation and restoration fund should be established for the responsible government department to conduct mine closure activities in the event that ASGM operators are unable to conduct these activities.
- Partnerships with LSM to remediate ASM sites should be explored as part of coexistence models.

Tailings Reprocessing

ASGM tailings are typically reprocessed to extract residual economic value. Research indicates that cyanide leaching is the most practised method for recovering gold from tailings. However, due to the ubiquitous use of mercury in ASGM and the mixing of tailings at processing centres and in tailings ponds and dumps, cyanidation is often applied to mercury-bearing tailings, which is considered a "worst practice" under the Minamata Convention. The findings support the following recommendations:

- Sensitization and awareness campaigns need to be conducted with ASGM miners and processors on the mixing of mercury-laden and mercury-free tailings and the risks of using cyanide on mercury-laden tailings.
- Research, development, and piloting of mercury-free technologies should be encouraged in the ASGM sector.
- Processing centres should provide ASGM miners access to mercury-free technologies to limit the use of mercury.
- Processors must be mandated to conduct mercury removal before cyanidation.

Mercury Recovery, Management, and Disposal

The characteristics of mercury-laden tailings from ASGM vary greatly, making mercury recovery challenging as there is no one-size-fits-all scenario. Thus, the method of choice will depend on economic and technical factors that could fit with the local community's socio-economic situation. Available methods for mercury recovery from ASGM tailings include adsorption, vaporization, and gravimetric techniques, but none are universally suitable (UNEP, 2021b). The factors influencing method selection include mercury concentration, technical limitations, economic considerations, and necessary expertise. Proper handling and storage of recovered mercury are essential for worker safety and environmental protection, with guidelines provided by organizations such as Pure Earth and the Artisanal Gold Council. Packaging must prevent evaporation and resist chemical reactions, while transportation requires adherence to strict regulations, proper labeling, and contingency plans. Worker safety relies on appropriate personal protective equipment and adherence to established protocols. Collaboration and adherence to guidelines are crucial for safe and sustainable mercury waste management in ASGM.

ASGM and Critical Minerals

ASGM tailings are potentially a source of critical minerals, which could influence the management of ASGM tailings. The findings support the following recommendations:

- Tailings should be mapped and surveyed to understand the potential for secondary mineral extraction.
- Skills development, training, and information need to be provided to ASGM operators to enable them to extract valuable materials from gold tailings.

International Governance Frameworks

The production and processing of tailings is a matter of global importance because it can produce many negative social, environmental, and health impacts. However, ASM tailings management has not been prioritized by the international community; its governance is currently limited to two chemical-focused guidance documents. The findings support a key recommendation:

- For sound tailings management, an international ASM-specific tailings management standard should be created and then operationalized by means of sensitization programs and interventions.
    - Key stakeholders include governments, multilateral organizations, development partners, and non-governmental organizations.

Regional Governance Frameworks

Most regional blocs do not have frameworks that provide for ASM, let alone tailings management. Regional covenants and protocols are important because they drive the synthesizing of national frameworks to a regionally accepted standard. The findings support the following recommendations:

- Urgently develop comprehensive regional frameworks for ASM, with a specific emphasis on tailings management, to standardize regulations, promote cooperation, and improve ASM governance across member states.
- Support regional organizations in building the capacity of member states to effectively implement and enforce these regional frameworks. This includes providing training and technical assistance while sharing best practices.
- Promote the exchange of information and experiences among regional blocs that have successfully implemented ASM and tailings management frameworks. This sharing of knowledge can expedite the development and adoption of effective regional standards.

National ASGM Frameworks

Most national frameworks provide for tailings management under the mining code or environmental regulations, but most countries have not adopted ASM-specific tailings management or waste management provisions, which has resulted in confusion about the duties and obligations of ASM operators. The findings support the following recommendations:

- Legal frameworks need to be created with specific provisions for ASM tailings and mine waste management; such provisions should outline the duties and obligations of ASM operators.
- Extension services should be provided to train and build capacity for ASM operators or government departments that undertake tailings-management activities.

Although legislation exists for tailings management within national frameworks, most countries have not adopted ASM-specific tailings management provisions. Furthermore, enforcement mechanisms are limited, which has resulted in widespread negative impacts stemming from poor tailings management. Additionally, there is a general lack of awareness that laws and policies related to ASM tailings management exist. The findings support the following recommendations:

- Monitoring and enforcement in ASM generally need to be strengthened to limit the negative impacts of ASM and encourage best practices in the sector.
- Government stakeholders must be provided with training and up-to-date information on legislation related to ASM.

Institutional support is key to improving tailings management for ASGM operators who are constrained by limited capacity and capital. The findings support a key recommendation:

- Centralized institutions need to be created to support the sound management of tailings, such as processing plants, disposal sites, and buying centres.

Most national frameworks do not explicitly support the reprocessing of tailings through processing licences and support programs. This is a missed opportunity because governments could collect extra taxes on the sale of tailings. Licensing also offers governments greater oversight of the sector and could enhance enforcement and better practices. The findings support a key recommendation:

- Governments should create legal provisions to support the reprocessing of tailings, including the development of processing licences separate from primary mining licences, legislation that allows for the sale of tailings, and a fiscal regime that can be applied to the sale of tailings.

The Minamata ASGM National Action Plans (NAPs) should be incorporated as an integral component within national ASGM frameworks. The findings support the following recommendations:

- Recognizing the Minamata NAPs and aligning them with existing national strategies can enhance the effectiveness of efforts to reduce mercury use, improve environmental sustainability, and promote safer and more responsible ASGM practices.

- Coordination and cooperation should be encouraged between government agencies, international organizations, and local stakeholders to ensure the successful integration of the Minamata NAPs into the broader ASGM governance framework.

Informality of ASM

Sound tailings management is hindered by informality. Legislation and other tailings management frameworks can only be applied to formal operators. The findings support the following recommendations:

- Governments and other stakeholders must advance and support the formalization of the ASM sector to improve tailings management. This support should be designed to help the most marginalized groups overcome obstacles they face in accessing services and resources.
- Formalization could be advanced through streamlined processes, institutional support, capacity building, information sharing, the creation of ASM zones, and the creation of favourable legislation.

LSM-ASGM Interface

LSM and ASGM activities often occur in the same areas, which offers an opportunity for cooperation and collaboration between the two stakeholders. The findings support a key recommendation:

- LSM organizations should be encouraged to work with ASGM operators through skills transfer, technology transfer, and tributing arrangements, which could enhance how tailings are created and managed in ASGM.

Industrial mine operators are held accountable by various standards, guidance documents, and interventions. This body of knowledge offers various lessons for the management of ASGM tailings. The findings support a key recommendation:

- Tailings management frameworks in ASM can draw on best practices from existing LSM guidance documents.

Gender and ASGM Tailings Management

Women are active participants along the ASGM tailings value chain. However, gender-related concerns have not been mainstreamed within tailings management approaches. The findings support the following recommendations:

- Regional and national frameworks and supply chain interventions should recognize the role of women and include gender-specific components to support their safe and secure participation.
- Targeted programs to support women in ASM should be designed with a deep understanding of the unique socio-cultural challenges and opportunities that women face in this sector. These initiatives could include:
    - Gender-sensitive training and capacity building: Create training programs that are tailored to the needs and preferences of women in ASGM. These

programs should cover various aspects of processing, including safe and efficient techniques, equipment operation, health and safety measures, and environmental management. It's essential to ensure that the training materials and methods are culturally sensitive and accessible to women with varying levels of education and experience.

- Promoting women's leadership: Encourage and support women to take on leadership roles within ASGM cooperatives or groups. This encouragement can include providing training in leadership and management skills, facilitating networking opportunities, and creating mentorship programs where experienced women in the sector can guide newcomers.
- Access to finance and resources: Establish mechanisms to help women access the necessary financial resources and equipment. This may involve setting up microfinance programs, providing grants or low-interest loans, or creating cooperative savings and credit groups specifically for women. Ensure that women are aware of these opportunities and can navigate the application processes.
- Childcare support: Recognize that many women in ASGM may have caregiving responsibilities. Develop childcare facilities or support systems to enable women to participate in processing activities without compromising their ability to care for their families.
- Sensitization: Sensitize program staff, trainers, and community leaders to the cultural norms and beliefs that may affect women's participation in ASGM processing. Create an inclusive and supportive environment that respects women's roles in both the household and the workforce.
- Advocacy and policy support: Advocate for policies and regulations that promote gender equality and protect the rights of women in ASGM. Engage in dialogue with relevant authorities to ensure that women's voices are heard in decision-making processes.

Conclusion

The management and reprocessing of tailings from ASGM have yet to garner significant interest from government largely due to the informality of the ASGM sector, coupled with resource constraints and limited access to affordable and sustainable tailings treatment methods.

However, this study, with its comprehensive findings and insightful recommendations, aims to serve as a crucial catalyst for governments to establish an enabling environment for the adoption of responsible practices in ASGM tailings management and reprocessing. Formalizing the sector and implementing robust environmental public policies are essential steps towards ensuring the sustainable management of ASGM tailings.

This report represents an initial step, laying the groundwork for further studies and collaborative efforts aimed at enhancing our understanding and management of ASGM tailings and reprocessing opportunities.

Table of Contents

Acronyms

AMV	Africa Mining Vision
ANEEMAS	Agence Nationale d'Encadrement des Exploitations Minières Artisanales et Semi-mécanisées
ANM	Brazil's National Mining Agency
ASEAN	Association of Southeast Asian Nations
ASGM	artisanal and small-scale gold mining
ASGMO	artisanal and small-scale gold mining operation
ASM	artisanal and small-scale mining
EAC	East African Community
ECOWAS	Economic Community of West African States
EIA	environmental impact assessment
EMS	Environmental Management System
EPP	Environmental Protection Plans
ESG	environment social and governance
ESIA	environmental and social impact assessment
GISTM	Global Industry Standard on Tailings Management
ICMM	International Council on Mining and Metals
ICOLD	International Commission on Large Dams
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development
ISO	International Organization for Standardization
LSM	large-scale mining
LSMO	large-scale mining operation
NAP	National Action Plan
OES	United States Department of State's Bureau of Oceans and International Environmental and Scientific Affairs
PML	Primary Mining License
SADC	Southern African Development Community
SDG	Sustainable Development Goal
SEA	strategic environmental assessment
SMMRP	Sustainable Management of Mineral Resources Project
STAMICO	Tanzania's State and Mining Corporation
UEMOA	Union économique et monétaire ouest-africaine
UNECE	UN Economic Commission for Europe
UNEP	UN Environment Programme
WHO	World Health Organization

Glossary

Alluvial/alluvium	Detrital mineral/geological sediment material that accumulates due to the action of flowing water (and may be consolidated or unconsolidated), the processing of which may lead to preferential concentration of valuable high-density minerals, like gold, into an extractable mass: an alluvial deposit.
Alluvial mining	Loosely refers to the extraction of unconsolidated gold-bearing material from an alluvial deposit for processing to recover gold.
Artisanal and small-scale mining	Ranges from informal individual miners earning a subsistence livelihood to more formal and regulated small-scale entities producing minerals commercially. It is, by definition, carried out using simple, non-mechanized techniques and is largely labour-intensive. Small-scale mining can be slightly more capital-intensive and will likely include some level of mechanization, though it is also carried out by small groups of individuals, cooperatives, or communities.
Amalgamation	Process of using mercury to recover free gold.
Artisanal and small-scale gold mining (ASGM) formalization	Broad undertaking inclusive of legalization, organization, and progressive compliance of ASGM.
Bioaccumulation	Gradual accumulation of chemicals in living organisms that happens when an organism absorbs the chemical faster than it excretes it.
Colluvial/colluvium	Unconsolidated mineral/geological sediment material that accumulates at the bottom of a slope due to the action of gravity, the processing of which may lead to the concentration of gold into an extractable mass: a colluvial deposit.
Cyanidation	A hydrometallurgical process used to extract gold from ores by dissolving them in a solution of potassium cyanide or sodium cyanide. Gold is further recovered from the solution by various methods, including precipitation.
Doré	Unrefined gold produced by smelting of gold concentrate, usually close to the mine site. Gold grade or concentration usually varies from 80% to 95%. Remaining content is usually composed of other precious metals, such as silver, but can also include copper, iron, and other base metals depending on the mineralogy of the ore.
Eluvium	Mineral/geological sediment material that accumulates from in situ weathering, the process of which may lead to preferential concentration of valuable high-density minerals, like gold, into an extractable mass: an eluvial deposit.

Formal ASGM	Refers to ASGM activities that are formally recognized by national legislation and regulated by national governments. Formal ASGM operators are given permits and participate in national economies through taxes and royalties.
Free-milling gold	Gold ores where the gold may be recovered by simple comminution and physical separation.
Gangue	Unwanted material or impurities that encase the valuable mineral within an ore deposit.
Gender	Refers to the roles, behaviours, activities, and attributes considered appropriate for women and men in different cultural contexts. Gender influences how they perceive themselves and others and how they act and interact.
Informal ASGM	Refers to ASGM activities that occur outside of legislative structures without recognition from the national government.
Lithification	The process of transforming sediments into rocks.
Mercury emissions	Mercury emitted into the atmosphere.
Mercury-free gold	Gold produced without the use of mercury.
Mercury releases	Mercury released into the water and soil.
Mercury retort	A device designed to capture mercury (preventing the loss of mercury vapour into the atmosphere) during the process of burning a mercury-gold amalgam to recover the gold.
Methylmercury	A toxic organometallic complex of mercury that is highly bio-available and thus liable to bioaccumulate in organisms.
Minamata Convention on Mercury	Global treaty to protect human health and the environment from the adverse effects of mercury by addressing specific human activities that contribute to widespread mercury pollution.
Mineral certification	A voluntary or mandatory scheme designed to certify whether a mineral has been produced in a socially and environmentally responsible manner. It is often supported by compliance with a standard and due diligence in associated mineral supply chains.

National Action Plan	A plan developed by a country to manage reduction of mercury releases and emissions, "Pursuant to Article 7.3 of the Minamata Convention" and in accordance with Annex C of the Convention.
Tailings	Mineral material left over in slurry form, usually uneconomic, after valuable minerals have been extracted from an ore.
Tailings dam	A facility for storing tailings with embankments to contain the slurry.
Tailings management	The disposal, sale, transport, and (re)processing of tailings.
Winnowing	A dry gravimetric concentration technique that uses air instead of water to separate denser elements. It is a mineral processing technique that involves the separation of valuable minerals from lighter, less valuable materials or impurities using air currents or controlled airflow, typically employed to concentrate valuable ores.

1.0 Background and Context

1.1 Background

This global report is developed with the support of the United States Department of State's Bureau of Oceans and International Environmental and Scientific Affairs (OES) as part of the project **Developing Policies to Reduce Mercury Pollution From the Artisanal and Small-Scale Gold Mining (ASGM) Sector**. The project aims to support the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) and its resource-rich member countries to design and implement appropriate regulations for sound management (including of mercury) and responsible exploitation of tailings from ASGM.

The three-phase project began in October 2022 and will be completed by September 2025.

The project will deliver new research and facilitate capacity building, deep-dive support, technical assistance, and peer-learning opportunities to strengthen the technical competency and institutional capacity of policy-makers, enabling them to better understand the main challenges and applicable best practices in ASGM tailings management and reprocessing.

This global assessment report is part of the first phase of the project, in which the IGF Secretariat conducts preliminary research exploring global trends in ASGM tailings and reprocessing governance. The research examines international and regional governance of tailings management and reprocessing, national tailings frameworks, large-scale mining (LSM) tailings management, and technical and policy considerations for the sound management of ASGM tailings, as well as reprocessing opportunities.

To ensure the study's relevance and thoroughness, the Secretariat actively sought input from its member countries, engaging with more than 80 nations during its annual general meetings in 2022 and 2023. The themes and priorities included in this preliminary report are the result of this scoping exercise. A comprehensive guidance document for governments with policy options will be released in 2025. This report does not aim to duplicate the UN Environmental Programme's *Sound Tailings Management in Artisanal and Small-Scale Gold Mining* guidance document released in 2021 (UNEP, 2021b).

1.2 Context and Thematic Scope

The history of gold mining by individuals spans thousands of years, but a significant transformation occurred in the early 2000s when a substantial surge in commodity prices created heightened global demand for gold. Concurrently, increasing levels of poverty and unemployment drove millions of individuals across Africa, Asia, and Latin America to turn to ASGM as a means of livelihood. Other contributing factors include the effects of climate change, conflicts, and challenges in traditional rural sectors like agriculture, all of which have led to economic hardships (IGF, 2017a. ASGM employs an estimated 20 million people in 80 countries around the world and accounts for up to 20% of the world's annual gold production (Bickham & Brandstaetter, 2022; World Bank, 2020). As a vital source of the raw mineral inputs that are used in various modern industries, artisanal and small-scale mining (ASM) plays an important role in national economic development and contributes to global sustainable development (In IGF, 2017a; World Bank, 2020).

ASM is a complex and diversified sector that ranges from informal subsistence artisanal mining activities to formal small-scale commercial mining operations (IGF, 2017b). As a result, definitions for ASM vary across international institutions and national frameworks. Artisanal mining is generally considered to refer to formal or informal mining and processing carried out by individuals, groups, families, or cooperatives using rudimentary, manual, or traditional labour-intensive techniques (IGF, 2017b). Recognizing the growing prevalence of mechanical equipment usage at artisanal mining sites, modern legislation in several countries has evolved to include an acceptable mechanization threshold for artisanal mining practices (IGF, 2022). While small-scale mining is also carried out formally and informally by small groups of individuals or communities, it is considered to be more capital-intensive, less labour-intensive, and more mechanized than artisanal mining (IGF, 2017b). ASM comprises all stages of the mineral value chain, including extraction, mineral trading, primary processing, secondary processing, and export (IGF, 2017b).

Although ASM encompasses a broad spectrum of activities, the vast majority of ASM occurs informally. Those involved in ASM often work in remote or secluded areas and tend to fall into the most economically and socially disadvantaged groups, with very little or no formal education and limited social and familial support. Women and children within the artisanal mining sector face heightened vulnerability. They are frequently among the lowest-paid participants and confront a multitude of challenges stemming from gender norms and socio-economic obstacles that curtail their rights and restrict access to finance, land, licences, networks, and information (IGF, 2022).

ASGM is context specific, involving mining alluvial deposits in riverbeds or hard rock mining in underground shafts. Processing ore from both methods generates tailings, consisting of a liquid slurry of crushed rock, water, trace metals, minerals, and processing additives like mercury, cyanide, petroleum by-products, and sulfuric acid (Sibanye-Stillwater, 2023). Tailings can contain hazardous chemicals that pose risks to water bodies, potable water supplies, agriculture, aquaculture, food supplies, human health, and natural ecosystems.

The ASM sector faces challenges such as low productivity and inefficient exploitation and processing practices that result in low mineral recovery rates. Consequently, ASGM tailings often contain economically viable amounts of gold and other valuable minerals, including highly coveted critical minerals.

ASGM tailings can be (re)processed using techniques like gravitational, magnetic, and flotation separation, as well as mercury amalgamation and cyanidation. These techniques enable ASM operators to extract value from what was originally considered waste and can serve as a secondary or primary source of income. However, improper tailings management and the use of dangerous chemicals—such as mixing mercury with mercury-free tailings or applying cyanide to mercury-laden tailings—pose significant environmental risks.

Small-scale mining, involving more machinery and affecting larger areas, can achieve higher gold-recovery rates than artisanal mining, reaching up to 70% (Cobbinah et al., 2021. Consequently, small-scale mining often handles ASGM tailings reprocessing.

Responsible tailings reprocessing by small-scale mining can be achieved through strategies like processing old LSM tailings, implementing separate but parallel mining schemes, and establishing agreements with LSM companies. These approaches encourage cooperation between different mining scales, ensuring responsible tailings reprocessing and mutually beneficial outcomes (Betancur-Corredor et al., 2018; Veiga et al., 2022).

ASM is typically informal, seasonal, or migratory, often lacking attention to environmental management. Unlike industrial mine operators, ASM frequently disregards waste management at the end of the mine life cycle. ASM operators tend to leave their tailings behind in poorly constructed ponds without stabilization or containment measures. Even more capitalized small-scale operators often lack the resources to conduct meaningful mine-closure activities. This lack of waste management poses significant environmental and health risks, especially when tailings contain toxic chemicals that can leach into the environment, contaminating land and water. Women and children are particularly susceptible to exposure to these chemicals due to their involvement in ASGM activities, and such exposure can have adverse effects on women's sexual and reproductive health and infant health.

This report explores the significant growth of ASGM in recent years to involve millions of participants globally and make substantial contributions to both national and global economies. The report provides a comprehensive overview of ASGM, encompassing a wide spectrum of practices from informal artisanal methods to more structured and mechanized small-scale operations. It acknowledges the vulnerability of ASGM participants, particularly women and children, and underscores the context-specific nature of ASGM, which includes diverse mining techniques and the generation of potentially hazardous tailings.

Within ASGM, inefficiencies are evident and lead to low mineral recovery rates, prompting the reprocessing of tailings for economic gain. The report addresses the environmental and health risks associated with inadequate tailings management. The discussion extends to responsible tailings reprocessing strategies and agreements, shedding light on the often underestimated environmental management challenges within ASGM.

Additionally, the report delves into various aspects of ASGM tailings management and the broader governance of ASM. Specifically, ASM formalization is discussed as a crucial governance imperative for achieving responsible ASGM tailings management and enhancing value addition through improved tailings reprocessing. ASM formalization aims to bring informal and often illegal mining activities into the legal and regulated sphere. It involves a series of steps and measures designed to integrate informal miners into the broader mining sector, with the overarching goals of promoting sustainability, improving livelihoods, and enhancing governance. However, ASM formalization is a complex and context-specific

process, subject to variations across regions and countries. The report identifies challenges to formalization and offers key measures to facilitate positive progress in ASGM formalization.

The methodological approach applied in this research includes a detailed literature review of good practices in tailings management and reprocessing; research on public information about ASGM tailings; consultations, interviews, surveys, and inquiries with representatives of the mining and environmental agencies of selected countries; and consultations with ASGM specialists and mining experts. The report concludes by providing a summary of the thematic discussions and governance considerations for successful ASGM tailings management and reprocessing.

PART A:
Technical Considerations

2.0 ASGM Ore Extraction and Processing

2.1 Current Trends in ASGM

ASGM varies widely across countries, geological contexts, and the geomorphology of the mineralized land. However, the general processes remain the same:

1. The gold miner begins by extracting the ore.
2. The ore is processed to separate the gold from the waste material, called gangue (the remnants of this processing step are called tailings).
3. The tailings are either reprocessed by the ASGM miner to extract residual gold or sold to a processing centre or an individual buyer who will rework or reprocess the tailings further. In most cases, however, the tailings are disposed of (as illustrated in Figure 1).

This section provides an overview of the current methods and processes used by ASGM operators (the first two steps in Figure 1). The next section deals with the third step—tailings generation, handling, management, and reprocessing.

FIGURE 1. The ASGM process

Ore Extraction
- Alluvial
- Eluvial
- Hard rock
- Waste scavenging

Processing
- Comminution
- Separation

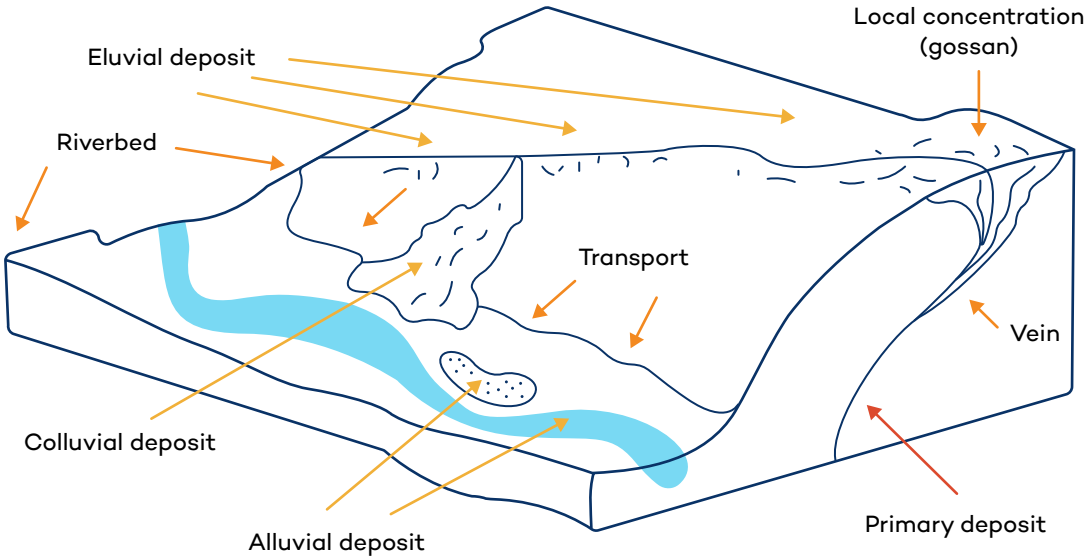
Tailings
- Sale
- Disposal
- Reprocessing

Source: Authors.

2.2 Ore Extraction

ASGM can involve working on secondary or tertiary alluvial deposits found in past or present riverbeds or can take the form of underground hard/primary rock mining, which involves manually digging vertical shafts or tunnels up to 35 metres deep (MacDonald et al., 2014). The specific mining method employed by the ASGM is associated with the specific type of deposit of the gold occurrence. Figure 2 illustrates the common types of gold deposits exploited by the ASGM sector.

FIGURE 2. Types of gold deposits typically exploited by the ASGM sector



Source: Mathis et al., 2005.

Alluvial, eluvial, and colluvial mining (also called soft rock mining) refer to the extraction of unconsolidated gold-bearing material for processing. The geological deposits may refer to recent unconsolidated material as well as ancient, lithified material. On land, miners commonly use shovels, picks, axes, hoes, chisels, and hammers for extraction; better-equipped operators use excavators to extract large amounts of gold-bearing bedrock. In recent alluvial gold deposits, the miners work close to or on riverbanks (see Figure 3). Along these riverbanks, ASGM miners pan for gold and use sluice boxes (homemade or manufactured) to capture ore from waterbodies. Better capitalized operations may use high-pressure pumps (a process sometimes referred to as “hydraulicking”) and dredges to extract gold ore from the riverbed deposits.

FIGURE 3. Artisanal miner panning for gold in Mali

Source: Grégoire Bellois, 2016.

In hard rock mining, miners work in either an open pit or an underground shaft, using pickaxes, chisels, shovels, drills, jackhammers, and, sometimes, explosives. Extraction can involve open-pit methods, underground mining methods, or a combination of both.

Open-pit mining involves removing the overburden, generating significant amounts of waste. In contrast, underground mining accesses the mineral deposit through tunnels and shafts, producing significantly less waste.

In addition to primary extraction from natural deposits, in many countries worldwide, waste scavenging is a second form of extraction. Waste pickers (or "ore selectors") use hand selection or hand sorting to scavenge for gold-bearing material in the waste rock produced by large-scale operators or other artisanal miners (Taj, 2020). As presented in Box 1, waste scavenging could offer a better gender representation among workers.

BOX 1. WOMEN WASTE PICKERS

Cultural beliefs and gender norms often confine many women in the ASM sector to lower-earning roles along the value chain. This limits their active involvement in the primary extraction phase, which is commonly regarded as "men's work" due to perceived physical and mental differences. However, in numerous countries, women play significant roles in secondary extraction or waste rock scavenging. For instance, women waste pickers in Bolivia, called *palliris*, and in Peru, called *pallaqueras*, specialize in gathering gold from mine waste generated by male artisanal miners. These women are relegated to scavenging due to the prevailing belief in these countries (and many others) that women bring bad luck to miners and are therefore prohibited from entering mine sites. Waste picking is a dangerous activity as the work is physically demanding and strenuous. The women work extremely long hours under severe weather conditions, and most of them do not have the finances to practice necessary health and safety measures. The women are exposed to higher levels of dust than other miners and consequently are at a higher risk of contracting diseases and physical ailments such as tuberculosis and rheumatism (Blow, 2019). Most women waste pickers are unrecognized and operate informally; they therefore have no option but to sell their findings on the black market at prices far lower than the international market price for gold. These socio-economic obstacles make them especially vulnerable to exploitation and abuse and restrict their capacity to be equitably included and involved in projects targeted at supporting ASGM workers.

Sources: Blow, 2019; Taj, 2022.

2.3 Ore Processing

After extraction, ore is either processed on site or transported to a secondary location or a processing centre. Ore processing consists of two stages: comminution and separation.

In the comminution stage, miners or processors crush, mill, and pulverize the ore to recover gold. This process differs in different countries. In some, jaw crushers, stamp mills, and ball mills are commonly used for this task. On the more rudimentary end of the spectrum, some miners manually grind ore using mortars and pestles (see Figure 4); this technique is employed by a relative larger proportion of female miners (see Box 3). The purpose of the comminution stage is to reduce the size of the ore particles to help liberate the gold from the gangue. Many miners will use a sieve to ensure that the ore has been crushed into an appropriate size for further processing.

Separation is the process of extracting the gold from the ore. This stage may involve various combinations of the techniques described in this section. Each mining operation is unique, and the techniques used for separation depend on the type of ore and on access to water and electricity.

FIGURE 4. Mortar and pestle in Mali

Source: Nellie Mutemeri.

Gravity Concentration

Because gold is denser relative to other minerals in ore, gravity separation is used to separate particles of heavy minerals, including gold, from the gangue, which consists of lighter minerals such as quartz and some silicates. Operators can use water as the medium for panning, sluices, and shaking tables, and better-capitalized operations may use spiral, vortex, and centrifugal concentrators. In winnowing, air is used as the medium of separation; this technique is used by artisanal miners in areas where water is not easily available.

Magnetic Separation

Magnets can be used to separate any magnetic materials from the concentrate, or ground ore. One technique involves securing magnets to the bottom of a pan to separate magnetic material from the gold.

Flotation Separation

Gold and some of the minerals that mineralogically associate with it (e.g., sulphides) can be made hydrophobic by using a proper foaming agent. Floatation separation leverages this hydrophobia to separate gold from the gangue. A slurry consisting of the milled ore mixed with water and a frothing agent is added to a flotation tank. Air is then released into the tank, creating bubbles. The gold-bearing particles float to the surface attached to the bubbles, the froth is scraped away, and the concentrate is processed further for gold recovery using techniques such as cyanidation and roasting, depending on the mineralogy. This technique demands significant capitalization and technical expertise, making it uncommon among artisanal operators but more prevalent among well-capitalized small-scale operators.

FIGURE 5. Amalgamation barrel in Colombia

Source: Nellie Mutemeri.

Mercury Amalgamation

ASGM operators can use mercury amalgamation, or concentrate amalgamation, where mercury is added to the concentrate obtained from gravity concentration. This is typically done in a pan, a sluice, or an amalgamation barrel (see Figure 5), in which the processors add approximately 1 or 1.5 units of mercury for every unit of gold. This method creates a 50–50 gold-mercury amalgam; the processor then uses heat to evaporate the mercury to reveal the "sponge" gold (see Figure 6).

Amalgamation can also take place during the initial processing stage, simultaneously with the comminution phase; this method is called whole-ore amalgamation, as opposed to concentrate amalgamation. It consists of adding a large amount of mercury to a mill, crusher, trommel, or steel drum during the comminution phase so that it comes into contact with 100% of the ore. This practice has been deemed a "worst practice" under the Minamata Convention on Mercury (see Box 2). Whole-ore amalgamation is a mercury-intensive method that uses between 3 and 50 units of mercury for every unit of gold recovered, which is significantly more than the amount added during concentrate amalgamation. Whole-ore amalgamation is inefficient and captures only approximately 30% of the gold from the ore (Veiga et al., 2006), and most of the mercury used is released into the tailings (Sousa et al., 2010). When mercury is used in the initial phases, it contaminates the remainder of the process, as well as the equipment used to process mercury-free ore.

FIGURE 6. Mercury vaporizing conducted by an ASGM operator in La Mina, Honduras

Source: IGF Secretariat (2019) – Honduras MPF Assessment.

Mercury amalgamation has been used for thousands of years to process silver and gold, and it remains widespread today because mercury is relatively inexpensive, easily sourced, and easy to use, and it recovers gold quickly. ASGM processors often do not adopt any safeguards when they are burning off the mercury. Smelting has been known to occur in residential areas, in kitchens, and at gold shops, without any protective equipment, and with other people present, including women and children. The mercury vapours emitted into the atmosphere often exceed the limit recommended by the World Health Organization (WHO) for public exposure of 1,000 nanograms/cubic metre (UNEP, 2012).

Mercury is a powerful neurotoxin that can have a wide range of impacts on human health and the environment. Exposure to mercury can cause impaired cognitive function, neurological damage, kidney damage, and more (UNEP, 2012). Mercury exposure is particularly dangerous for women, children, and fetuses, as it increases the likelihood of physical deformities and impairs brain function (Esdaile & Chalker, 2018). It can also negatively impact people's nervous, digestive, and immune systems, damage their sexual and reproductive health, and cause death. As a result, a variety of acute health impacts—kidney dysfunction, respiratory disease, neurological disorders and symptoms, and immunotoxicity/autoimmune dysfunction—have been recorded in local mining communities (Gibb & O'Leary, 2014; Vergara-Murillo et al., 2022).

Unlike some other pollutants, mercury is an element and cannot be broken down in the environment. Vaporized mercury can travel quickly through the atmosphere and can

contaminate entire ecosystems. Mercury can adversely impact global food supplies and, consequently, human health because it bioaccumulates and biomagnifies in organisms, including humans.

BOX 2. THE MINAMATA CONVENTION ON MERCURY

The Minamata Convention on Mercury is a global treaty that aims to protect human health and the environment from the adverse effects of mercury. It entered into force in August 2017 and represents 148 parties, including 128 signatories as of March 1, 2024.

The Convention aims to control the anthropogenic releases of mercury throughout its life cycle. The main focal areas of the Minamata Convention include a ban on new mercury mines, the phasing-out of existing ones, the phasing-out and phasing-down of mercury use in several products and processes, control measures on emissions to air and on releases to land and water, and the regulation of the informal sector of artisanal and small-scale gold mining (ASGM). The Convention also addresses interim storage of mercury, its disposal once it becomes waste, and sites contaminated by mercury, as well as health issues.

ASGM is the largest source of mercury pollution on the planet[1]; it is estimated that between 650 and 1,400 tonnes of mercury are emitted through ASGM each year, accounting for 37% of global anthropogenic mercury emissions (Seccatore et al., 2014). As such, the Minamata Convention requires that party nations reduce—and where feasible, eliminate—the use and release of mercury from ASGM.

Additionally, Article 7.3 of the Minamata Convention states that each party that has significant ASGM activity in its territory shall notify the Secretariat. The party shall also develop and implement a national action plan (NAP) in accordance with Annex C of the Convention. Each country's NAP will be unique; however it must include baseline estimates of mercury use, ASGM practices, and other socio-economic, health, and legal aspects. It must also include actions to eliminate the four ASGM activities deemed "worst practices": (a) whole-ore amalgamation, (b) open burning of mercury, (c) burning in residential areas, and (d) using cyanide on mercury-laden tailings. These practices should be replaced with better ones, namely: (a) milling and concentrating the ore before amalgamation, (b) using mercury vapour–capture tools, (c) processing in designated areas, (d) removing mercury before applying cyanide, and (e) the best practice of not using mercury at all.

The Convention also provides financial and technical support for countries undergoing the NAP process. Through these mechanisms, each country can reduce mercury use and mitigate its negative impacts at a country level.

Atmospheric deposition and direct releases to waterways of mercury often result in the contamination of fish with methylmercury (MeHg) and that fish consumption is the most important route of exposure of MeHg to humans globally. As a result, communities living downstream of ASGM operations often are at risk from the contamination of fish by Hg. Many fish populations around the world have mercury concentrations that exceed consumption advisories, and the largest source of Hg is atmospheric mercury deposition

1 However, debates persist due to the unreliable nature of ASGM contribution inventories. It's worth noting that coal combustion also represents a substantial source of mercury pollution. For more insights, see Obrist et al. (2018), Outridge et al. (2017), Streets et al. (2017), and Streets et al. (2019).

to which ASGM makes one of the largest contributions (Kocman et al. 2017; Sundseth et al. 2017; Streets et al. 2017).

Beyond the direct use of mercury in gold processing as an amalgam, ASGM activities may indirectly exacerbate mercury-related issues. These activities are often also associated with increased erosion and deforestation, factors that may increase mercury exposure. The greatest health concerns with environmental releases are with methyl mercury, which is the form of mercury that bioaccumulates in fish. ASGM activities may affect mercury methylation rates, which may in turn affect contamination of fish. ASGM activities may act to both increase or decrease methylation rates. For example, acid drainage can increase mercury methylation whereas cyanide releases or fixation of Hg with sulfides may decrease methylation (Hsu-Kim et al. 2018).

Chemical Leaching

Chemical leaching, a method primarily employed by large-scale miners, is gaining popularity in ASM as a mercury-free alternative for gold recovery. This process uses a lixiviant, which can be thiosulphate, cyanide, chlorine, or urea, to extract gold from the ore. In ASGM settings, cyanide is commonly used as the lixiviant and can be applied in two ways:

1. Heap leaching: A solution containing sodium cyanide or calcium cyanide is sprayed over piles of crushed ore placed on impermeable liners called leach pads. As the solution percolates through the ore heap, it dissolves the gold, creating a gold-rich solution. This solution is collected on the pad and later treated to recover the gold using activated carbon or zinc.
2. Vat or tank leaching: A cyanide solution is added to a concentrated ore mixture within cement vats, large drums, pools, or tanks. The solution slowly seeps through the ore, extracting gold as it goes. The impregnated solution flows out through a drain and is continuously recirculated back into the vat until no more gold can be recovered.

When done properly, these chemical leaching techniques provide ASM with a more environmentally friendly alternative to mercury-based gold recovery methods.

Cyanidation the most widespread chemical leaching technique for gold recovery, can be conducted safely and without harm to the environment if the cyanide is transported, stored, used, and handled properly. The International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold (the Cyanide Code), developed by the International Cyanide Management Institute, is a voluntary standard widely used in the gold and silver mining sector. It provides guidelines and shares best practices with mining operators on the responsible use of cyanide to reduce the potential exposure of workers and communities, limit releases into the environment, and prepare response actions in the case of cyanide release or exposure.

Cyanide is a highly toxic chemical; inhalation, ingestion, and contact with it can be deadly. Cyanide can poison people, animals, plant life, and aquatic systems. Cyanide compounds also persist in the environment, including in plants and animal tissue, for a long time after contamination.

The use of cyanide by ASGM operators has the potential to create adverse dangerous impacts. ASGM is generally unregulated, and cyanidation often occurs without any safeguards. Although it has been reported that ASGM operators typically use vat leaching

(personal communication), due to limited capitalization and capacity, cyanidation often occurs in large holes in the ground without containment structures to prevent cyanide seepage into the ground. Seepage can contaminate soil and groundwater supplies, which can subsequently impact food supplies and human health. As well, the use of cyanidation on a material already contaminated by mercury enhances the mobility of the mercury by creating mercury-cyanide complexes and is considered a "worst practice" by the Minamata Convention (see B (either heap or Vat leaching), ox 2).

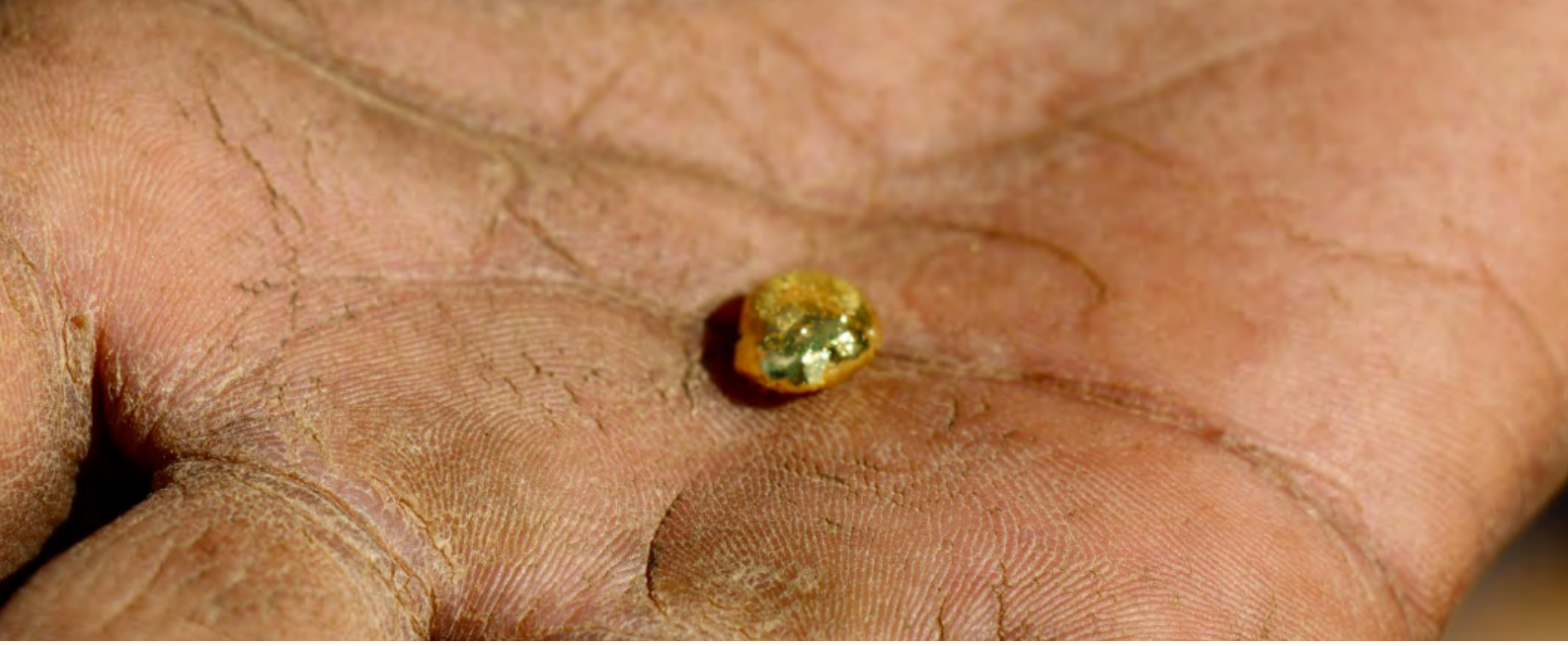
Direct Smelting

Direct smelting represents the final phase in gold recovery, typically following the use of one or more of the preceding methods. It is employed with exceptionally high-grade, free-milling gold concentrate as a more sustainable and environmentally friendly substitute for mercury amalgamation. In direct smelting, a small amount of gold concentrate is mixed with a chemical agent called flux, usually borax. The addition of flux serves to reduce the viscosity and lower the melting point of non-gold materials within the concentrate. The mixture is then heated in a crucible, often using a blowtorch, until it reaches a temperature of 1,065°C. At this temperature, gangue minerals separate from the molten gold. As the process continues, the molten gold cools and solidifies into a gold doré, which can undergo further refinement and processing.

BOX 3. WOMEN IN PROCESSING

While women are often excluded from extraction, they actively participate in various processing activities along the ASGM value chain. For example, in Bolivia, women gather and process ore manually using sledgehammers. Women account for 20% to 30% of the ASGM workforce in Burkina Faso, where they predominantly carry out various processing tasks, such as manual ore crushing, collecting water for processing activities, and concentrating the ore using sluices. In many ASGM-producing countries, such as Indonesia, the Philippines, and Kenya, women are often responsible for mercury amalgamation and smelting. Women tend to conduct processing activities manually without protection due to capital limitations, and they are exposed to a wide range of risks, including silicosis, chronic bronchitis, and tuberculosis. In the Philippines, for instance, many of the women who are responsible for decomposing the amalgam with mercury over kitchen stoves have reported kidney pain, respiratory problems, and dizziness. The consequences of mercury exposure are greater for women of childbearing age and pregnant women because mercury bioaccumulates in the body and impacts the developmental outcomes of babies.

Sources: Hruschka, 2015; Kaboré & Ariyaratne, 2020; Sturmes, 2020; WHO, 2016.



3.0 ASGM Tailings Generation, Handling, Management, and Reprocessing

3.1 ASGM Tailings Disposal

When processing occurs at the extraction site alongside a waterbody such as a river or stream, it is common for the tailings to be released into it. This is done because when the ore has been processed and the gold extracted, the residual material is believed to not hold significant value anymore and is therefore disposed of in the easiest possible way.

Tailings are also frequently deposited at the mine site, either through dry-stacking in open areas or within tailings ponds (as depicted in Figure 7). Tailings ponds are also often filled with tailings from several sites that may have been processed using different methods, including mercury amalgamation and cyanidation. Due to a lack of capacity, many operators do not conduct basic containment activities, such as building cement-lined ponds. They also often lack the finances to purchase impermeable sheeting or covers to prevent toxic tailings from leaching into the environment. As a result, tailings ponds are sometimes simply holes dug in the ground, and without the appropriate safeguards, toxic elements contained in the tailings are easily introduced into the environment. Furthermore, ASGM miners often do not conduct any restoration or remediation activities and simply abandon the mine site and tailings ponds once activities have ceased, which can greatly impact the environment and health of local communities.

The proper management of tailings disposal would involve:

- identification of appropriate sites for tailings disposal:
    - where no mining is expected in the near future (so that the installation is not expected to be disturbed)
    - far (or isolated) from streams, rivers, and other waterbodies
    - far from inhabited areas
    - far from agriculture activities
    - close to processing operations (to avoid transporting the tailings over long distances)

- identification of ways to secure tailings disposal sites:
    - proper liner (e.g., geotextile) at the base of the pond
    - fencing of the site to limit entry of humans or animals
    - elimination of leakages
    - proper containment structures to withstand extreme weather events and other natural hazards
- separate handling of tailings depending on the processes by which they were produced, particularly if contaminated with chemicals like mercury and cyanide

FIGURE 7. ASGM tailings pond

Source: UNEP, Pure Earth (2022).

- information dissemination and sensitization of ASGM:
    - clarify where the tailings should be disposed
    - clarify how tailings should be disposed
    - discuss risks associated with tailings disposal
    - discuss risks associated with mercury and cyanide use

BOX 4. ASGM TAILINGS AND MERCURY WASTES

In Article 11, the Minamata Convention on Mercury (UNEP, 2013) defines mercury waste as substances or objects consisting of, containing, or contaminated with mercury or a mercury compound. Tailings from mining (as well as overburden and waste rock) fall into this category if their mercury content exceeds a defined threshold. This threshold was defined as 25 mg/kg for tailings from large-scale mining in Article 6 of the COP decision MC-4/6: Mercury waste thresholds in 2022, 9 years after the adoption of the convention (UNEP, 2022a).

However, the same decision specifies in Article 5 that no threshold needs to be established globally for ASGM tailings from operations where mercury is used to extract gold from ore. All such tailings can be considered mercury waste and should be managed in an environmentally sound manner according to existing Article 7 of the Minamata Convention (on ASM). The decision MC 4/29 (UNEP, 2022b) further specifies that the residual trace amount of mercury left in the tailings before reprocessing through cyanidation should be specified by the relevant authorities to prevent any negative impacts on human health and the environment.

3.2 Sale of Tailings

Transactions involving ASGM tailings arise from the recognition that the initial ASGM gold recovery processes are not always efficient, leaving behind residual amounts that can be extracted economically and may involve the following:

- Miners exchanging their tailings in lieu of costs of processing services at toll treatment facilities: Many ASGM miners do not process their own ore. Instead, they take the ore to individual processors or processing centres that have the capacity and equipment to recover gold. Many times, the tailings are used as a full or partial payment for the processing activities. In some mining sites in Mali, women are paid with leftover tailings for helping men wash mineral powder, a transaction that is often the only form of income for women who are otherwise unable to access resources and services (interview responses). The processors will reprocess the tailings to extract value and sell the residual gold to mineral buyers.
- Mineral processors who buy tailings from ASGM miners: ASGM miners stockpile their tailings and sell them to processors once the pile has reached a significant monetary value. In Mauritania, for example, a 20-tonne dump truck of tailings can be bought by processors for USD 100 (personal communication). In some countries, such as Tanzania, mining law includes a specific license for these processors.

With regard to tailings management, some of the challenges associated with these transactions include:

- management of the tailings as they move from one actor to another in the gold extraction cycle
- inappropriate handling of the tailings due to limited knowledge about the origin of the materials. For example, when tailings originate from different sources, it is impossible to ascertain what methods were used in the processing stage. Consequently, mercury-laden tailings may end up contaminating mercury-free tailings, creating a larger volume of mercury-laden tailings which, if not managed properly, can then be introduced into the environment. The risk of cyanidation of mercury-laden tailings is high.

Proper management of the sale of tailings would involve:

- identification of sources of tailings:
    - geographic location
    - type of ore (which influences the mineralogical composition of the tailings)
    - type of processing (which would indicate the potential mercury contamination in some batches of tailings)
- registry of the transactions related to the tailings, including the buyer and the quantity and quality of tailings sold. This would help
    - control flows of money (limiting illicit financial flows),
    - keep track of tailings produced in relation to the gold produced and environmental stewardship of the associated waste materials, and

- ensure the proper taxation of the transactions. Some of the revenue from this tax could be applied to capacity building for various actors or other interventions that incentivize good practices in relation to tailings transactions.

3.3 Transport of Tailings

Tailings are often transported to and from (re)processing sites in vans, trucks, or lorries. These tailings are often laden with toxic chemicals that need to be handled with care. However, when the proper techniques, such as linings or covers, are not used to contain the tailings, people and the environment are at risk of exposure to toxins.

Proper management of the transport of tailings would involve:

- having clear and identified pickup and discharge locations and sites
- separating transport lines for tailings contaminated with mercury and those that are not
- having personal protective equipment for transport operators, including loaders and unloaders, especially when handling mercury-laden tailings
- properly maintaining trucks and loaders to limit the risks of leaks and accidents

3.4 Reprocessing (Secondary Extraction)

In the realm of ASGM, gold recovery techniques are often inefficient, resulting in tailings that harbour economically significant amounts of gold. Reprocessing these tailings for secondary recovery has emerged as a viable option, providing miners with an opportunity to extract valuable gold that may have eluded initial extraction efforts or was previously considered uneconomical to recover.

Various stakeholders within the ASGM value chain engage in tailings reprocessing, and women tend to play a relatively higher role than in other ASGM activities (see Box 5). One common approach involves ASM operators reprocessing their own tailings using the same methods initially employed. Alternatively, ASM operators may opt for a different, more comprehensive processing approach, potentially incorporating equipment like ball mills and centrifuges. Benefit-sharing arrangements can vary, with the original tailings owner receiving a share of the gold produced during reprocessing or selling the tailings outright for cash. Additional agreements between mining stakeholders in ASGM tailings reprocessing may involve collaborations with small- or large-scale mining operations (LSMOs) employing modern technology for gold and mineral recovery from the tailings (Sousa et al., 2010).

The reprocessing of these tailings involves employing the common processing techniques described in section 2.3. For instance, in Sierra Leone, at the rudimentary end of ASGM, miners use sluices lined with carpets to wash the tailings, effectively capturing gold particles. Another method involves exposing gold-bearing tailings to sunny conditions, expediting the oxidation of gold-bearing sulphides and making the gold more accessible for extraction. Miners repeat this process until they have extracted as much gold as possible from tailings.

In many ASGM-hosting countries, cyanidation stands out as the predominant method for reprocessing tailings due to its efficiency in extracting low-grade gold. A notable example is Kenya, where the proliferation of leaching plants, driven by the “cyanide revolution,” has

resulted in numerous plants operating without the necessary licences (Global Initiative Against Transnational Organized Crime, 2022b; Verbrugge et al., 2021). Furthermore, current ASGM practices often involve cyanidation following mercury amalgamation instead of replacing it. This practice leads to the formation of mercury-cyanide complexes, increasing mercury's mobility, toxicity, and availability, thereby posing significant risks (Malone et al., 2023).

Several initiatives have sought to demonstrate the feasibility of gold recovery from ASGM tailings. For example, Ghana and Tanzania have embraced a hub-and-spoke model, where multiple gravimetric separation systems (the "spokes") supply a central processing hub. This central hub employs professionally managed industrial-scale processes to extract the remaining gold while preventing the mixing of mercury-free and mercury-laden tailings.

In the Madre de Dios region of Peru, an initiative has successfully demonstrated gold recovery without cyanide. Larrabure Moreyra (2022) reported achieving recoveries of over 86% of the gold content in ASGM tailings using hydrometallurgical techniques to reprocess artisanal gravimetric table concentration tailings. In a separate instance in French Guyana, a study aimed at reprocessing gold tailings from a small-scale operation reported a 70% gold recovery rate using flotation (Durance et al., 2010).

Proper management of tailings reprocessing would involve:

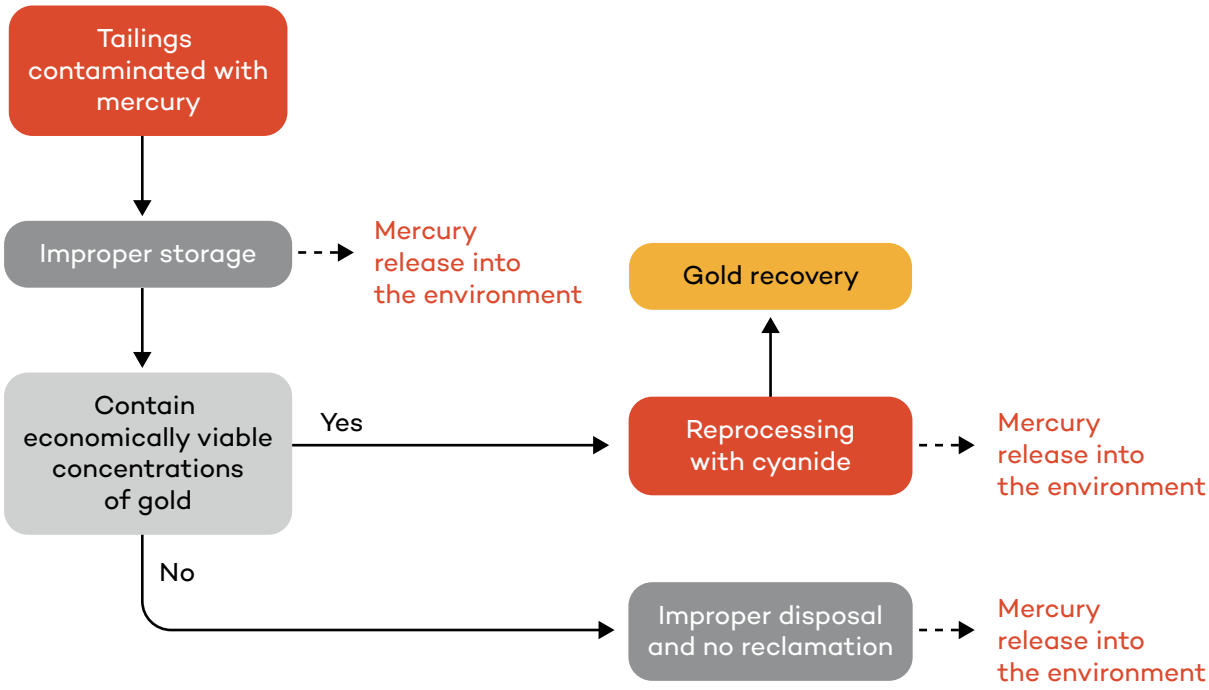
- determination of tailings composition:
    - define ore mineralogical composition of the secondary material to determine what metallurgical recovery process needs to be implemented
    - confirm contamination with mercury or lack of contamination
    - assess the presence of associated potentially toxic minerals from the original ore (heavy metals, radioactive materials, and toxic chemicals)
    - determine the presence of potentially associated elements of interest that could be recovered as by-products, some of which could potentially be considered critical minerals (see Box 5).
- for mercury-laden tailings, any reprocessing (especially using cyanidation) should first involve proper separation and safe storage of the mercury
    - It is important to note that there are no globally accepted mercury concentration thresholds, i.e., a determination of the mercury levels low enough for safe cyanidation (see Box 4).
- for reprocessing via cyanidation, cyanide should only be used by organized and trained miners who can comply with chemical management protocols to ensure occupational health and safety and protect the environment
- proper health, safety, and environment protocols should be in place at reprocessing centres:
    - All operators, especially those in contact with chemicals (cyanide, mercury) should be equipped with proper personal protective equipment.
    - All operators should receive initial training and regular updates on safety protocols.

- Proper signage should be put in place for reprocessing operators, as well as for transport actors and any person working at the reprocessing site.

- clear reporting of the gold recovered for
  - tracking of the gold and benefit sharing, including taxation purposes
  - evaluation of the residual gold in the secondary tailings from each specific ASM site, which would allow for evaluation of the efficiency of the initial metallurgical process and help target specific operations to improve their initial recovery.

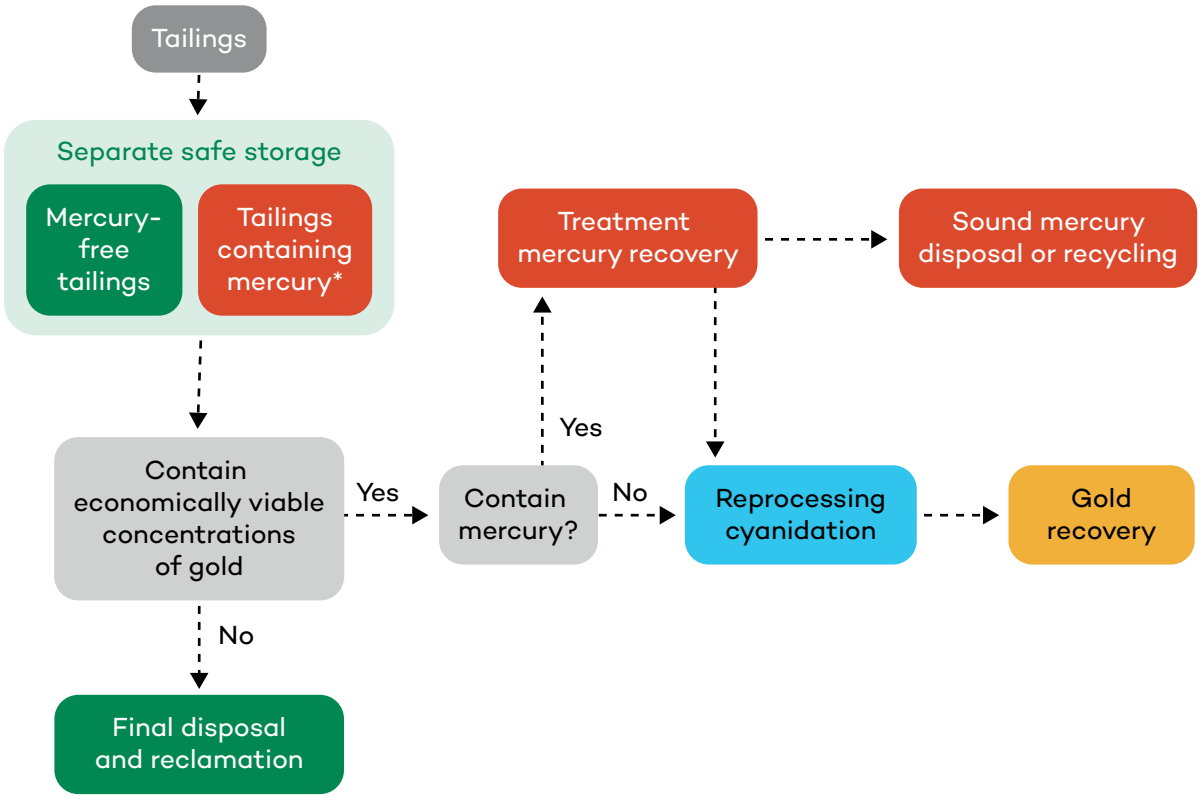
Workflows presented in Figures 8 and 9 Illustrate good and poor management practices in tailings reprocessing (UNEP, 2021c).

FIGURE 8. Workflow showing poor ASGM tailings-management practices



Source: UNEP, 2021c.

FIGURE 9. Workflow showing sound ASGM tailings-management practices



**Minimize the quantity of mercury-containingtailings by applying mercury-free methods or, if mercury is used, by applying it only to concentrate*
Source: UNEP, 2021c.

BOX 5. WOMEN AND REPROCESSING

Women are deeply embedded in the reprocessing of tailings all around the world. It is a key area in the ASGM value chain where women tend not to face heightened competition from male miners, although this is obviously not always the case. In Colombia, for example, the *chatarreras* have to negotiate with male mine owners to access and process their tailings; they often face discrimination and are given the lower-grade tailings because the higher-yielding tailings are reserved by the mine owners for other men. Conversely, in many ASGM areas, male miners abandon their mine sites along with the tailings in search of their next opportunity. Women, who are often not migratory, will then perform processing activities on the tailings to extract residual gold. In Tanzania, women typically rework the tailings while men perform some of the primary processing activities.

Sources: Kaboré & Ariyaratne, 2020; McDonald, 2023.

BOX 6. BY-PRODUCTION POTENTIAL FROM ASGM TAILINGS: AN OPPORTUNITY TO PRODUCE CRITICAL MINERALS

Critical minerals, also known as critical elements, critical raw materials, green minerals, or strategic minerals in different regions and countries, are generally considered by destination countries to be minerals of strategic importance to national industries and economic development in the face of an energy transition characterized by decarbonization and by digital transformation (also referred to as the fourth Industrial Revolution). Critical minerals are those deemed to be particularly vulnerable to supply chain disruption due to geological scarcity, high concentration of reserves in a few countries, production or refining capacities, geopolitical issues, or other supply restrictions. Although the definition and demarcation of critical minerals differs from country to country depending on national priorities, these two tenets—economic importance and supply risk—typically underpin the categorization of critical minerals from the point of view of destination countries. For example, in 2023, the European Union published a list of 34 critical raw materials; this is the fifth iteration of this list since 2011. In 2022, the United States published its list of 50 critical minerals; it includes 14 more minerals than the first version in 2018.

There is overlap between these lists. The Australian government, for instance, considers 26 resource commodities to be critical minerals. These minerals are of strategic importance not only for Australia but also for their partner countries: the United States, United Kingdom, Japan, India, South Korea, and Canada (Geoscience Australia, 2023). Across national critical mineral lists, the common minerals are gallium, indium, tungsten, platinum-group elements (particularly platinum and palladium), cobalt, niobium, magnesium, molybdenum, antimony, lithium, vanadium, nickel, tantalum, tellurium, chromium, manganese, and rare-earth elements. The world's industrial economies have prioritized these minerals, as they are key to the development of the technologies needed for a low-carbon digitized future, such as advanced vehicle manufacturing, renewable energy technologies, batteries, energy storage, aerospace technologies, and information and communication technologies.

The demand for these minerals exceeds the expected supply, and due to a decline in exploration activities around the world and the lag between exploration and production, the industrial economies are looking for alternative ways of securing these critical minerals (Sarker et al., 2022). The secondary extraction of tailings could offer a prime solution. Tailings are widely available all around the world, which would reduce the wait time needed to develop a new mineral supply chain. Moreover, tailings potentially contain recoverable amounts of critical minerals that could be higher than the concentrations found in some primary ores (Sarker et al., 2022). Reworking tailings that have already been extracted and crushed involves only reprocessing, which limits operating costs. However, specific metallurgical studies need to be performed, as the composition of the tailings might not be known, especially after the addition of chemicals during the initial processing.

Mineral deposits contain various elements, and gold can be found with copper, zinc, cobalt, and antimony. Gold tailings can therefore be an important source of these critical minerals. For ASGM, this could have various impacts.

On the positive side, the rush for critical minerals has resulted in attention being given to ASM value chains. This has resulted in responsible supply chain interventions such as the International Tin Supply Chain Initiative Programme for Responsible Mineral Supply Chains

in the Democratic Republic of the Congo; the European Partnership for Responsible Minerals, which has projects in 11 countries; the International Conference on the Great Lakes Region Mineral Certification Mechanism; and the Certified Trading Chains. The latter two interventions are supported by the German government. These interventions work with governments and supply chain actors to improve the governance of the sector, increase formalization efforts, enhance transparency of the value chain, and reduce potential risks. These initiatives also provide the ASM stakeholders with support, from financing to access to markets and a range of other extension services to upgrade their operations to meet human rights and due diligence standards. Similarly, interventions that are developed to extract critical minerals from ASGM tailings could enhance the governance of the sector through the creation of agile ASM-specific legislation for secondary extraction. Through focused programming, governments and development partners could be encouraged or aided in mapping and sampling ASGM tailings to ensure that processors are deriving the highest benefit and extracting all the available minerals (as illustrated by the case study of Australia's Exploring for the Future project in Box 7). At an operational level, tailings reprocessing could be improved through the introduction of new (chemical-free) equipment accompanied by training and capacity building. However, processes should be adapted to the mineralogy of different tailings, as well as to each specific element or mineral intended to be extracted.

Conversely, greater attention being given to ASGM tailings could result in conflict for resources. More financed and better-equipped small or even large operators could crowd out ASGM operators. With access to more efficient technologies, these other operators will make it difficult for ASM processors to compete. This could potentially drive ASGM tailings processors out of the formal sphere as they seek alternate (illicit or illegal) markets to sell their products. Raising awareness about the potential of ASGM tailings reprocessing opportunities is crucial as this aspect has received limited attention to date. This lack of focus has contributed to an environment characterized by insufficient oversight and regulation.

Grades of mineral deposits exploited by ASGM operators can sometimes exceed 10 g/t. Even with such high grades, most of what is mined is not gold. This material could potentially include elements that have not been initially considered by ASM because they are only interested in gold or don't have the skills nor the processing capacities to extract other elements. Reprocessing tailings with adapted metallurgical technologies can open the way to extracting other elements of interest, should the initial geology allow it, including those defined as critical minerals. It is therefore imperative to determine if the ASGM tailings contain commercially extractable quantities of any of the critical minerals.

BOX 7. CASE STUDY (AUSTRALIA): MAPPING EXISTING TAILINGS AND THE EXPLORING FOR THE FUTURE PROJECT

Geoscience Australia, an agency of the Australian government, is leading an AUD 225 million project called Exploring for the Future. One of its central components is the creation of a Mine Waste Atlas. To create this Atlas, Geoscience Australia has teamed up with the University of Queensland, RMIT University, and the Geological Survey of Queensland to survey national mine waste sites and to map the potential of the tailings and has identified 1,050 sites so far. It is the first time a country has mapped all its tailings storage facilities and compiled comprehensive information about them.

The Atlas of Australian Mine Waste is an interactive digital map that provides accurate real-time information on Australian mine tailings, waste rock, smelter residues, and related mine-waste materials for large-scale operations. The data allows users to find a wide range of mineral information and data relevant to each mine site, including location, commodity groups, rehabilitation status, etc. As the surveying activities continue, the Atlas will be updated, constituting an ever-growing repository of mine-waste information.

Future research will focus on the mineralogy of these tailings and on metallurgical processes to unlock the potential to extract critical minerals.

The main objective of the Exploring the Future project is to secure Australia's economic future through sustainable resource extraction. The Atlas provides Australians with an opportunity to identify and extract valuable mineral resources, specifically critical minerals, from previously mined waste.

4.0 Mercury Recovery, Management, and Disposal

4.1 Mercury Recovery

As emphasized previously, it is essential to remove mercury from mercury-laden tailings before reprocessing them. The diverse nature of tailings from ASGM implies that there's no one-size-fits-all approach for mercury recovery. Thus, the method of choice will depend on economic and technical factors particular to the local socio-economic situation of the ASGM community. Available methods for mercury recovery from ASGM tailings include (UNEP, 2021b):

- adsorption on metal plates (e.g., copper, silver, or tin)
- vaporization through heating, then condensation, of elemental mercury
- gravimetric methods using mercury's high density (d = 13.5)
- foam flotation
- distillation
- electrolysis
- activated carbon and electrodeposition

The technical descriptions and comparative advantages of these techniques, some of which are at the pilot stage, are described in the report from Pure Earth (2023a).

No single technology is universally suitable for all types of tailings. Each of these methods has its own limitations, which should be carefully weighed when choosing and designing the most appropriate technique for mercury removal in specific situations. The criteria to consider include:

- the effective mercury concentrations. The best recovery is achieved with higher initial concentrations, and residual mercury with low concentrations tends to be challenging to recover.
- the technical limits of the technology in separating mercury from tailings
- the specific form of mercury targeted for removal: mostly elemental mercury, as opposed to mercury compounds such as methylmercury.

- economic considerations, energy consumption, and infrastructure requirements
- the expertise necessary to ensure operational effectiveness

Even after mercury recovery, the mercury levels in treated tailings might still not meet the criteria for the tailings to be either safely disposed of or used as aggregate.

4.2 Storage and Handling of Mercury

Mercury recovered from tailings and waste contaminated by mercury need to be handled and stored with proper care and safety measures to ensure the safety of workers and to limit the risk of any contamination to the environment. The practical details of such handling are described by Pure Earth (2022) and by the Artisanal Gold Council and planetGOLD (Cordy et al., 2022).

The criteria for the proper packaging of mercury and mercury-contaminated waste are tightness against evaporation, non-reactivity between mercury and the container material, and mechanical strength to withstand the weight of mercury during transport. With a density of 13.5, 1 L of mercury weighs 13.5 kg.

Handling and recovering mercury generates mercury-contaminated waste that must also be taken care of properly. Packaging should consider the high volatility potential of mercury and should provide as much insulation from the atmosphere as possible.

Proper labelling is essential to ensuring safety along the chain from recovery to the disposal of mercury.

The handling of mercury and mercury-contaminated waste is a critical step at which operators are most at risk of contamination. Appropriate personal protective equipment—consisting of goggles, mask, gloves, clothes, and footwear—is essential to ensuring the safety of workers.

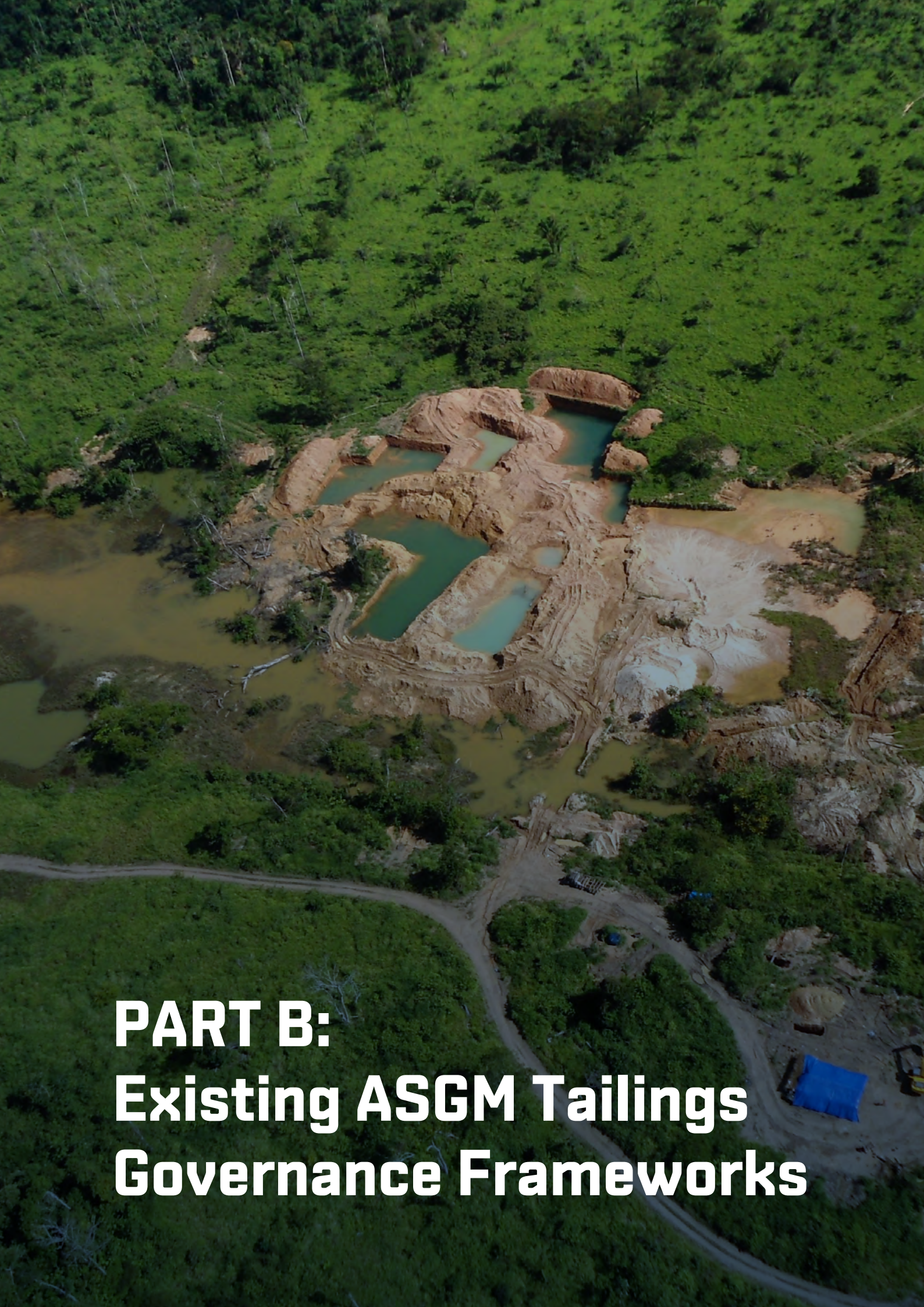
Mercury and mercury-contaminated waste must be stored in a secure location that is protected from any potential natural risks such as fire, flooding, and earthquakes. Storage facilities should be isolated from living areas such as kitchens and sleeping and eating areas.

4.3 Transport of Mercury

The transport of mercury, like any hazardous material, should follow thorough procedures to ensure the safety of drivers, handlers, communities adjacent to transport routes, and the environment at large. Companies and drivers should be registered and required to adhere to strict safety protocols as a first prevention tool, and all trucks must be maintained in good operating condition.

The criteria for ensuring the safe transport of mercury waste include (Cordy et al., 2022):

- solid regulations and the registration of companies and workers;
- vehicles that meet the requirements for handling hazardous material;
- a contingency plan and a working emergency management plan, with regular drills for workers and authorities;
- proper labelling of vehicles to identify risks; and
- properly labelled containers and an effective inspection and tracking system.



PART B:
Existing ASGM Tailings Governance Frameworks

Significant guidance and literature are available on ASM or ASGM management, such as *IGF Guidance for Governments: Managing Artisanal and Small-Scale Mining* (IGF, 2017b); however, the focus on ASGM tailings management has been relatively limited. Currently, only a few publications delve into the intricacies and best practices related to managing tailings generated from ASGM operations. The following sections examine frameworks the specifically address ASGM tailings management.

5.0 International Governance Frameworks

The creation of international protocols to regulate ASGM tailings has been largely neglected, and tailings management within ASGM has not been given sufficient attention even though ASGM tailings are laden with mercury and other contaminants and are a key contributor to mercury pollution (UNEP, 2021b).

This section provides an overview of current tailings governance frameworks. Despite the fact that ASGM tailings pose a great risk to the environment and human health globally, the international governance of ASGM tailings is currently limited to two chemical-focused guidance documents:

- UNEP's *Sound Tailings Management in Artisanal and Small-Scale Gold Mining* (2021b)
- PlanetGOLD's *Best Management Practices for Cyanide Use in the Small-Scale Gold Mining Sector* (2021)

There are also national programs to eliminate mercury following Minamata Convention commitments.

5.1 UNEP's Sound Tailings Management in ASGM

Since the 2013 Minamata Convention on Mercury, the use of mercury in ASGM has received considerable attention. UNEP's *Sound Tailings Management in Artisanal and Small-Scale Gold Mining* (UNEP, 2021b) is the only international guidance document that has been created specifically for the management of tailings in ASGM. It is a technical document that provides an overview of the available knowledge on the management of mercury-containing tailings

generated by ongoing ASGM practices. The recommendations for tailings management along the mining life cycle are based on experiences and specific case studies gathered from mining sites around the world. The document includes key considerations and recommendations for tailings management in ASGM.

- Policy recommendations:
    - Understand the local political, socio-economic, and environmental context.
    - Review legal and regulatory frameworks to identify gaps and propose improvements with respect to tailings management.
- Technical recommendations: The best way to manage mercury-containing tailings is to not generate them in the first place. However, if such tailings are generated, the following control measures must be taken into account:
    - Keep mercury-contaminated tailings separate.
    - Measure mercury content and perform additional chemical and mineralogical characterization of tailings.
    - Never apply cyanide to mercury-contaminated tailings.
    - Remove mercury before reprocessing mercury-contaminated tailings.
    - Ensure safe disposal of the recovered mercury; cyanide should only be used by organized and trained miners who can comply with chemical management codes.
    - Use impermeable lining systems and cover tailings.
    - Do not use mercury-contaminated material to construct tailings structures.
    - Ensure safe transport of tailings.
    - Ensure tailings structures are constructed away from human settlements, grazing and farming areas, and rivers, as well as outside flood areas.
    - Mark and fence the tailings structures.
    - Do not dump tailings containing mercury back into streams or in flood-prone areas.
    - Restore the surface grading and revegetate the land to reduce erosion.
- Social recommendations:
    - Engage ASGM communities in the restoration plans.
    - Organize educational sessions focused on the benefits of restoration and future restored land-use possibilities.
    - Ensure miners' participation and build interventions on the formalization efforts.
    - Allocate financial mechanisms and responsibilities to ensure the sound management of tailings.
    - Inform the community about the presence of mercury-contaminated tailings and the associated risks.
    - Design and conduct educational programs.
- Monitoring recommendations:

- Use geospatial tools, e.g., GIS, to keep track of the locations and characteristics of mercury-contaminated tailings.
- Use remote sensing to identify and track the progress of the existing tailings.
- Use periodic sampling and characterization of the tailings to monitor changes.

5.2. National Action Plans

The Minamata Convention is enacted in ASGM at the country level through the National Action Plans (NAPs; UNEP, n.d.), which are required for all parties to the convention that have declared they have more than insignificant ASGM in their territory. As of March 20, 2024, 33 countries have finalized their NAPs, with another 45 under development (Figure 10).

The implementation of these NAPs is supported largely through the planetGOLD program. UNEP has developed several guidance documents to facilitate the creation of NAPs (UNEP, n.d.). Among these, the *Sound Tailings Management in Artisanal and Small-Scale Gold Mining* guidance (UNEP, 2021b), as previously mentioned, is particularly pertinent to this study. Additionally, the guidance for integrating gender-related considerations into NAPs (UNEP, 2021a)—the only one of its kind—lays the foundation for mainstreaming such considerations within the ASGM sector.

Some of the countries that have submitted NAPs acknowledge the presence of practices that lead to the production of tailings contaminated with mercury and the cyanidation of materials containing mercury. These practices are considered to be worst practices by the Minamata Convention and are widely recognized as being among the most harmful within the realm of ASGM, as detailed in Table 1.

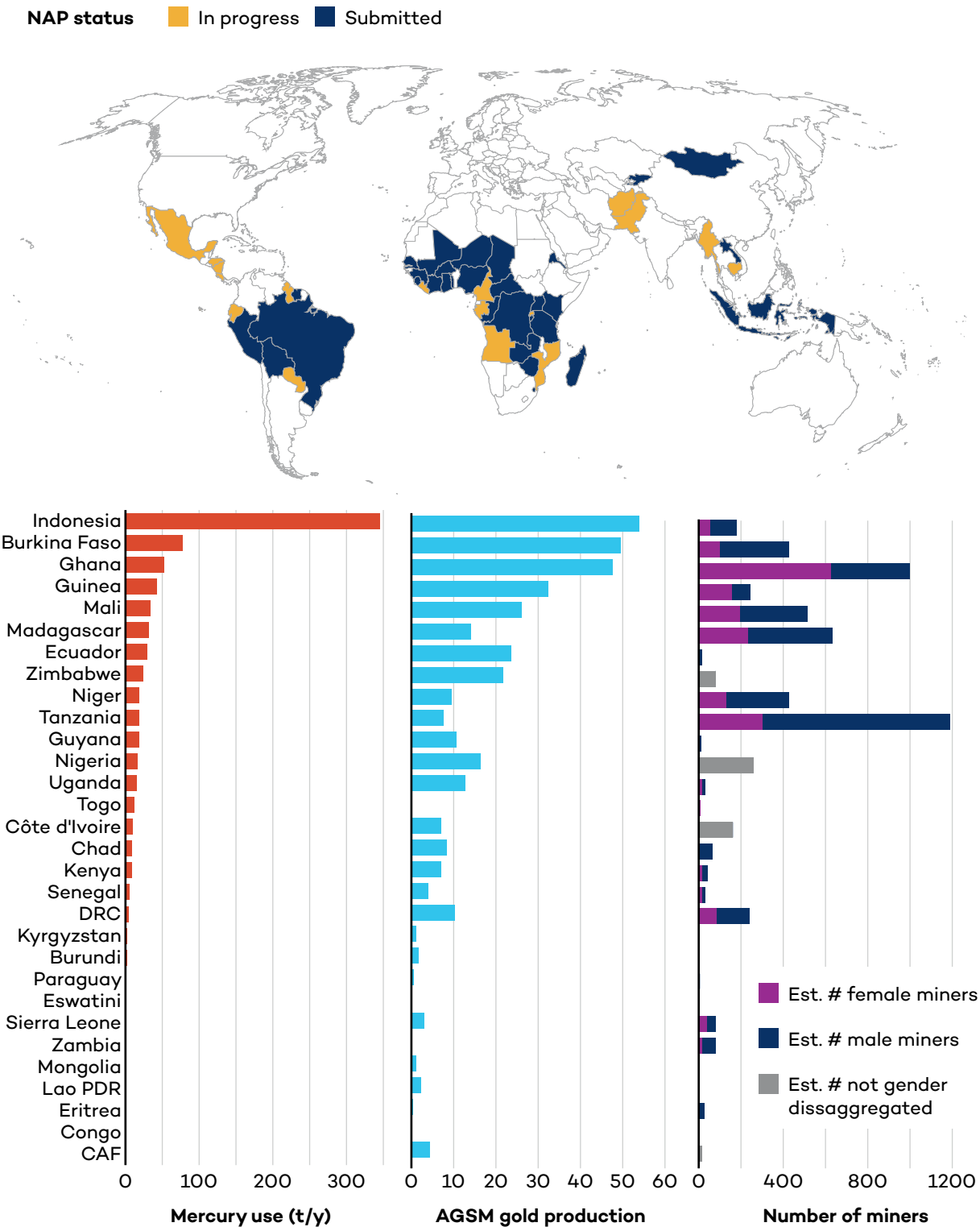
TABLE 1. Country data on worst practices as reported in NAPs

Country	Worst practices	Mercury use baseline (tonnes)	Reduction target	Elimination target date
Burkina Faso	2, 3, 4	77.60	50% by 2024	2029
Ecuador	1, 2, 3, 4	29.60	80% by 2030	ND
Ghana	1, 2, 3, 4	52.25	10% by 2025	ND
Kenya	1, 2, 3, 4	8.20	50% by 2024	ND
Mongolia	ND	0.24	50% by 2023	ND
Nigeria	2	16.07	50% by 2030	ND
Tanzania	2, 3, 4	18.80	30% by 2025	ND

Note: Cameroon, Colombia, Peru, and South Africa have not yet submitted their NAPs to the Minamata Secretariat. The Philippines has not submitted an NAP but Practice 1 is reported in the literature (Natural Resources Defense Council, n.d.). Brazil's NAP is under development. 1 = whole-ore amalgamation, 2 = open-air burning of amalgam, 3 = burning of amalgam in residential areas, 4 = cyanidation of mercury-bearing tailings, ND = no data.

Source: Authors.

FIGURE 10. NAP status



Source: Source UNEP, Permission granted : Insights from ASGM National Action Plans | Global Mercury Partnership (unep.org)

There is currently no comprehensive data available about women's participation in tailings reprocessing, including in UNEP reports. Table 2 provides a summary of reports from various countries. In all cases, in their NAPs, these countries outline their intentions to prohibit detrimental ASGM practices through a variety of interventions, some of which are already in progress through donor-funded projects. These initiatives involve the formalization and promotion of mercury-free gold extraction methods. However, there have been no reported activities specifically related to women's participation in tailings reprocessing on the UNEP's dynamic dashboards (Global Mercury Partnership, n.d.).

NAPs from Kenya, Mongolia, and Nigeria have no specific mention of how women are involved. Cameroon and the Philippines have not submitted NAPs.

TABLE 2. Gender statistics in countries where NAPs have been developed

Country	% of Women	Mention of women's involvement in tailings reprocessing
Brazil	NAP development in progress	UNEP NAP platform indicates that although women waste pickers in Latin America face multiple levels of daily discrimination while providing for their families, they are beginning to address gender division and relations within their value chain and bring gender issues to light within their organizations. In 2012, a number of national and regional organizations in Brazil launched a series of meetings with women waste pickers from various cooperatives to contribute to the design of a pilot project in the state of Minas Gerais.
Burkina Faso	23	Mention of women being involved in "spoils" around abandoned mining sites.
Colombia	n/a	Has not submitted an NAP. According to UNEP, in Colombia, ASGM women's representatives have noted that mining tasks within the mines are typically performed by men, while women engage in activities such as chiselling, breaking, burning, and transporting materials. Additionally, UNEP suggests that enhancing the safety of women at mining sites through technology can help establish them as equal members within ASM communities. For instance, Colombia is implementing biometric registration as part of traceability initiatives funded by the Better Gold Initiative, illustrating how technology can play a role in achieving gender equality in ASGM communities (UNEP, 2023).
Ecuador	10	According to the UNEP NAP website, in many cases, women on mining sites in Ecuador are family members of the mine operators, and as such, are involved in mining activities in parallel to their daily responsibilities. In some ASGM sites, it was reported that there is a significant presence of women to collect low-grade rocks from waste dumps and that some of these women have managed to become formalized (UNEP, 2023).

Country	% of Women	Mention of women's involvement in tailings reprocessing
Ghana	62.5	No specific mention of how women are involved. Respondents mentioned women's limited involvement in the mechanized reprocessing of ASGM tailings except as suppliers of tailings feed.
Peru	15	According to UNEP, many of the women in ASGM are only allowed to work as waste rock collectors, who earn, on average, less than minimum wage (UNEP, 2021a). Also, a study by Montt (2018) suggests that air pollution can reveal gender-based inequalities in care—women tend to work less during high-pollution weeks because they must stay with their children, who are unable to go to school.
South Africa	n/a	Has not submitted an NAP. Secondary and primary data from this study report that women are involved in tailings reprocessing, mostly as illegal miners reworking the old tailings of derelict and ownerless mines (Twala, 2023).
Tanzania	25	No specific mention of how women are involved in the UNEP NAP data platform. Data from this study indicates that some women are involved in tailings reprocessing. However, the numbers are low, probably due to difficulties in accessing capital to finance the processing operations.

Source: UNEP, 2023.

5.3 PlanetGOLD's Best Management Practices for Cyanide Use in the Small-Scale Gold Mining Sector

The planetGOLD program's *Best Management Practices for Cyanide Use in the Small-Scale Gold Mining Sector* (2021) is the only other international guidance that is applicable to ASGM tailings management. It focuses on managing the risks of cyanidation in ASGM in countries where it is permitted by law. Although it is based on the International Cyanide Management Code, a voluntary industrial mining protocol that generally targets industrial operators, planetGOLD makes ASGM-specific recommendations for tailings and waste management, namely:

1. ASGM operators should use the lowest possible concentration of cyanide to reduce risks to wildlife from exposure to tailings and to water quality from potential seepage.
2. Ponds and impoundments must be constructed and managed to ensure that rainfall or local flooding does not result in the release of cyanide-contaminated effluent.
3. Tailings ponds and impoundments should be designed to take advantage of natural cyanide degradation processes.
4. To protect groundwater supplies, tailings ponds should be designed using impermeable liners and should be regularly monitored for leaks.

5. Tailings ponds containing cyanide should have proper signage, be fenced off, and be covered with impermeable lining to protect human and animal health.
6. Governments, ASGM stakeholders, and financial institutions should work together to develop funding for plant decommissioning.
7. ASGM regulators must enforce mine-closure and cyanide plant–decommissioning policies and regulations, and these should be tailored for the ASGM sector.
8. In addition to following planetGOLD's tailings-specific recommendations, the guide suggests that ASGM operators should observe health and safety protocols when working with cyanide, mine sites should create emergency response plans, and miners should be provided with technical and safety training on the responsible use of cyanide.

5.4 Regional ASGM Tailings Frameworks

This section highlights policy frameworks within the Africa Mining Vision (AMV), which is a continental initiative for the mining sector. Additionally, it provides an overview of the regional mining frameworks applicable to ASGM tailings management and reprocessing across African, Asian, and Latin American and Caribbean countries.

5.4.1 The AMV

The AMV is the primary policy framework created by the African Union to help its member states maximize their mineral resource wealth in a sustainable manner. The AMV recognizes the importance of ASM as a driver for economic growth but also acknowledges that ASM uses rudimentary methods and equipment, as well as techniques that are inefficient and hazardous to the environment and human health. The AMV does not explicitly address tailings or mine-waste management but does reinforce the need for both appropriate ASM legislation and formalization to ensure ASM operators abide by sound environmental practices and health and safety protocols. The AMV has a few implementation tools. The key one of relevance to tailings management is the African Minerals Governance Framework, whose main objective is "to deepen the commitment to the AMV by serving as a monitoring tool to help African countries determine their progress with regards to realising the transformative ambitions of the Vision" (Economic Commission for Africa, 2017). Even though the African Minerals Governance Framework is not explicit about ASGM tailings management and reprocessing, its provisions do cover the subject under the pillars on "environmental and social issues" and "artisanal and small-scale mining," with clear assessment frameworks.

The African Minerals Development Centre, the implementing agency of the AMV, created an ASM policy template guidance for national framework development aligned with the principles espoused in the AMV (n.d.). In reference to waste and tailings management, the policy guidance acknowledges the environmental challenges associated with ASM, specifically that miners use pollutants and release processing waste into the environment, and that operators are not expected to have mine-closure plans and do not carry out rehabilitation activities. To remediate these practices, the African Minerals Development Centre (n.d.) recommends that ASM policies should be aligned with national environmental legislation; ASM miners should receive training on environmental management; local governments should monitor environmental compliance; and ASM policy should be climate responsive.

5.4.2 Regional Blocs

Regional blocs, also known as regional economic communities or regional organizations, are groups of countries within a specific geographic region that come together to promote economic integration, trade, and cooperation. These blocs often have their own decision-making bodies and mechanisms for creating and implementing policies and regulations. Laws or regulations adopted by regional blocs can have a significant impact on member countries' legal frameworks and practices. Appendix 1 examines and details the provisions related to ASGM tailings management within the protocols of the regional blocs in Africa, Asia, and Latin America. Gender is not typically included in regional frameworks (Box 8).

BOX 8. GENDER AND REGIONAL TAILINGS GOVERNANCE

Most regional organizations do not provide guidance on sound tailings management, and as a result gender-based considerations are not and cannot be mainstreamed. The AMV does state that the shared continental vision for mineral resource development is "a sustainable and well-governed mining sector that effectively garners and deploys resource rents and that is safe, healthy, gender and ethnically inclusive, environmentally friendly, socially responsible and appreciated by surrounding communities." This is inclusive of women-friendly and environmentally friendly practices that could apply to waste management. The Association of Southeast Asian Nations (ASEAN, 2022) provides that members must include mainstreaming gender-related considerations into all aspects of mine planning, operation, and closure to minimize negative impacts and maximize benefits. The Economic Community of West African States (ECOWAS) Model Mining and Minerals Development Act (ECOWAS, 2019) mentions that member states shall address gender-related issues along the entire value chain, and the East African Community Mining Bill (2017) recommends that members must ensure that all persons, in particular women, undertaking any mineral activity or mining operation are respected and protected. Although neither of these pieces of legislation directly applies to tailings management, they can be considered relevant to all mining activities, including waste management.

Overall, tailings management predominantly falls into regional environmental protection frameworks or waste-management strategies. Specialized guidelines for ASGM tailings disposal or management have not been developed at a regional level.

5.5. National ASGM Frameworks

National laws have a great impact on the sound management of ASM and the mitigation of the sector's negative impacts. They set out the duties and responsibilities of each of the ASGM stakeholders and form the basis for institutional support. This section explores the national frameworks of selected countries from Africa, Asia, and Latin America. The countries included in this section were chosen because the researchers were able to collect primary data through government surveys and/ or interviews with local experts.

Appendixes B and C provide a comprehensive overview of the legislative frameworks for tailings management, especially legislation applicable to ASGM, in various gold-producing countries worldwide, and Appendix C. This data is sourced from the legal statutes of each respective country and collected through interviews with government authorities and local

experts. Supplementary information from a literature review enhances the comprehensiveness of this overview.

The analysis of national frameworks was carried out on 13 of the 15 countries listed in Appendix B due to the limitations of publicly available information specific to ASGM tailings management.

Here is a summary of the key findings from the analysis:

1. The use of mercury by ASGM operators is prohibited in most of the countries assessed, except for Nigeria, Tanzania, Ghana, Peru, and Honduras.
2. The use of cyanide by ASGM operators is prohibited in approximately half the countries assessed: Mongolia, Ghana, Burkina Faso, Tanzania, South Africa, Kenya, and Cameroon.
3. All mining codes incorporate regulations related to tailings management. However, most countries' legislation does not encompass tailings-management provisions specific to ASM.
4. Ghana, Tanzania, Colombia, and Chile have created legislation that explicitly applies to ASM permit holders. Legislation concerning the responsibilities of ASM operators in Kenya, Tanzania, the Philippines, and Mongolia appears to be ambiguous.
5. Most countries mandate ASM operators to submit either an environmental impact assessment (EIA) or an environmental and social impact assessment (ESIA) as a prerequisite for their applications before commencing mining activities. However, these requirements are typically applicable solely to small-scale operators and normally not for artisanal mining permits. Many of the country-mandated environmental plans require the applicant to submit a rehabilitation plan or a waste-management plan. Nigeria, Cameroon, and Kenya also require applicants to pay a rehabilitation fee or purchase a bond along with the EIA; in the event that the mine operator is unable to perform rehabilitation activities, this bond can be used by the government to rehabilitate the mine site.
6. The establishment of a state-financed rehabilitation fund that can be used to rehabilitate mining sites is included in the legislation of Cameroon, the Philippines, and Mongolia.
7. Nigeria and Cameroon have also created legislation that allows enforcement agencies to levy fines on operators that pollute or do not respect the environment.
8. Kenya, Tanzania, Burkina Faso, Ghana, the Philippines, and Mongolia have created specific legislation that allows for the (re)processing of mine tailings, including the establishment of permitting systems.
9. While the laws related to the management of ASGM tailings can be vague and are not always tailored specifically to ASM, they do exist. However, the country examples highlight that despite the presence of such legislation, its effectiveness is impeded by the informal nature of the sector and the absence of robust enforcement mechanisms.

The remainder of this section provides a detailed analysis for each of the 13 countries.

Brazil

ASGM tailings management in Brazil is provided in:

- Decree-Law No. 227/1967 (Mining Code)
- Decree No. 9,406/2018 (Regulation to Mining Code)
- Federal Law 12.305/2021 (National policy for solid residues management)
- Resolution ANM 85/2021 issued by the National Mining Agency (2021)
- Resolution ANM 68/2021 (Regulation for mine closure plans)

Brazilian mining activities are regulated by Decree-Law No. 227 of February 28, 1967, which established the principles and guidelines for mining exploration, as well as the state regime and supervision ("Mining Code"). Mining activities must also comply with Brazilian Federal Constitution, Decree No. 9,406, of June 12, 2018, which regulated the Mining Code; other laws and decrees; and all the ordinances and resolutions issued by the Ministry of Mines and Energy and the National Mining Agency (ANM).

ASM activities are subject to specific regulations and policies and are categorized in the general mining laws and policies (see Box 9). The Mining Code does not expressly address the ownership and use of tailings and waste derived from mining activities. However, Resolution ANM No. 85/2021 establishes that tailings and waste materials constitute an integral part of the mine from which they were generated, even if they were disposed of outside the area of the mining title. If tailings are disposed of in areas encumbered by third parties and are not linked with a mining title, a new mining title needs to be granted for the use of those areas (Article 5).

On the other hand, if the operator intends to economically exploit any other mineral substance not covered by the mining title, including minerals within the tailings or waste materials, an Economic Use Plan may be necessary. The Economic Use Plan must include the construction of structures for the disposal and reuse of these materials, according to Resolution ANM 85/2021 (National Mining Agency, 2021).

If tailings and waste contain a mineral different from the originally requested mineral, "the mining title must incorporate the new mineral, observing different technical elements established in the Annex of the Resolution" (National Mining Agency, 2021).

In the case of reusing tailings and waste materials, "50% of the royalty rate can be deducted when these materials include other minerals" (National Mining Agency, 2021).

BOX 9. CASE STUDY: INSTITUTIONAL SUPPORT FOR ASGM TAILINGS MANAGEMENT IN LOURENÇO DISTRICT, BRAZIL

An example of institutional support for ASGM tailings management is the case of Lourenço District. ASGM mining at Lourenço is carried out under the supervision of a cooperative formed in 1995, after an LSM company ceased its activities in the region, where it had operated since 1980 and produced more than 20 tonnes of gold.

Currently, the cooperative has 708 members (17% women and 83% men). As part of its mining title, the cooperative owns historical tailings that can be reprocessed through a coexistence agreement with a conventional gold mining company. An assessment of a tailings deposit at Lourenço was carried out as part of a capacity-building collaboration sponsored by the World Bank's Extractives Global Programmatic Support program (NAP. Mineração / USP, 2022).

The assessment of historical tailings was based on a sampling campaign carried out on two ASGM tailings deposits at Lourenço. Samples were collected from a drilling grid of 20x40 metres, with 199 holes drilled using a mechanical auger drill. The samples were homogenized and shipped for lab analysis of gold.

The results of the analysis were processed to build into a preliminary geological model of the tailings deposits. The assayed grades were as high as 1.40 g/t, and the assessment of the deposit resulted in contents of nearly 68,000 ounces of gold. The findings of this preliminary assessment are currently being used by the Lourenço cooperative to establish cooperation with an LSMO to set up a tailings-reprocessing and land-reclamation project.

Burkina Faso

ASGM tailings management in Burkina Faso is provided in:

- Law 036-2015/CNT onthe Mining Code (Loi 036-2015/CNT portant code minier)
- Law no. 006-2013 on the Code for the Environment (Loi no. 006-2013 portant code de l'environnement)Decree 2018-1017 (November 16, 2018) for the organization of artisanal miners (Décret 2018-1017 du 16 novembre 2018 portant organisation des exploitations artisanales)
- Decree 2017-047 Artisanal mine sites rehabilitation fund (Décret 2017-047 Fonds de réhabilitation des sites miniers artisanaux)
- Decree 2015-1420 Establishing ANEEMAS: The National Agency for the Supervision of Artisanal and Semi-Mechanized Mining Operations (Décret 2015-1420 Agence Nationale d'Encadrement des Exploitations Minières Artisanales et Semi-mécanisées [ANEEMAS])

Burkina Faso is currently in the midst of a gold rush, with gold being the country's primary export. It is estimated that artisanally produced gold exceeds that from the industrial sector (planetGOLD, n.d.). In recent years, the country has made efforts to formalize the sector, although these efforts are increasingly compromised by security concerns. Under Burkina Faso's mining law, no artisanal mining can occur legally without a mining permit. ASGM in Burkina Faso is subject to three types of permits and authorizations, which cover artisanal mining, semi-mechanized mining, and small-scale mining (Decree 2018-1017 [November 16, 2018] for the organization of artisanal miners; Decree 2017-047 Artisanal mine sites rehabilitation fund).

The Burkina Faso Mining Code, as outlined in mining law, also provides for the reprocessing of artisanal mining heaps, dumps, and tailings from mines and quarries. This reprocessing consists of mine waste (spoils, waste, and tailings) being treated and valorized either by the miners themselves or through a third-party permitting system (Article 65). The mining law contains provisions for the management of mine waste, the rehabilitation of mine sites, and the reprocessing of tailings for all types of mining operations. However, it does not specify the obligations of ASM operators with regard to tailings management. Nonetheless, it does emphasize that ASM operators are required to conduct their activities with consideration for the environment. Holders of ASM permits, which cover a range of activities, including small-scale mining, semi-mechanized operations, reprocessing of mine and quarry tailings, dumps, and spoil heaps, as well as artisanal mining, are mandated to adhere to an environmental commitment document (cahier de charge; Article 97) under the mining law.

Additionally, the Mining Code, in accordance with the mining law, explicitly bans ASM operators from using chemicals, specifically mentioning mercury and cyanide (Article 77). It also enforces ASGM and reprocessing title holder compliance with public health and occupational safety standards and upholds environmental preservation (Article 76). The mining law also institutes a bond for environmental restoration (Article 78) and includes provisions for the creation of a fund to rehabilitate artisanal mining sites (Article 28). These mining law provisions are reiterated in the environmental commitment document (cahier de charge). Specific details are provided in Decree 2017-047.

In 2015, Burkina Faso established a specialized agency responsible for overseeing and promoting the artisanal mining sector (Decree 2015-1420 Establishing ANEEMAS: The National Agency for the Supervision of Artisanal and Semi-Mechanized Mining Operations [Décret 2015-1420 Agence Nationale d'Encadrement des Exploitations Minières Artisanales et Semi-mécanisées (ANEEMAS)]), which has been operational since 2018. ANEEMAS's scope of activity encompasses both administrative and regulatory oversight of artisanal mining, as well as regulation of commercialization and environmental management under the mining law. ANEEMAS's status and attributions were expanded on August 10, 2023, to become the National Company of Precious Substances, granting it the ability to process minerals produced in Burkina Faso and establish a refinery, among other initiatives. Burkina Faso also created its first mine tailings processing facility in February 2024 (Ministry of Energy Transition, Mines, and Quarries, 2024).

Under the ANEEMAS regulations and in accordance with the Decree 2018-1017 (November 16, 2018) for the organization of artisanal miners (Décret 2018-1017 du 16 novembre 2018 portant organisation des exploitations artisanales), a new system was introduced in 2022. This system involves transferring the responsibility for managing ASGM sites to individuals or entities through the signing of site-management agreements. As of this writing, 135 sites have been subject to such agreements. The ASGM mine-site agreement is signed with the site manager and includes a clear commitment to comply with environmental regulations and labour laws and an acceptance of future liability in the event of damages (Article 4 of the model agreement). This is understood to include the oversight of sound tailings management by ASGM organizations and enforcement of the prohibition of the use of mercury and cyanide in formalized sites.

Within these formalized sites, site promoters and managers are responsible for the management of the tailings, including depollution. In the management agreements, tailings and mine wastes must be treated in designated treatment zones. Unfortunately, the reality

is that miners illicitly transport the residues, moving them away from controlled sites to use prohibited chemicals for primary or secondary extraction.

In Burkina Faso, there is an interesting linkage between mercury and financing; it is common for informal financiers to provide mercury to secure access to gold from ASGM miners (Bugmann et al., 2022). As a result, mercury use is widespread, despite the creation of legislation banning it. The use of cyanide is also prevalent in tailings reprocessing operations; a study conducted in various ASGM areas around the country revealed that tailings processing plants were hotspots for mercury and cyanide contamination, including of soil and water (Brugger et al., 2018). The operationalization of legal frameworks has been challenging, and chemical use is dangerously widespread. However, the Burkina Faso government is participating in the planetGOLD project to implement its NAP and reduce hazardous chemical use.

Cameroon

ASGM tailings management in Cameroon is provided in:

- Law No. 2016/017 of 14 December 2016 relating to the Mining Code
- Law No. 96/12 of 05 August 1996 Relating to Environmental Management (Loi cadre relative à la Gestion de l'Environnement Loi n°96/12 du 5 aout 1996)

None of Cameroon's laws specifically contain a standalone provision for ASM tailings management. Rather, the Mining Code states that non-industrial operators (i.e., artisanal miners) are exempt from having to provide an EIA, whereas all other miners have to conduct an ESIA and a hazard and risk assessment. They must develop an environmental management plan. Each operator, including ASM, is responsible for the restoration, rehabilitation, and closure of a mine site (Article 136 of the Mining Code). "Title-holders and authorizations must, in view to ensuring the rational exploitation of mining resources in harmony with environmental protection, ensure (…) the disposal of non-recycled waste in an environmentally appropriate manner, (…) the management of waste in accordance with current legislation and regulations" (Article 137 of the Mining Code). "Holders of mining permits may choose to pay the financial cost of rehabilitation, which can be carried out by the competent Administration" (Law No. 96/12 Of 05 August 1996 Relating To Environmental Management, Article 37). The Mining Code also states that the regulator can leverage fines of more than XAF 10,000,000 on any operator that does not respect the environment in accordance with national law. Article 235 of the Mining Code also enables the creation of a rehabilitation fund for ASM operators, which at the time of writing has not been established. To operationalize the mining law and advance the formalization of the sector, the Cameroonian mining authorities are required to conduct biannual mine-site visits.

In Cameroon, gold is predominantly mined by ASM, and it is common for ASGM operators to channel tailings from washing tables directly into rivers, which causes sedimentation and siltation that affect aquatic life and other livestock. The tailings that have been dumped into the river that runs through the Ngoyla-Mintom forest massif area have impacted water quality. In the same area, the metal trace elements found in tailings have also impacted the soil quality (Funoh et al., 2017). An analysis conducted in 2021 of the water and sediment of the Lom River beside an ASGM operation found that concentrations of nickel, cadmium, iron, and mercury all exceeded the WHO-recommended limits (Ngounouno et al., 2021). This finding indicates that the mine waste is not being managed in accordance with the law but is instead

being dumped and is seeping into the waterbody. Additionally, finding mercury (which is prohibited under the Cameroonian Mining Code) and cyanide indicates that ASGM operators are illegally using toxic chemicals without taking the proper safety measures. This finding was further supported by a WHO study that found that the hair of 71% of ASGM miners in Batouri, a town in eastern Cameroon, contained mercury that far exceeded acceptable limits; the amount of mercury indicated that the majority of these miners were exposed to mercury between 2 and 10 years of age, which puts them at risk of acute mercury poisoning (Kaslow, 2022).

The Government of Cameroon has created mining and environmental legislation that provides for proper tailings management. Except for the creation and submission of an EIA (Article 135), from which artisanal mine operators are exempt, the legislation applies to all categories of mining title holders. The Cameroonian Mining Code also financially disincentivizes improper environmental actions, including inappropriate tailings management. Although the Mining Code provides for the creation of a rehabilitation fund, it is currently inactive. It is evident that the Government of Cameroon has created a legislative framework to encourage proper tailings management. However, as illustrated by the examples above, tailings have not been managed with the appropriate level of care, which could be attributed to poor enforcement mechanisms.

Colombia

ASGM tailings management in Colombia is provided in:

- Mining Code (Law 685/2001)
- Law 2250/2022

The main law governing the mining sector is the Mining Code (Law 685/2001) and its corresponding regulations. Colombia has an environmental regulatory framework, which includes specific regulations for exploration and exploitation activities, as well as for management of tailings and other related activities.

In 2022, the Colombian government issued Law 2250 for the formalization and legalization of ASM activities in the country. This law provides different rules for commercialization of minerals and for environmental and circular economy in the mining sector.

Law 2250 promotes the circularity of material flows and the extension of their useful life through the implementation of technological innovation, alliances and collaborations between actors, and the promotion of business models based on sustainable development concepts. Article 12 of the Law states that:

In areas where mining exploitation activities are carried out, authorized under the prerogative for formalization processes, or mining titles in the exploitation phase granted for the exploitation of precious metals (gold, silver, platinum), precious and semi-precious stones, construction materials and other minerals susceptible to being reprocessed, which have an environmental instrument, may deliver the waste and tailings resulting from the extraction of the mineral to third parties, in order to be used by companies, associations or unions that have experience in mining work. For this purpose, the mining owner, or the miner with prerogative under formalization processes and the third party interested in taking advantage of the sterile material must sign a private document specifying, among other aspects, the conditions of delivery of material, transportation, and place of use thereof. In the case of

mining titles of metals and precious metals (gold, silver, platinum), the secondary use and marketing carried out by companies, associations or unions must have, for the declaration of payment of royalties, the laboratory certificate established by the approximate content of metals and precious metals, as applicable.

As per Law 2250, the environmental authority will monitor and control reprocessing activities within the framework of its powers, carrying out inspections in which it will verify that the amount of secondary use reported is lower than the product reported by the mining owner in its quarterly royalty declaration, in accordance with the provisions for the commercialization of minerals. The case study below (Box 10) presents an example of responsible recovery of mercury from contaminated ASGM tailings.

BOX 10. CASE STUDY (COLOMBIA): CIRCULAR ECONOMY AND RESPONSIBLE RECOVERY OF MERCURY FROM CONTAMINATED ASGM TAILINGS

ASM is important for Colombia's social and economic growth and represents more than 70% of the country's total gold production. However, these operations use mercury to extract the gold from the ore. In 2018, the Colombian government banned mercury in gold mining to reduce its impact on the environment and reduce mercury exposure to miners and the general population. In this sense, Colombia has taken steps to eliminate the use of mercury from ASGM processes. To achieve this goal, the government has worked with Pure Earth, an organization focused on developing evidence-based solutions to mercury and lead poisoning and pollution. Pure Earth's innovative technique uses copper plates to decontaminate mercury-filled waste tailings from ASGM. The copper plates are set in a stepwise fashion and covered with silver. These plates then capture drops of elemental mercury that adhere to them due to the affinity of silver for mercury. Both silver and mercury are transitional metals and have the ability and tendency to form alloys, which makes the capture possible (Pure Earth, 2022).

The project started in 2022 in the department of Antioquia and seeks to develop a model for the responsible and profitable recovery of mercury and gold from tailings, based on previous experiences in experimental processing plants. The main objective of the project is to develop technical protocols to safely handle, store, and dispose of mercury recovered or seized from subsistence and small-scale mining activities, including contaminated tailings, and mercury captured from amalgam burning (Pure Earth, 2022). Through this technology, artisanal and small-scale miners can eradicate the use of mercury, protect the livelihoods of their communities, and help Colombia pursue green growth.

Ecuador

ASM tailings management in Ecuador is provided in:

- Law 45/2009 "Mining Law"
- The Ministerial Agreement No. 37/2014, modified in 2016 "Environmental Regulations for Mining Activities"
- The Executive Decree No. 120/2009 "Special Regime for ASM activities"
- The Ministerial Agreement 15/2015 "Guideline for beneficiation plants and tailings"

The Ecuadorian Mining Law (Law 45/2009) regulates the activities that mining operators conduct as they explore and exploit mining concessions and process and commercialize minerals. The Law prioritizes the use of land where the mining concessions are located and regulates environmental aspects in connection with the exploration and exploitation of mining concessions.

A specific national inventory for ASGM is provided in the Mining Law and its rules, which include a record of productive associations. Furthermore, in 2009, the government issued Executive Decree 120, through which a special regime for ASM was established. Despite the presence of such regulations, their implementation depends on the continuation of the ASGM sector formalization initiatives by the government.

Regarding management of tailings, the Ministerial Agreements No. 37/2014 and 15/2015 set the specifications for environmental protection and establish guidelines for beneficiation plants and management of tailings for mining activities in the country. There is no distinction between the different scales of mining and there are no specific rules for the ownership of tailings.

Ghana

ASGM tailings management in Ghana is provided in:

- The Minerals and Mining Act, 2006 Act 703
- The Environmental Assessment Regulations, 1999
- The Minerals and Mining (Health, Safety and Technical) Regulations, 2012 (L.I. 2182)
- Regulation 71—Plans of Dams, Lakes, Waste Dumps
- Regulation 107—Mine Waste Rock Dump
- Regulation 108—Discontinuance of Waste Dumps
- Regulation 241—Environmental Management of Processing Plant
- Regulation 242—Tailing Pipelines of Processing Plants That Use Cyanide
- Regulation 265—Tailings Storage Facility Impoundment
- Regulation 286—Closure of Waste Dumps
- Regulation 480—Environmental Protection Provisions for Small-Scale Mining
- Regulation 515—Code of Safe Working Practice

Ghana's Minerals and Mining Act (2006) requires all licence holders to produce minerals by an effective and efficient method, to observe good mining practices and health and safety rules, and to pay due regard to the protection of the environment during mining. Additionally, the Environmental Assessment Regulations (1999) require mining operators and processing permit holders with a mining lease of more than 10 hectares to submit an EIA. The key guidance for tailings management and all other technical aspects of mining in Ghana comes from the Minerals and Mining (Health, Safety and Technical) Regulations (2012), which makes direct reference to small-scale tailings management. Regulation 472 sets out the general duties of small-scale miners, including that obtaining a small-scale mining operating permit requires the applicant to submit a plan showing how they intend to carry out the mining operations and how they intend to rehabilitate the mined area. A holder of a small-scale mining licence must rehabilitate and revegetate land that is no longer used for mining within 1 month after

termination of activities (Regulation 480—Environmental Protection Provisions for Small-Scale Mining). The Chief Inspector of Mines is also required to conduct a final inspection of the closing mine after rehabilitation work is completed and shall, if satisfied with the rehabilitation, issue a rehabilitation certificate. The Regulation also provides a wide array of technical guidance on tailings management for all classes of mine operations, including on plans for dams, lakes, and waste dumps; on mine waste-rock dumping, discontinuance, and closure; on safe working practices; on environmental management of processing plants; on tailings pipelines of processing plants that use cyanide and tailings storage facility impoundment, among others. Ghana's Mining Code also makes provisions for processing but maintains that permit holders cannot commence processing activities unless a plan detailing the layout of the processing infrastructure (including water sources and tailings ponds and storage facilities) has been submitted to the Chief Inspector of Mines. The law also states that small-scale operators may purchase mercury from authorized mercury dealers in quantities that are reasonably necessary for mining activities. Ghana also has created an impressive decentralized system for monitoring and enforcement of small-scale mining; it has nine Minerals Commission District Offices that are complemented by regional and zonal Environmental Protection Agency offices. This system is meant to enhance governmental oversight of small-scale activities.

Ghana is Africa's largest gold producer, and ASGM has been practised for centuries. In the 1980s, the Government of Ghana regularized ASM; however, approximately 85% of the ASM operators are unlicensed (Abdulai, 2017). The ubiquitous informality of the sector is driven by the high economic and opportunity costs related to formalization, and has created a gap in the enforcement of legislation, as enforcement agencies choose to not engage with illegal entities that are sometimes armed and backed by powerful, dangerous individuals (Adu-Baffour et al., 2021). Coupled with the legal use of mercury, this informality and lack of enforcement has resulted in poor tailings management. In southwestern Ghana, where informal gold mining is prevalent, the Water Resources Commission reported that 60% of the waterbodies were polluted by ASGM activities (Mubarik, 2017). Illegal ASGM operators, known locally as "galamseys," often preserve tailings in open pits close to waterbodies; they tend to abandon these tailings, and the runoff has been known to destroy nearby agriculture and biodiversity, as witnessed in Prestea (Mensah & Tuokuu, 2023). Ghanaian farmers are being affected by ASGM tailings mismanagement, as the resulting land degradation and polluted water sources have made it so that they are unable to cultivate crops like cocoa (Siaw et al., 2023).

Despite the creation of legislative frameworks accompanied by robust technical regulations explicitly aimed at ASM and enabling enforcement structures, Ghana has struggled to formalize the majority of ASM miners and curb unauthorized mining and the poor practices that accompany it.

Kenya

ASGM tailings management in Kenya is provided in:

- The Mining Act, No. 12 of 2016
- The Environmental Management and Coordination Act 1999 (EMCA), Amended 2015

In relation to ASGM, artisanal permit holders must mine and produce minerals effectively and efficiently in a manner that observes good mining practices and health and safety rules and

pays due regard to the protection of the environment (Article 98 of the Mining Act). To ensure that mine closure is properly performed, license holders have to provide a bond or some other form of financial security to sufficiently cover the costs associated with the implementation of their environmental and rehabilitation obligations as stated by the law (Article 131 of the Mining Act). Gold mining operations must submit EIAs (Section 58 of the Environmental Act). Sections 72 and 87 set up the conditions for mine operators to manage mine waste by not polluting water bodies and improperly handling and disposing of waste. In addition, any person intending to transport waste, operate a waste disposal site or plant, or generate hazardous waste shall apply for a waste licence prior to starting operations (Section 88). The Mining Code of Kenya also explicitly provides for tailings reprocessing under a permit, which allows the holder to work a mine dump or mine waste and tailings on the land but not to undertake any other mining operations.

ASM in Kenya gained legal recognition only with the passing of the Mining Act in 2016; prior to that legislation, ASM was unregulated and, as a result, remains largely informal. Nonetheless, ASGM forms a substantial part of the national mining industry—it is estimated that ASGM contributes USD 224 million annually to the country's economy, which is over half the total GDP percentage of mining (Casey, 2021). Although the use of both mercury and cyanide by ASGM operators is banned, the Government of Kenya in its NAP submission observed that the cyanidation of tailings is increasing, and most cyanide processors do not separate mercury-laden tailings from mercury-free tailings. Furthermore, the government confirmed that the practice of cyanide leaching of mercury-contaminated tailings is prevalent in Kenya (Ministry of Environment and Forestry, 2022). A study conducted in the ASGM counties of Kakamega and Vihiga confirmed that poor tailings management and chemical seepage have resulted in significant amounts of soil and water pollution, rendering the drinking water unsuitable for human consumption (Ondayo et al., 2023). In Lolgorian, the improper management of tailings has impacted agriculture: mercury-contaminated tailings have been dumped near farming lands and mercury has bioaccumulated in the soil and degraded its quality and fertility (Tampushi et al., 2022). The environmental and corollary socio-economic impacts of ASGM have caused rising tensions between Kenya's farmers and miners. In 2019, a task force was established by the district commissioner in Migori County that closed over 40 gold mining and processing plants after finding that the mines were discharging tailings into the River Kuja and River Migori that feed into Lake Victoria (Mbula & Byron, 2019). The mines and processing centres were found to be illegally using cyanide that had been illegally imported from Tanzania.

Kenya's national legislation covers the management of mine waste and tailings and the requirements for rehabilitation and restoration after mine closure. However, this legislation is vague regarding the obligations of ASM operators. The mining law and environmental code implement certain obligations for all mine operators, including that they are required to conduct an EIA and take out a financial bond or other form of financial security to cover reclamation activities. Kenya's Mining Act (2016) also explicitly provides for a permit for the processing of tailings or mine waste in addition to primary extraction licences (Article 10). Despite the creation of legislation, the widespread informality of Kenya's ASM sector has thwarted the uptake of sound tailings-management practices, which has resulted in conflict between miners and farmers. It is evident that the Government of Kenya recognizes that ASGM tailings are not being managed properly, and the actions taken in Migori County indicates that there is a willingness to enforce the laws.

Mongolia

ASGM tailings management in Mongolia is provided in:

- Mining Code (amended in 2010)
- ASM Regulation 308 (2010)
- The Regulation on Extraction of Minerals by Artisanal and Small-Scale Mining (2017), (ASM Regulation 151)
- Joint Order of the Minister of Mines and Heavy Industry, Minister of Environment and Tourism, dated August 28, 2019, numbered A/181 and A/458, regarding the Approval of Rehabilitation and Closure Procedures for Mines, Mining, and Concentration Industries
- Decree #A/04 of Ministry of Environment and Tourism (2014)
- Environmental Protection Law of Mongolia (1995)

In 2010, the Government of Mongolia amended its Mining Code to officially recognize ASM. ASM Regulation 308 sets out the responsibilities and duties of ASM operators, including a requirement that ASM permit holders submit an environmental restoration report, but it does not include any reference to tailings management. ASM Regulation 151 (2017) falls short in adequately addressing the legal obligations of artisanal miners. Orders A/181 and A/458 (2019) provide details of the documents required for the closure management plan but do not include waste management. Additionally, Decree #A/04 requires ASM operators to deposit funds in the soum (or district) environmental rehabilitation fund as collateral prior to commencing extraction in case they do not rehabilitate the area; however, information about this fund is lacking.

The Government of Mongolia has been proactively formalizing the sector for the last 13 years, yet the financial costs around permits and the taxes levied on ASM operators have disincentivized miners from becoming formal. Generally, Mongolia is considered to have made significant strides toward formalization (Levin-Nally & Jacot, 2019). Both the reviewed literature and primary data suggest that formalized ASGM operations generally manage their tailings. However, there is no available literature on the impacts of Mongolia's national legislation on tailings management.

The legal framework has gaps, as waste management and environmental protections are not adequately covered by the law. The framework does, however, require ASM operators to contribute to a rehabilitation fund prior to commencing operations, which is used to restore mined-out land in the event that ASM operators are unable to do so. Financial information related to this fund is unreported; it is, therefore, difficult to ascertain how the fund is being used or the impact it has had. The Mongolian government has created a law that allows for the establishment of processing plants, has become a signatory to the Minamata Convention, and has developed and approved an NAP. As a result of the mercury ban, the government established centralized processing centres to assist ASGM operators in the safe processing of their gold and tailings.

Nigeria

ASGM tailings management in Nigeria is provided in:

- The Minerals and Mining Act (2007)
- The Minerals and Mining Regulations (2011)

- The Environmental Impact Assessment Act (1992, as amended by EIA Act CAP E12 LFN 2004)
- The National Environmental (Mining and Processing of Coal, Ores and Industrial Minerals) Regulations, 2009 S. I. No. 31

Mining laws apply to all categories of mining title holders and do not differentiate or make any exceptions for ASM.

The Minerals and Mining Regulations of 2011 states on tailings disposal that: No mineral title holder shall, without the permission of the Ministry deposit tailings in any natural watercourse (Article 9.20 and the Minerals and Mining Act of the 2007 adds that "the Minister may by regulations prescribe the quantity of tailing[s] that may be deposited in any natural watercourse by a lessee," (Article 126). The Minerals and Mining Regulations (2011) state a general rule that "every title holder" is required to: (a) provide an effective management system for their tailings throughout the period of operation; (b) make adequate arrangements to protect the general public, particularly the host community, from the risks associated with tailings storage; (c) ensure that tailings are properly treated before they are discharged into the watercourse; (d) ensure proper treatment of mine waste before final disposal to prevent air and water pollution and contamination; and (e) provide adequate measures to minimize the effects of air pollution" (Article 125).

The Regulations also require all licence holders to submit an EIA and an Environmental Protection and Rehabilitation Fund Implementation Timetable prior to starting mining operations (Article 154). However, the Environmental Impact Assessment Act (1992) limits the requirement to submit an EIA to mining leases that cover ''more than 250 hectares or ore processing including (...) gold" (Article 11, a & b).

All leaseholders are also required to carry out effective rehabilitation of the mined-out areas to the satisfaction of the Mines Environmental Compliance Department and pay a prescribed rehabilitation fee proportionate to their profits to defray further costs of rehabilitation and reclamation (Article 90 of the Minerals and Mining Act, 2007).

The government of Nigeria is required to provide extension services, including by providing an EIA report and detailed guidelines on waste and tailings disposal (Article 91 of the Minerals and Mining Act, 2007). Tailings containing heavy metals or other toxic materials or substances shall be treated and disposed of in a government-approved designated site or landfill (Article 10 of the National Environmental Regulations, 2009 S. I. No. 31). Nigeria's environmental code also employs a polluter-pays principle that requires mine owners or operators to take out an insurance bond and submit a reclamation plan containing details about the tailings.

The legal frameworks on tailings management have had limited enforcement. In northern Nigeria, poor extraction, processing, and tailings-management practices have resulted in lead pollution of soil exceeding 100,000 ppm—250 times greater than the U.S. Environmental Protection Agency's recommended levels (Environmental Law Institute, 2014). Prior to the adoption of the mining regulations, in 2010, a lead-poisoning outbreak caused by mine waste claimed the lives of more than 400 children in artisanal gold mining villages in Zamfara state (Bartrem et al., 2022). Even now, the majority of ASGM operators in northwestern Nigeria are informal, and they operate without any understanding of the proper management of tailings and waste water or the impacts of tailings mismanagement. Miners on the Opo River, for example, have disrupted and polluted waterways by damming the river to wash raw gold

and tailings (Adebayo, 2022). Samples taken from the Osun River (which is part of a United Nations Educational, Scientific and Cultural Organization World Heritage Site) showed that the water was contaminated by mercury, lead, and cyanide, the use of which is permitted in Nigeria (Adebayo, 2022). In the Anka ASGM region, soil and water samples indicated an extremely high level of contaminants that pose ecological and health risks (Adewumi & Laniyan, 2020).

Nigeria's mining laws and attendant environmental laws provide for the proper management of tailings. Through its legislation, the government of Nigeria supports sound tailings management through extension services and the creation of state-run or government-authorized facilities. The law also requires that mine operators take out a reclamation bond to ensure that money is allocated to rehabilitation prior to starting operations. Although the government of Nigeria has created a robust legislative framework, its impacts have been constrained by the unrestricted use of dangerous chemicals and the inadequate enforcement of these laws has resulted in environmental and health risks.

Peru

ASGM tailings management in Peru is provided in:

- Supreme Decree N° 014-92-EM, 2022 (General Mining Law)
- Law 28271 (Regulation of the identification of environmental impacts of the mining activity)
- Law 31211 (Regulation of the final destination of mine tailings)
- Law 28964 (Regulation of responsibility for inspection of mining activities)
- Law 27651 (National policy for the formalization of the artisanal mining sector)

The legal framework for mining activities is provided by the General Mining Law and its corresponding regulations. Peru also has an extensive environmental regulatory framework, which includes specific regulations for exploration, exploitation, processing, transportation, and storage of minerals, as well as tailings management and reprocessing.

There are no specific regulations for ASGM tailings ownership and reprocessing. The tailings-management regulations are general, and they are applied to all scales of mining.

Peruvian law provides several measures for storage of tailings and other waste products. It is important to mention that the environmental certification of the titleholder could include additional complementary measures for tailings storage facilities. Compliance with all of these measures is overseen by the Environmental Evaluation and Inspection Organism and the Organism for supervision of the Investment in Mining and Energy. In 1997, the World Bank, in collaboration with the Peruvian Ministry of Mines and Energy, published a guide for tailings management (Directorial Resolution No 19-97-EM/DGAA; Ministry of Energy and Mines, 1997). The guide provides orientation for companies, consultants, and other actors involved with mining tailings management. It advises on factors that affect decisions on the selection of methods and technology according to local geography, geology, and climate considerations, as well as the level of complexity, to address tailings-management initiatives. From a regional perspective, another best practices guide that involves ASM tailings management was published by the Environmental Authority of Arequipa Province (2014). This guide proposes standards for management of tailings, including for their physical and chemical stabilization. As discussed by Velásquez et al. (2022), proper management of ASGM mining tailings faces

challenges beyond storage, as operators must consider their impact on the environment and on people's health. Recycling can be an attractive alternative to storage as long as the environmental and health-related considerations are taken into account when reprocessing tailings to produce construction materials and minerals for agriculture applications.

The Philippines

ASGM tailings management in the Philippines is provided in:

- RA No. 7076 (the People's Small-Scale Mining Act of 1991)
- The Presidential Decree No. 1586 (1982): Establishing an Environmental Impact Statement System Including Other Environmental Management Related Measures and for Other Purposes

With regard to tailings management, Presidential Decree No. 1586 (1982) is not explicit and does not outline the duties of the ASM operator, but Section 13 states that the holder of a small-scale mining contract must comply with pertinent rules and regulations on environmental protection and conservation, particularly those on tree cutting, mineral processing, and pollution control. Section 20 of the Act provides for the creation of a People's Small-Scale Mining Protection Fund, from which the national government can support information dissemination and training of small-scale miners on safety, health, and environmental protection, and can establish mine-rescue and -recovery teams. Presidential Decree No. 1586 establishes that any proposed project or undertaking that significantly affects the quality of the environment must submit an environmental impact statement.

ASGM in the Philippines can be traced back to precolonial times, but its proliferation is attributed to the demise of large-scale gold mining, which, like other industries, was a victim of unabated rent-seeking in the 1980s (Verbrugge et al., 2021). The end of LSM had a particularly unique impact on ASGM: first, many members of the former LSM workforce joined the ASGM sector; second, the skilled members of the LSM workforce, such as chemists and engineers, began deploying their skills in ASGM operations. This shift resulted in the adoption of gold processing using cyanide in ASGM and the spread of cyanide processing plants. The introduction of cyanidation meant that latent tailings could now be reworked, and valuable residual gold could be recovered. The early adoption of cyanidation has meant that cyanide exposure is one of the most prevalent hazards in the Philippines' ASGM sector (Leung & Lu, 2022). Many ASGM operators perform cyanidation with their bare hands, which, as tests have shown, has caused their blood cyanide levels to be alarmingly high (Leung & Lu, 2016). In many of the illegal ASGM mines, children as young as 4 years old perform many of the mining activities, including cyanide leaching of tailings (Price, 2015). Unlike cyanide, the use of mercury is banned, but ASGM operators often perform mercury amalgamation and pour the water used to wash the gold amalgam directly into drainage canals that run beside houses. The contaminated water gets flushed into rivers; for example, the Ambalanga River is heavily contaminated by mercury (Maglambayan et al., 2005). In fact, it turned blue in 2017 because of pollution from the dumping of cyanide and cyanide-contaminated tailings, with tests showing that the river contained 2.6 milligrams per litre (mg/l) of cyanide, which far exceeded the water-quality standard of 0.1 mg/l for fresh water (Cabreza, 2017). These transgressions by ASGM miners are generally not addressed, but in 2018, after several environmental incidents in which fish died, the local government in Itogon issued an order to stop all ASGM mining and processing activities in the region. In spite of this action by the government—which

constituted a positive step forward in managing ASGM activities—illegal mining continues (See, 2023).

The national mining framework and attendant environmental legislation of the Philippines do not adequately cover aspects relating to tailings management or the duties of ASM operators. Although the law establishes a fund to support ASM activities, improper chemical use has caused harm to local water systems.

South Africa

ASGM tailings management in South Africa is provided in:

- The South African National Standard SANS 10286
- The Mine Health and Safety Act No. 29 of 1996

South Africa is considered to be a world leader in tailings-related regulations and standards aimed at preventing tailings-dam failures. Due to the proliferation of tailings dams and several tragic tailings spills, the government created The South African National Standard SANS 10286 and the Mine Health and Safety Act No. 29 of 1996 to regulate mine-waste activities. A recent comparative analysis of the Global Industry Standard on Tailings Management (GISTM) and South African national standards revealed that current South African requirements meet or exceed the requirements of the GISTM in most areas (Dladla & Ramsamy, 2022). However, these requirements pertain only to LSM activities and formal mining operations. At present, although South Africa's ASM Policy has been gazetted, national laws are still considered ambiguous with regard to formally regulating ASM activities. No binding legal instruments have been developed to support implementation of the new ASM Policy.

In the absence of appropriate regulation, ASGM tailings management in South Africa can be considered ineffective (if not non-existent) and has resulted in various negative social, health, and environmental impacts.

Tanzania

ASGM tailings management in Tanzania is provided in:

- The Environmental Management Act, 2004
- The Mining Act, Revised Edition, 2019

Primary Mining License (PML) holders[2] are required to submit an environmental protection plan (EPP) within 4 months of receiving their licence (Section 54 of the Mining Act). PML holders are required to stack or dump any mineral or waste product in compliance with the applicable regulations (Section 55). Moreover, licence holders are required to ensure that the production, transport, storage, treatment, and disposal of waste arising from mining operations is carried out in accordance with environmental principles and safeguards prescribed under the Environmental Management Act (Section 107). The Environmental Management Act provides for the management of various types of waste and sets out the obligations for each category. In addition, the Mining Act also provides for a stand-alone processing licence, and a 2019 amendment to the Mining Act allows for tailings to be traded.

[2] The PML is the category of mining licence for mining activities that could be defined as ASM, as per the Mining Act, Revised Edition, 2019.

The Tanzanian government is a frontrunner in ASM formalization and has legally recognized ASM for more than four decades (see Box 11), but due to the high economic costs and due process that accompany formalization, the majority of ASM operators have been unable or unwilling to formalize. Subsequently, the majority of ASGM occurs outside of the scope of the law, and the legislation that was created to manage ASGM is unimpactful. In addition, human rights concerns have emerged around tailings practices. Research found that children between the ages of 12 and 15 were employed in tailings reprocessing. In addition to manually washing and crushing tailings, they were participating in mercury amalgamation processes (Mutagwaba et al., 2018). The use of mercury is widespread in Tanzania's gold-processing regions, even though most of these zones are also close to residential areas. In northwest Tanzania, many ASGM processing operations have amalgamation ponds on site. However, many of them are not properly reinforced, and when it rains, the toxic chemicals run off into natural waterbodies (Merket, 2018). In Tanzania, both the environment and human health have been impacted by improper tailings management, and tailings are being washed into Lake Victoria from the Tanzanian side. This water source is of critical importance to millions of people, particularly as a source of livelihoods. Abandoned tailings dumps cause land degradation and impact the livelihoods of nearby farmers.

The Tanzanian government has delineated the responsibilities of ASM operators. However, when it comes to the management of ASM tailings, Tanzanian laws lack clarity and specificity. Additionally, the implementation of legislation has had minimal influence on how ASGM operators in Tanzania handle tailings, as a significant portion of operators work outside the legal framework. Consequently, there is extensive mismanagement of hazardous chemicals, leading to severe health consequences.

BOX 11. CASE STUDY: INSTITUTIONAL SUPPORT FOR ASGM TAILINGS MANAGEMENT IN TANZANIA

Tanzania has a long-standing tradition of ASGM, and it has arguably the most advanced formalization policies in the region, as evidenced by the creation of legislation to support ASM formalization in 1979 (Kinyondo & Huggins, 2021). The Tanzanian government has shown its commitment to maximizing the socio-economic benefits of ASM through its creation of national frameworks to support and advance ASM operations in the country.

Legislation Related to Tailings

Tanzania's 1998 Mining Act introduced PMLs for small-scale mining. An amended Mining Act in 2010 clarified environmental responsibilities for PML holders, requiring them to submit environmental protection plan (EPPs). Tanzania also introduced a separate Processing License, and in 2019, amendments allowed tailings trading. While Tanzania lacks an explicit framework for ASM tailings management, existing legislation, like the 2010 Amended Regulation, addresses environmental impacts, including tailings management. The 2019 amendment facilitates legitimate tailings trading, potentially leading to more responsible processing frameworks. The Processing License emphasizes high environmental standards for tailings handling.

Extension Services Related to Tailings

In addition to legislative frameworks, the Tanzanian government also provided extension services to ASM operators to aid in responsible tailings management and processing.

The Tanzanian government, with the support of the World Bank, implemented the Sustainable Management of Mineral Resources Project (SMMRP) Phase 1 and 2 from 2009 to 2019. This project provided support for the Tanzanian government to sustainably develop the mining sector, including the ASM subsector. The program did not have a component explicitly focused on tailings management, but many aspects of the SMMRP are related to tailings.

The SMMRP supported the preparation of missing policy and regulatory instruments needed for the sustainable practice of ASM. These included working with the Ministry of Energy and Minerals to simplify the EPP process. The Ministry of Energy and Minerals recognized that it was a challenge for most ASM operators to prepare EPPs as required by law. To help ASM operators overcome this hurdle, the Ministry of Energy and Minerals, together with the environmental regulator (the National Environment Management Council), developed a streamlined EPP for ASM. The World Bank also supported the government to create mine-closure guidelines for ASM; however, these guidelines do not appear to have been adopted.

In 2014, the government extended the mandate of STAMICO to include the coordination and transformation of the ASM sector into a "well-organized, mechanised, productive and environmentally responsive subsector" (Merket, 2018). Since then, STAMICO has provided a wide range of services to ASM operators, including data collection, geological and mineral resource information sharing, market information, and capital. Additionally, STAMICO provides access to processing equipment, and at its three demonstration centres (centres of excellence) in Mbeya and Geita, it provides mineral processing services that include access to a carbon-in-pulp cyanide-processing plant. However, the waiting list to access these three facilities is approximately 6 months long. Nonetheless, their creation sets the scene for responsible tailings processing. The centres of excellence also provide training to ASM operators on how to manage their operations sustainably and how to navigate the EPP process (Mutagwaba et al., 2018).

Through the SMMRP, STAMICO established a small-scale mining facility to microfinance the mechanization of ASM operations. The main condition of the financing was that operators were required to submit an EPP including a tailings management plan. In 2018, the financing was suspended pending an impact assessment by the Ministry to investigate how the funds were used.

In 2019, the Tanzanian government piloted mineral-trading hubs in the gold-producing region of Geita. The mineral-trading hubs give small-scale miners and gold processors access to a government-regulated market where they can directly and legally trade gold without having to travel to market centres. The hubs also allow the government to collect levies on the traded gold. To encourage miners to transact through the gold-trading hubs, the government has lowered the tax on gold and included banking institutions that offer financial assistance to miners and dealers. The main objective of the mineral-trading hubs is to curb smuggling and improve the transparency of ASGM. These hubs could also be used by tailings processors to access fair and secure markets. Because testing is done on site, the hubs can also be used to regulate tailings processors and encourage miners to process tailings responsibly.

The government of Tanzania has created an enabling legislative framework for ASM formalization; however, the PML and its accompanying requirements have created a high bar for entry and have relegated the majority of ASM operators to informal unregistered activities. The licence holders who can afford to legalize are provided with a host of services by the Tanzanian government. Although tailings processing and management are not directly provided as an extension service, support for tailings management and processing is available through institutional structures.

PART C:
Policy Considerations

6.0 Formalization and Sound Management of Tailings

It is widely believed that formalization is "the" solution to the mercury contamination issue and other environmental problems caused by ASGM. According to the Swiss Agency for Development and Cooperation (2011, p. 5), "There is no 'quick fix' to the 'mercury problem' of ASGM, because it is not a 'mercury problem' but a formalization challenge."

Formalization in the context of ASGM refers to the process of bringing informal or unregulated mining activities into the formal framework. While often mistaken to mean simply legalization (related to licensing, contracts, and requirements related to environment, health, and safety), formalization also broadly incorporates technical aspects (access to geological data, equipment, processing, etc.), institutional aspects (related to organizations such as cooperatives and associations, capacity building, coordination), and financial aspects (access to capital, payments of taxes and fees; Kinyondo & Huggins, 2020). One of the aims of formalization is to improve the environmental and social governance of ASGM operations by promoting responsible mining practices, ensuring environmental protection, and enhancing the welfare of miners and affected communities.

In addition to promoting good ASGM practices and protecting the environment, formalization can be beneficial for ASGM workers. Formalized ASGM operations are more likely to access financial support, including funds for improving environmental and social practices. Compliance with formalization requirements can also enhance market access for responsibly produced gold. Formalized ASGM operations are also more likely to access technical support and training from LSM companies, development partners, multilateral agencies, and non-governmental organizations (NGOs). More broadly, properly managed ASGM tailings and reprocessing within formalized scenarios can contribute significantly to the achievement of several Sustainable Development Goals (SDGs):

- **SDG 1:** No Poverty: Responsible ASGM practices, including effective tailings management and reprocessing, can generate economic opportunities, improve miners' livelihoods, and reduce poverty in mining communities. This result is not only through improved environmental and health impacts, but also through the economic gains from gold recovery.

- **SDG 5:** Gender Equality: ASGM involves a significant number of women in various areas of the operation, from extraction to marketing. Improved tailings management and reprocessing practices can generate greater financial, technical, safety, and health outcomes for women in mining.
- **SDG 6:** Clean Water and Sanitation, and SDG 3: Good Health and Well-Being: Proper tailings management can prevent contamination of water sources, reducing health risks associated with toxic substances, such as cyanide and mercury. Although more applicable to large-scale processing, recycling of water in tailings management using dewatering technology can also reduce the overall consumption of water (Araya et al., 2021). These measures result in improvements in the health and well-being of miners and the community in general.
- **SDG 12:** Responsible Consumption and Production: Reprocessing tailings contributes to more sustainable resource use by extracting valuable minerals from waste materials. Increased production efficiency also leads to reduced consumption of water and energy, as well as reduction of waste.
- **SDG 13:** Climate Action: Responsible tailings management reduces environmental degradation and contributes to efforts to mitigate climate change.
- **SDG 17:** Partnerships for the Goals: Collaborative efforts among governments, NGOs, mining companies, ASGM operators, and local communities are essential to achieve responsible tailings management and contribute to the SDGs. Multistakeholder collaborations are crucial to address the financial and technological constraints faced by ASGM in conducting proper tailings management and reprocessing.

The formalization of ASGM, however, is not straightforward and can be a complex and challenging process. It involves overcoming various obstacles that can arise due to the unique characteristics of ASGM and the contexts in which it operates. For example, in West Africa, formalization involves navigating through various authorizations and registrations, which is challenging for artisanal miners unfamiliar with engaging with public administration (Nikiema et al., 2020). Experiences in Peru's ASGM sector suggest formalization is just the beginning: miners encounter further challenges post-formalization and are likely to return to informality if continued support is not provided (Martinez et al., 2021). Section 6.1 examines some of the main challenges in formalizing ASGM.

6.1 Challenges Facing ASGM Formalization

6.1.1 Land Tenure and Tailings Ownership

Land tenure is one of the key barriers to formalization. In many ASGM regions, unclear or informal land-tenure systems, overlapping claims, and the absence of clear legal frameworks often result in conflicts over land ownership. The lack of formal recognition of land rights leaves miners vulnerable to displacement and exploitation, fostering a climate of uncertainty that hinders the implementation of regulatory measures and environmental safeguards. Moreover, the ambiguity surrounding land tenure exacerbates the difficulty of implementing responsible mining practices and establishing sustainable development initiatives, perpetuating an environment of informality and perpetually tenuous legal standing. Yet, the management and disposal of tailings are often contingent upon the land rights and ownership structure. In most of the countries examined for this report, ownership adheres to a consistent

framework. In contrast, informal tailings ownership exists beyond established legal frameworks, rendering legal responsibilities and obligations irrelevant to unauthorized operators. The ownership structure of tailings generated by informal actors often exhibits similarities across different countries.

For most of the countries reviewed in the dataset, ownership follows a similar structure:

- Tailings produced by formalized ASGM activities are initially owned by the primary licence holder. If the permit holder has the capital and capacity, they will process the tailings and must satisfy the responsibilities for waste management and disposal.
- If the licence holder does not rework the tailings themselves, they sometimes sell the tailings to a licensed processor; at other times, the tailings are left as payment to the licensed processor for the processing of ore. In this case, the responsibilities around waste management and disposal are transferred to the processor.
- The primary licence holder can sell their tailings to the state. The government can take ownership of the tailings, and if the state has capacity, the tailings will be reworked at a state-run processing centre.
- The government can also sell the tailings to a licensed processor, who takes on the responsibility for them.
- If the mining operation is sold by the permit holder to another permit holder, the new owner becomes responsible for the entire operation, including the tailings.
- If the permit period comes to an end, the ownership of the concession, along with the tailings, reverts to the state. The concession (including tailings) re-enters the system, and a new permit can be issued for primary mining activities or, in some countries, a stand-alone processing permit can be issued under which the permit holder can process remaining tailings.
- If there is an overlap of titles between an ASGM operation (ASGMO) and an LSM operation (LSMO), each party should ultimately be responsible for tailings they produce, as well as adhering to the land-access obligations as per the provisions of their mining permit or right. These situations arise in jurisdictions that permit the establishment of artisanal mining corridors in an area that also falls under another type of licence. Artisanal mining corridors are areas legally dedicated to ASM activities. However, this overlap often creates complexities due to the limited capacity of the artisanal mining corridor operators to meet their permit obligations. There are many permutations of this type of overlap, depending on jurisdiction. The following examples exist:
    - Where a licensed artisanal mining corridor overlaps with an area that also falls under an exploration permit, and if the corridor existed before the exploration permit, then the holder of the latter must exercise caution to not unnecessarily interfere with the artisanal mining corridor activities, and the relationship has to be brokered by government for amicable co-existence. Any waste generated by the artisanal mining activities is the responsibility of the corridor participants. If the exploration permit precedes artisanal mining activities, then the establishment of the latter may be permitted by government in discussion with the exploration permit holder. And again, responsibility for management of any tailings generated by the artisanal mining activities falls under the obligations of the artisanal mining corridor permit.

    - Where licensed artisanal mining overlaps with an area that also falls under a mining permit or concession, and if the corridor existed before the mining concession, then the corridor may continue to operate with the concurrence of the new mining permit or concession holder. There may also be situations where the new LSM concession holder may consider allowing the establishment of a corridor after the concession or permit has been granted. In both situations, environmental impacts are normally the responsibility of the mining permit holder. However, tailings and land access may be negotiated as part of the mining development agreement.

- Once mine activities are no longer economically viable, the mining permit holder must perform the required restoration and rehabilitation activities in order to receive a mine-closure certificate. The rehabilitation processes involve ensuring that the tailings are properly disposed of. Only after these activities are conducted effectively is the land relinquished back to the state. Many permit holders struggle to appropriately rehabilitate the land; as a result, their mines are abandoned and become ownerless and derelict mines. Without any alternatives, the state becomes the custodian of derelict mines and is responsible for rehabilitation activities.

Conversely, informal ownership of tailings operates outside of legal frameworks, meaning that the legal responsibilities and obligations of operators do not apply to those operating unlawfully. The ownership structure of tailings generated by informal actors tends to follow a similar pattern across countries.

- Informal miners often rework the tailings themselves and dispose of any remaining waste.
- Tailings may be sold to an unlicensed processor or used as a form of payment to such a processor. The unlicensed processor is responsible for waste disposal.
- Tailings might also be sold to a licensed processor or used as a form of payment for a licensed processor. However, unlike informal miners and processors, licensed processors are obligated by law to process, manage, and dispose of the waste in compliance with national regulations.

6.1.2 Lack of Awareness and Education

Formalization processes often involve navigating through various authorizations and registrations, which is challenging for artisanal miners unfamiliar with engaging with public administration.

Many ASGM operators lack awareness about formalization processes, their benefits, and their legal and environmental requirements. Awareness and education are needed not only on the importance and benefits of formalization but also on the use of environmentally friendly technologies (Zolnikov & Ramirez Ortiz, 2018). This lack of education and the complexity of applying and complying with formalized standards and technologies can hinder operators' willingness to engage in formalization.

6.1.3 Informal and Unregulated Nature

ASGM is often conducted informally without legal recognition or adherence to regulations. This informality makes it challenging to gather accurate and reliable data on ASGM

operations, impacts, and socio-economic conditions—all of which are needed to make informed decisions. Transitioning to formal operations requires significant changes in practices, management, and compliance. Implementing environmentally sustainable practices might require miners to change their methods and adopt new techniques. As a result, many ASGM miners might resist formalization due to concerns about increased oversight, taxation, or changes in traditional mining practices. In fact, many ASGM operators prefer to stay informal and small, as they find it beneficial to avoid taxes, stringent labour laws, environmental requirements, and standards that would increase their operating costs (IGF 2022; Kinyondo & Huggins, 2020). On the other hand, ASGM operators face difficulties in securing legal recognition because, in many cases, they operate in areas that are already licensed. For example, many licence holders residing in cities in Tanzania are often not willing to relinquish their titles or enter into joint ventures with ASGM operators.

6.1.4 Limited Access to Finance and Technology

Formalization often requires investments in technology, equipment, and infrastructure that many ASGM miners cannot afford. Limited access to finance can hinder their ability to meet formalization requirements. Several initiatives led by large-scale companies or launched in partnership with development organizations and governments have tried to address the issues of finance and technology in ASGM. However, these initiatives tend to be one-offs and do not ensure the sustainability of such support. Better recognition of this challenge has emerged in several countries where initiatives have been taken to provide ASGM with financial instruments. For example, Ecobank Ghana established partnerships with various stakeholders, notably Ghana Post, to support small-scale operators, including ASGM operators ("Africa's Local Banks," 2013). Similarly, Bank Rakyat Indonesia had a program to provide financial services to small-scale miners in Indonesia (planetGOLD Indonesia, 2020). In Peru, some regional savings and credit banks have developed financial products and services tailored to the needs of ASM and facilitated through partnerships with organizations like Minera Orex, Los Andes, and Solidaridad (Solidaridad, 2023).

6.1.5 Security Concerns and Complex Regulatory Environment

Unclear land tenure and ownership rights can complicate formalization efforts, leading to conflicts with other concession holders, including LSM, as well as conflicts with other economic activities and competing interests, especially agriculture. Ongoing conflicts or security concerns can make it difficult to implement formalization measures effectively. On top of these issues, regulatory frameworks can be complex and challenging to navigate, especially for small-scale miners who might have limited legal knowledge or access to legal assistance. Furthermore, top-down approaches have made it more difficult for ASGM operators to engage with legal requirements in a meaningful way; decentralized systems of governance would be more conducive. Given that ASGM is largely poverty driven, most of the miners lack education and find regulatory systems quite complex.

6.1.6 Lack of Institutional Capacity

Regulatory agencies and government bodies might lack the capacity to effectively oversee and manage the formalization process. Coordination among government agencies, NGOs, and other stakeholders is often necessary for successful formalization. However, achieving effective collaboration can be challenging. This is certainly one of the key challenges encountered by the Centres of Excellence in Tanzania, particularly due to competing

interests and a lack of coordination between the Ministry of Mines and the State and Mining Corporation (STAMICO) which is tasked with providing training and other technical support to ASGM operators (Kinyondo & Huggins, 2020). This lack of coordination can result in delays, inconsistent enforcement, and challenges in providing support to miners.

6.2 Measures to Address the Challenges of ASGM Formalization

Addressing these challenges requires a comprehensive and context-specific approach that involves collaboration among governments, NGOs, local communities, and miners themselves. ASGM formalization is a broad topic within which tailings management and reprocessing can be handled. As part of formalization, governments can establish integrated planning and zoning of ASGM through multistakeholder collaboration and active involvement. Designating mine sites for ASGM through a consultative rather than a coercive process can be an important starting point. The following sections focus on the measures that can be taken to foster the formalization of tailings management and reprocessing.

6.2.1 Strategic Environmental Assessments

Instead of enforcing ESIAs on ASGM in designated mine sites, it is crucial to first work on strategic environmental assessment (SEAs) in order to lay out the sectoral context at various levels, including ASGM. This ensures that ESIAs appropriate for ASGM are put in place. SEAs are defined as "the formalized, systematic and comprehensive process of evaluating the environmental effects of a policy, plan or program and its alternatives, including the preparation of a written report on the findings of that evaluation, and using the findings in publicly accountable decision-making" (Therivel & Paridario, 2013). As strategic frameworks, SEAs provide a broad oversight and vision and streamline various tools, whereas ESIAs are project- or site-specific. SEAs are useful for setting standards and guidelines that align with national economic, social, and environmental strategies, and as assessment tools and reference points for the performance of ESIAs. SEAs should have strategies to mitigate potential adverse impacts and enhance positive outcomes. Given the political nature and complexity of the decision-making processes, SEAs should be process-oriented and should flexibly integrate environmental and sustainability issues with development objectives (Lobos & Partidario, 2014). SEAs should, therefore, go through a thorough process involving:

1. **Stakeholder engagement**: One of the initial processes of formalization should involve consultations and engagement with the miners and communities in decision-making processes. This means that affected miners and communities have a voice in tailings management and reprocessing activities. Stakeholder engagement should also include government agencies, NGOs, and independent experts, incorporating their perspectives, concerns, and local knowledge into the assessment process. These engagements, which need to be based on an ongoing dialogue, can lead to better-informed decisions that prioritize local needs and concerns.
2. **Baseline data collection**: SEAs should involve the thorough collection of current and historical data to understand the existing environmental, social, and economic conditions in the area where ASGM zoning is being considered. This data collection may include factors such as water quality, soil, biodiversity, proximity to water sources, cultural heritage sites, demographic composition, and livelihoods. Such comprehensive

data collection ensures that environmental aspects are reconciled with a project's economic and social aspects. The assessments may also involve exploring different zoning scenarios and assessing their potential impacts on the environment, society, and the economy. This could involve considering zones for mining, reprocessing, and tailings storage while also accounting for conservation, agriculture, and other land uses, as well as aspects like water quality, soil health, biodiversity, community well-being, and livelihoods. This detailed level of assessment would help evaluate the potential positive and negative environmental, social, and economic impacts of each zoning scenario.

3. **Institutional capacity:** Given the lack of success with centralized institutional arrangements, decentralized governance frameworks are increasingly being considered as more effective. For example, Hilson et al. (2022) suggest that the Community Mining Scheme introduced in Ghana (in combination with ASM-designated areas) provides a decentralized platform in which district assemblies are involved in the scheme's coordination and administration. According to the authors, this involvement has led to some positive outcomes in reviving an institutional structure that is crucial for formalizing ASGM. Process-based SEAs are considered to facilitate organizational learning and institutional capacities (Lobos & Partidario, 2014). Therefore, efforts can be targeted to use SEAs in developing institutional and policy architecture at local and district levels.

6.2.2 Legal and Regulatory Requirements

Under the umbrella of SEAs, clear legal and regulatory frameworks need to be established for ASGM operations, including a licensing and permitting system that requires miners to adhere to environmental and social standards. Regulations should be comprehensive, enforceable, and aligned with international environmental and social standards and SDGs. Built within ESIA commitments, legal frameworks can require the use of environmentally friendly technologies and practices that reduce the release of toxic substances into the environment. As part of the conditions for participation in ASGM zoning, ESIAs should assess mining methods, potential impacts, waste-management and mitigation measures, tailings and reprocessing plans, and infrastructure requirements, along with monitoring plans to ensure responsible practices. ESIAs need to include tailings-management guidelines that cover proper waste disposal, containment and handling, and reprocessing techniques that minimize environmental impacts from uncontrolled waste discharge. This ensures that miners are responsible for managing their tailings; for preventing the contamination of soil, waterbodies, and surrounding ecosystems; and for rehabilitating disturbed areas.

It is important that regulations be tailored to the unique circumstances of ASGM operations, which helps overcome barriers and promote responsible and sustainable formalization. As ASGM involves a considerable number of women, legal frameworks must consider gender-specific needs and impacts, ensuring that women's voices are included in policy and decision-making processes while women are protected from exclusion, trafficking, and exploitation.

Governments should establish regulatory bodies or strengthen existing ones to oversee ASGM activities and to mandate and monitor ESIAs. Regular audits and inspections need to be in place to ensure compliance with regulations. These regulatory bodies should establish mechanisms for regular monitoring, data collection, and reporting of tailings-management and reprocessing activities. These mechanisms are also crucial in informing

formalization, which should be recognized as an ongoing process and subject to regular review and adaptation of policies, regulations, and practices based on feedback and changing circumstances. Government, industry, and community representatives can engage in regular policy reviews to assess the effectiveness of regulatory frameworks and make necessary adjustments.

While a regulatory mandate ensures compliance with legal requirements and sets standards, it is important that incentives be provided. These may include funding support for the adoption of safer and more efficient tailings-management and reprocessing technologies. Similarly, responsible gold buyers and industry partners can provide market linkages to formalized miners who adhere to environmentally and socially responsible practices. Governments can also provide incentives such as tax breaks, access to finance, and technical assistance to encourage miners to formalize and adopt responsible practices.

6.2.3 Development and Adoption of Technology and Innovation

Compliance with tailings-management and reprocessing requirements relies on technology development and innovation, as well as technology adoption by ASGM operators. Many ASGM operators continue to use either mercury or a combination of mercury and cyanide to process gold, with severe environmental and health implications (Malone et al., 2023). Failed experiences (Veiga & Fadina, 2020) suggest that long-term strategies are needed to account for changing contexts and evolving technologies, instead of simply requiring ASGM to comply with environmental regulations. ASGM operators lack the capital and technical know-how to invest in and employ processing technologies (Veiga & Fadina, 2020). This finding implies that ASGM operators urgently needs support in the form of strategic financing, credit facilities, and market linkages to raise their capabilities to engage in responsible tailings management and reprocessing.

Technological developments, such as mercury bioaccumulation by bacteria (Chasanah et al. 2018; Nurfitriani et al. 2020) or plants (Esdaile & Chalker, 2018), have immense potential to be used for the cleanup of mercury in ASGM tailings. Additionally, the development of gold phytomining could be an option for tailings management in ASGM locations where plants accumulate residual gold in above-ground biomass (Krisnayanti et al., 2016) and phytoremediation could be achieved where basic site preparation is done by conserving topsoil removed during the mining process and respreading it at the site once pits and steep slopes have been backfilled and contoured, respectively (Timsina et al., 2022). The funding to implement these developments, once they are proven feasible on a large scale, would necessitate multiple interventions, including promotion of partnerships with LSM operators, financial institutions, responsible gold buyers, and donor organizations. These partnerships could lead to collaboration to support the development and transfer of environmentally friendly and efficient reprocessing technologies by providing access to information, training, and support. Research and innovation could also play a role in promoting affordable technologies through efficiency and innovation.

6.2.4 Education and Capacity Building

Legal and regulatory requirements embodied in ESIAs cannot be effective if they are not accompanied by supportive mechanisms, such as capacity building and training. More broadly, it is considered impossible to formalize ASGM without providing training and education for miners. In fact, formalized processors pollute the most for several reasons, including

lack of education (Marshall & Veiga, 2017). Industry associations can provide training and capacity-building programs for miners on safer tailings-management and reprocessing methods. To ensure the sustainability of such support, multistakeholder partnerships led by relevant government agencies are crucial. ASGM operators are more likely to be attracted to formalized settings if they are provided with training and capacity-building programs on responsible mining techniques, tailings management, reprocessing, and safety measures.

6.2.5 Infrastructure Development

Public and private partnerships may catalyze investment in infrastructure, such as waste-containment facilities and processing plants, that supports responsible tailings management and reprocessing. For example, collaboration between the Tanzanian government and Geita Gold Mine ensured that the mine provided tailings-storage facilities for the centres of excellence that were designed as part of ASGM formalization efforts with the help of the World Bank (Kinyondo & Huggins, 2020). Sustainability of such efforts can only be achieved if infrastructure development is institutionalized and made part of a broad-based and long-term strategy. The institutional settings suggested under the SEA discussion in section 6.2.1 provide a focused purpose for such a strategy to be achieved on the ground.

6.2.6 Information Sharing and Advocacy

Ongoing strategic dialogue and consultations among policy-makers, miners, communities, and other key stakeholders are crucial to addressing misinformation and raising awareness around formalization and the importance of tailings management and reprocessing. Multistakeholder platforms that bring together government agencies, industry representatives, community leaders, NGOs, and international organizations need to be established. These platforms can facilitate dialogue, information sharing, and coordinated action. Information exchange may relate to successful case studies, experiences, and lessons learned on tailings-management and reprocessing projects, as well as broader environmental practices and formalization processes. According to Kinyondo and Huggins (2020), communication about the various technologies and services provided and demonstration of productivity gains as part of the formalization process are crucial to securing buy-in from miners. This finding demonstrates that, in addition to the legal, technical, institutional, and financial provisions, formalization depends on the spread, accessibility, and frequency of information shared.

In summary, ASGM formalization is a fundamental condition to achieve better outcomes of ASGM tailings management and reprocessing. If done well, formalization can set clear standards, enhance regulatory oversight, promote compliance and responsible practices, and improve livelihoods. Process-oriented SEAs that involve multistakeholder engagements, baseline data collection, and institutional capacity development offer a focused way to achieve these outcomes. Based on well-developed SEAs, ESIAs can be successfully implemented if clear legal and regulatory requirements are established in designated mine sites. ESIAs should consider the key role played by local institutions, not just in enforcing those requirements but also in providing various support mechanisms, including technology, finance, infrastructure, and training. All these efforts can succeed only if incorporated within a broad-based and long-term strategy accompanied by knowledge sharing and advocacy.

7.0 Taxation of Transactions Related to ASGM Tailings

Resource-rich countries use various fiscal tools to create a unique fiscal regime to govern their mining sector, including royalties, taxes, production sharing, and bonuses. Some countries differentiate fiscal regimes for large-scale, medium-scale, small-scale, and artisanal mining. Fiscal tools applicable to ASM could vary from jurisdiction to jurisdiction. Given the production size, artisanal and small-scale miners are generally exempted from taxes or granted reduced royalty rates. Some countries do not charge royalties for ASM but do impose export taxes.[3] Some examples of countries with different tax regimes for ASM are provided in Box 12. Our research shows that specific tax rules for tailings-related transactions in resource-rich countries are uncommon.

BOX 12. SAMPLE OF MINING COUNTRIES WITH A DIFFERENTIATED TAX REGIME FOR ASM

Ecuador

Small-scale miners pay a 3% royalty rate on gross revenues, as opposed to large- and medium-scale miners, who pay between 3% and 8% of net income depending on criteria of progressivity, production volumes, and/or mineral prices.

Source: Article 93 of the Mining Code (2009).

Sierra Leone

Artisanal miners pay a 3% royalty on gross revenues for minerals obtained pursuant to an artisanal mining licence. For other mineral rights holders, the government charges 5% for precious metals, 8% for special stones, and 6.5% for precious stones.

Source: Schedule 1 of the Extractives Industries Revenue Act (2018).

[3] For instance, Mali has an export tax of XOF 465,000 per kg, compared to XOF 30,000 per kg in Togo.

Zimbabwe

The ASM sector pays a 1% royalty rate on gold revenues, while LSM operators are charged between 3% and 5%.

Source: Finance Act, 2021- Act number 7 of Article 38.

While 20% of gold worldwide is estimated to be produced from ASM (Extractive Industries Transparency Initiative, 2022), many countries struggle to estimate how much revenue the government collects from the sector because of its informal nature. Gold is often sold and exported illegally, escaping the government's monitoring.

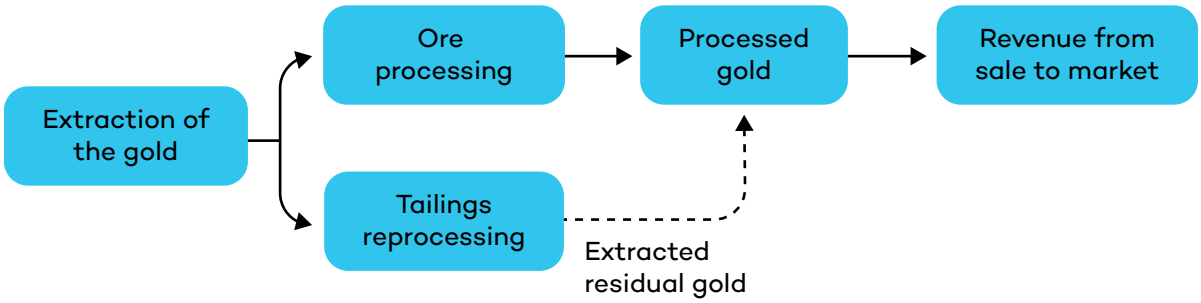
Generally, fiscal controls are a disincentive to the formalization of ASM activities. It is understood that when rent-seeking governments apply fiscal tools imprudently, it leads to non-compliance and higher rates of informalization.[4] However, potential government revenues can be derived from taxing the ASGM sector, specifically from the exploitation of tailings and the recovery of gold and subproducts (including critical minerals). Revenue-collection aspects are of utmost importance for countries looking to raise revenues from the ASM sector. Ideally, resource-rich countries would design different tax-policy responses depending on their policy goals, which include formalization of the sector and revenue collection.

If a mining jurisdiction decides to tax revenues derived from ASGM tailings-related transactions, it could consider features that differentiate the ASM sector from the medium and LSM sectors. For instance, ASGM extraction, processing, and reprocessing typically occur within one jurisdiction, unlike LSM, where cross-border transactions are common. Another example is distinguishing between instances where miners process the tailings themselves or sell their tailings to processing plants, either because they lack the capacity to reprocess the gold themselves or because the quantity of tailings is too low for profitable gold extraction. This section explores several different scenarios and points of taxation of the different actors.

Scenario 1

The gold miner extracts and processes the ore and reprocesses the tailings to extract residual gold from the waste. The gold miner then sells the recovered gold, generating income from the sale of gold domestically (see Figure 11).

FIGURE 11. Scenario 1



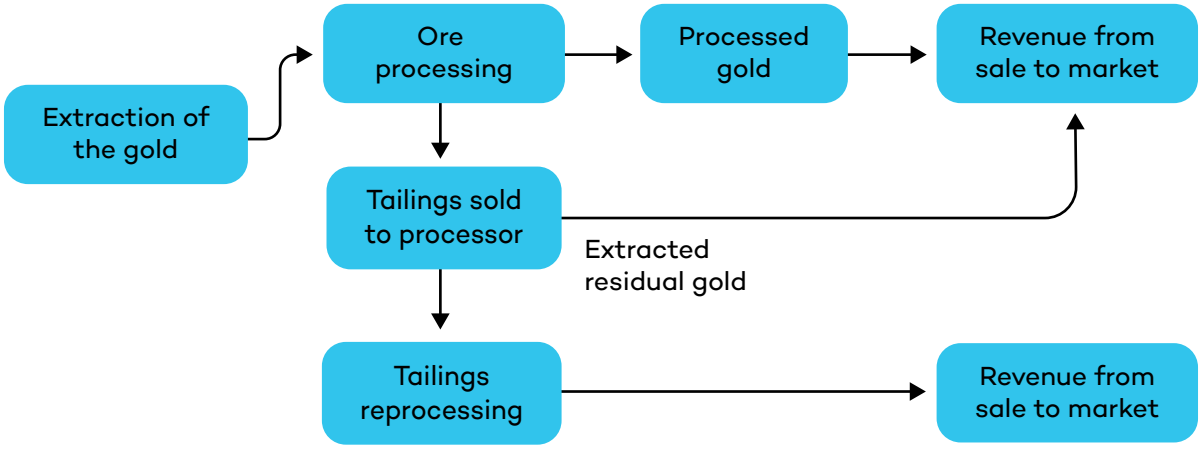
[4] In addition to taxes, the ASM operators make unofficial payments to non-state actors—such as landowners and local security, as well as financiers—that increase their production costs.

This scenario assumes that the miner has the capacity to both process the ore and reprocess the tailings. In addition, the miner generates sufficient tailings to economically process them, or they stockpile tailings until it is economically viable to process them in batches.

Scenario 2

The gold miner extracts and processes the ore and removes the tailings. The gold miner then sells the tailings to a processor, who reprocesses the tailings to extract residual gold from the waste. Then, the processor sells the recovered gold, generating income from the sale of gold domestically. The gold miner generates revenue from the sale of the ore (see Figure 12).

FIGURE 12. Scenario 2



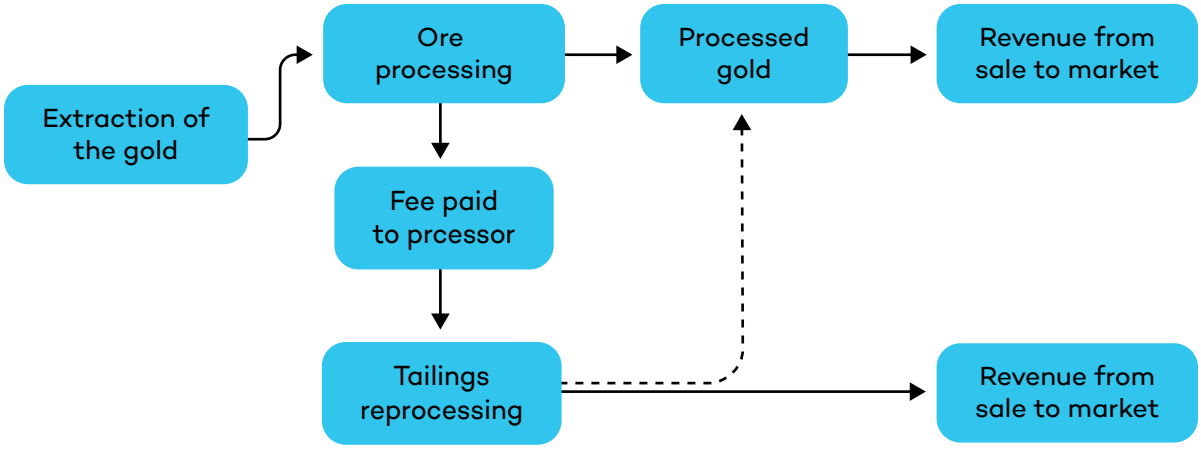
This scenario assumes that the miner lacks the capacity to process the tailings or that it is not economical for them to do so. In this case, the miner could pay taxes from the sale of gold extracted from the ore, while the processor could be responsible for paying taxes from the sale of gold processed from the tailings.

Scenario 3

The gold miner extracts and processes the ore and removes the tailings. The miner requests a toll processor to reprocess the tailings and extract residual gold from the waste. The gold miner pays a fee to the toll processor. Then, the gold miner sells the recovered gold, generating income from the sale of gold domestically (see Figure 13).

In this scenario, the toll processor may lack the capacity to market and sell the gold. Both the miner and the processor generate income that could be taxed. The miner is responsible for paying taxes on the sale of gold from the ore and the tailings. The processor could be taxed for profits made from processing the tailings.

FIGURE 13. Scenario 3



In some instances, a toll processor gets tailings as payment for processing a miner's ore. The toll processor then recovers the gold from the tailings to sell themselves. In such situations, toll processors have been known to deliberately set the equipment parameters for inefficient gold recovery to leave as much gold in the tailings as possible for their own gain.

Tax Policy Responses

There are policy choices available to governments, depending largely on the extent to which ASGM is formalized in the country, and on the extent to which formalization itself emerges as a priority given other competing pressures for limited government resources. Governments should consider implementing the following recommended changes in ASGM taxation:

- If formalization of the sector is a critical policy goal in resource-rich countries, governments should decide to temporarily exempt gold miners and processors from taxes on ASGM tailings-related transactions. Once a certain degree of formalization is achieved, resource-rich countries are better placed to adapt existing tax frameworks for ASGM tailings. The tax framework should clearly highlight the three scenarios above, as well as tax categories and the rates and bases to be levied.
- Over a period of transition (from exemption to full taxation), governments should consider granting tax incentives to the actors that reprocess the tailings to extract residual gold. See Box 13.
- Governments could consider facilitating or participating directly in the establishment of processing plants to reprocess tailings in an environmentally friendly way. Taking this step would allow governments to access pricing mechanisms directly, enabling them to better monitor operations between related parties.
- Governments should establish a robust transfer pricing system applicable to domestic transactions, as sales of tailings are often performed domestically. Where miners or processors sell their tailings to related parties, there is a risk of undervaluation of the sale price.
- Governments should closely monitor the minerals that are extracted from processing the tailings, particularly co-products and by-products that can be economically extracted, such as industrial sand, zinc, copper, and silver.

- Governments should ensure that all players that make profits from the processing of tailings are taxed, including landowners who charge contractual royalties to the licence holders and processing plants that are contracted by miners to reprocess tailings for a margin.
- Given the importance of the sector and the economic potential of tailings, governments should consider increasing capacity within the tax administration or the mining ministry (depending on which entity collects taxes applicable to the ASGM sector) to enable better oversight of tailings operations for the purpose of tax collection.
- Governments are encouraged to use different non-tax policy responses to promote formalization, such as access to credit facilities for ASM miners (IGF, 2017b).
- Neighbouring resource-rich countries might consider harmonization of ASGM taxes to help discourage miners from smuggling both ore and tailings into jurisdictions that charge lower taxes or none at all (International Monetary Fund, 2013).

BOX 13. A TAX-INCENTIVE FRAMEWORK FOR THE ASGM TAILINGS SECTOR

Tax incentives can be implemented to encourage reprocessing, the adoption of environmental best practices, and the dissemination of clean technologies in the ASGM sector (Masson et al., 2013). For instance, tax incentives could be provided when operators follow environmental best practices, including using cleaner technologies and mercury-free processing alternatives, which are normally agreed upon during the concession process. Exemption from import taxes for environmentally friendly mining and mineral-processing equipment should be strongly considered to encourage mining operations to favour purchasing cleaner technology for mining, processing, and mine-closure processes.

While cost-based incentives, such as accelerated depreciation, are encouraged for LSM because it is capital intensive, these types of incentives may not always apply to the ASGM sector, given the fact that it uses little to no capital.

Profit-based incentives, such as corporate income tax holidays or reduced rates for profit-based royalties, are generally discouraged and are not well suited for the mining sector. However, where governments are interested in companies reinvesting in reprocessing tailings, these types of incentives could be a good tax-policy response.

A strong system is required to monitor the granting and implementation of these tax incentives, including building capacity in tax authorities to monitor whether gold miners and processors meet the requirements to benefit from the incentives.

8.0 ASGM Interface With LSM and Implications for Tailings Management and Reprocessing

The scoping study of the governance of tailings management and reprocessing indicates that detailed and specific regulations are not readily available for ASGM. However, many mining codes around the world have comprehensive regulations for tailings management in the LSM sector. It is therefore logical to analyze the interface between LSM and ASGM and its implications for tailings management and reprocessing in the ASGM sector. The important areas to consider are the different ways in which LSM and ASGM interface, and the interplay with the key provisions for LSM tailings management and reprocessing in international and national frameworks, as well as in technical standards and guidance documents.

8.1 LSM–ASGM Interface

It is important to consider the coexistence of LSMOs and ASGM activities because they are often found in the same areas. The relationship between LSM and ASGM often revolves around access to gold resources, whether they are primary, such as virgin deposits, or secondary, such as tailings and rock waste. Such interactions can sometimes lead to conflicts, and, in the past two decades, numerous interventions have been implemented to resolve these conflicts and facilitate coexistence between ASM and LSM.

The interactions between LSM and ASGM, including ASM in a broader context, take various forms. The following sections explore the most prevalent aspects of these interactions and their implications for tailings management and reprocessing.

The primary concern is gaining access to and control over the resource offered by ASGM tailings, along with the governance issues that come into play. These governance matters are heavily influenced by the mining regulations in the jurisdiction, which impact mining rights as well as ownership rights and obligations, environmental and social impact management, taxation, and trade, among others.

8.1.1 Understanding the LSM and ASGM Interface and Implications for Tailings Management

It is important to understand the key concepts and categorizations that shape the relationships between LSM and ASGM, particularly regarding tailings management:

- **Proximity of operations**: ASGM can exist either on an LSM concession or in parallel near the LSM area. The location of ASGMOs with respect to LSM sites significantly influences the kind of interactions between the two, as well as the legal liabilities related to tailings management.
- **Legality of operations**: ASGMOs can either be formal (holding official permits) or informal. The legality of ASGMOs affects their interactions with LSMOs and the ways they are perceived by different stakeholders, including the government.
- **ASGM reprocessing tailings from LSM**: This practice is common in some regions. ASGMOs often utilize tailings discarded by LSM companies to extract residual gold and other valuable minerals. Some mining legislation has permitting systems for the exploitation and reprocessing of tailings.

8.1.2 LSM and ASGM Interactions: Scenarios and implications

8.1.2.1 Formal ASGM Outside of LSM Concessions

Since a formal ASGMO is operating legally and separately, it bears full responsibility for the management of its own tailings. This scenario presents an opportunity for ASGM operators to adopt best practices from LSMs. As this scenario reduces regulatory burden and disputes, the government can implement and enforce separate regulatory frameworks for both LSMOs and ASGMOs, ensuring optimal tailings management.

Given the competition for resources that is often found in developing countries even where ASGM is provided for in the law, some LSMOs have found it necessary to facilitate community groups to set up their own parallel small-scale operations to head off risks of illegal mining incursions on their concessions, as recently demonstrated by IAMGOLD and the government of Suriname at the Rosebel project (Bickham & Brandstaetter, 2022). The resource may be on land that was available for ASGM (e.g., at Barrick's Kibali Mine in the Democratic Republic of the Congo; Geenen & Marijsse, 2020). However, it may also be on land that the LSMO has relinquished for this purpose in agreement with government, as is reportedly the case in Ghana at AngloGold Ashanti's Obuasi Mine and Goldfields' Damang Mine (Smith et al., 2017). In Ghana, the government supports ASGM-LSM coexistence through the Community Mining Scheme (Minerals Commission of Ghana, 2021).

The implications for this type of interface is that tailings produced by each type of operation are managed as separate products under the law. Without exception, all mining laws regarding LSM hold the mining licence or rights holders responsible to manage their tailings, including those from any reprocessing that the operator may do itself or through a third party (i.e., subcontractor). The reprocessing of recently produced gold tailings by LSMO is not common, as recent LSMOs tend to have very efficient gold recoveries, resulting in low concentrations of gold in the tailings that do not warrant reprocessing. However, there may be other uses for the tailings (see Section 3).

South Africa was identified as a country where industrial-scale operations reprocess gold tailings; this is a sizable industry with some large players involved (Breytenbach, 2016). For example, Harmony Gold's Mine Waste Solutions reprocesses old tailings and waste-rock dumps in the Witwatersrand basin area (Mining Data Online, n.d.; see Box 14). Small-scale operators are also reported to be active in the area. ERGO (a subsidiary of DRGOLD) is the largest tailings processing facility in South Africa, with several mining rights to sands and slime dams. These tailings and waste-rock dumps were created at a time when the gold-extraction methods were not as efficient as they are now. The application of more recent gold-extraction methods makes it viable to process tailings with grades of less than 0.5g/t gold. Ghana is also reported to have LSMOs that reprocess their own tailings, as well as material brought from other operators; reportedly, Future Gold Resources (former Golden Star) and Adamu Resources are doing so. There are no specific provisions that regulate the sale of tailings.

In cases where separate and parallel ASGMOs are based on land relinquished by LSMOs, pre-existing tailings that are part of the relinquishment would become subject to the rights and obligations of the new ASGMO (Box 15). Hence, the ASGMO would use the tailings or any other mining waste as it would any other resource under the mining right or permit. The LSMO would have had to deal with all the legal and environmental issues required of it by the relinquishment provisions in the mining law with respect to any tailings that it may have generated.

In this study, we identified only one specific instance (in Colombia) where a proposal exists for explicit regulations to allow the movement of tailings for reprocessing. However, it is important to note that the proposed regulations appear to focus on reprocessing tailings within the context of ASGM and are primarily related to recent efforts aimed at cleaning up mercury-containing gold tailings generated by artisanal mining activities (personal communication; Colombia, 2020).

BOX 14. REPROCESSING OF GOLD IN OLD TAILINGS ON THE WITWATERSRAND

The old tailings storage facilities created by gold mines on the Witwatersrand basin in South Africa are now dumps that are being exploited by different types of operations to recover the residual gold.

On an industrial scale, operations like Mine Waste Solutions (previously owned by AngloGold Ashanti and acquired by Harmony Gold in 2020) reportedly also recover both gold and the uranium associated with it. Access to the tailings and waste-rock dump resources would have been subject to mergers and acquisition arrangements between the owners (with approval of the mining regulator) of the dump by virtue of the pre-existing mining right. However, in the case of what would have been derelict and ownerless mines (where responsibility had reverted to the state), access might also have been through a specific mining right application.

At the ASM scale, operations exploit this resource in a legal fashion by applying for mining rights or permits for the tailings and waste-rock dumps in accordance with the mining law. The miners use a combination of gravity separation techniques, culminating in mercury amalgamation or cyanidation. The sophistication of the methods used range from basic manual sluices to semi-mechanized processing plants.

BOX 15. SEPARATE AND PARALLEL EXISTENCE OF LSM AND ASGM IN GHANA—THE GOVERNMENT COMMUNITY MINING SCHEME

Ghana's history of gold mining goes back centuries. The contest between LSMOs and ASGMOs for access to gold deposits (including both primary and secondary residual resources) has manifested in a conflict between the two sectors. Over the years, different models for the separate and parallel existence of LSM and ASGM have been tried (also referred to as co-habitation), with varying levels of success. Recently, LSMOs have been relinquishing part of their concessions back to the government (which may include residual gold in tailings that could be reprocessed) based on the understanding that this land could be used for ASGM by local communities as an attempt to reduce illegal mining incursions, with limited success. However, better success is expected from the more recent Community Mining Scheme initiative, whereby the government uses some of this mineralized land to set up community mining schemes. While there is no specific mention of gender inclusivity in the guidance for this scheme, Ghana's Women in Mining Association is very active in advocating for women's equal participation in the mining sector in Ghana.

8.1.2.2 Formal ASGM on LSM Concessions

In this scenario, legal ASGMOs are located within the LSMO's concession area and could have started before or after the LSMO. In some jurisdictions in West Africa, ASGM permits could be legally granted during the exploration phase, creating a lawful overlap between ASGM and LSM (IGF, 2022). There may also be a situation where an LSMO, with permission from the government, agrees to the initiation of ASGM activities within the bounds of its concession area.

The primary risk for LSMOs is potential operational disruption due to ASGM activities. LSMOs might have increased responsibility regarding the management and potential environmental impact of tailings, given the presence of ASGM within their concession area. However, collaboration can lead to resource sharing, possibly resulting in enhanced ore processing and tailing management for ASGM operators. Indeed, collaboration could create an opportunity to leverage existing LSM infrastructure and knowledge for more efficient tailings management. It becomes crucial for the government to ensure LSMOs and ASGMOs are coordinating appropriately for effective tailings management within the LSM concession.

Provisions in the law where an LSMO is required to collaborate with pre-existing ASGM on its concessions are found in Guinea and Nicaragua (Veiga & Fadina, 2020). However, in both of these countries, the law only considers the lower end of ASGM (i.e., artisanal gold operations, as opposed to small-scale semi-industrial operations, which are provided for separately in the mining law).

In some situations, the LSMO may sublease part of its concession to an ASGMO as part of an agreement, a practice sometimes referred to as "tributing." Tributing can only be done with the government's agreement, and the mining law stipulates the conditions under which it can happen. This is the model applied at GCM Mining Corp in Colombia, where ASGM activities are integrated into the industrial-scale operation and there is a profit-sharing agreement on

the gold produced by ASM operations. The environmental liabilities are also shared, and the state oversees how the agreement is implemented.

Tailings management under this type of interface would take place largely according to the rights and obligations of the mining rights of both the LSMO and the ASGMO. However, in the case of Hemco Mine in Nicaragua, the LSMO has the ultimate responsibility for all activities on the concession, including management of the tailings. If the resource includes tailings that need to be reprocessed, the LSMO would manage this accordingly, but there is no mention of tailings reprocessing in the literature about Hemco Mine. Another example is IAMGOLD's Rosebel project in Suriname, where a designated tailings area has been established through a protocol with ASGMOs, with proper environmental requirements in place. This protocol removes legal liability from IAMGOLD, and a monitoring committee has been set up to control access to the mining area (Bickham & Brandstaetter, 2022).

8.1.2.3 Informal ASGM on LSM Concession

In this scenario, informal (operating without a permit but socially legitimized) ASGM activities take place within the LSM's concession area and may have been initiated before or after LSM operation.

In this case, LSMOs face the challenge of integrating or negotiating with pre-existing ASGM activities. If informal ASGMOs were present before LSMOs commenced, LSMOs may inherit pre-existing tailings-management challenges. LSMOs may also grudgingly accept informal activities on their concession, even if these activities started after their own operation commenced. LSMOs may accept the ASGM activities because of challenges in removing the informal miners, particularly when there is tacit permission from local stakeholders and the government does not have the political will to forcibly remove ASGM operators.

ASGM operators face the risk of displacement but may have the opportunity to negotiate terms of operation or employment with the LSMO. In this case, the LSMO might impose restrictions or requirements to adhere to tailings-management strategies, possibly leading to improved environmental outcomes.

Categorizing artisanal mining occurring on LSMO concessions as "informal" as opposed to "criminal" implies a level of legitimacy, even though the activities may be deemed illegal under strict consideration of the law. Informal mining legitimacy is largely conferred in an ad hoc way. However, more recently, some development actors have seen the need to provide a framework to confer this legitimacy. The Organisation for Economic Co-operation and Development (OECD) has a definition for legitimate ASGM (see Box 16) that includes alignment with most environment social and governance (ESG) and responsible mineral supply best practices, and the intention to legalize operations where possible. The LSMO concerned must have a special agreement with the community allowed by the government as an extra-legal arrangement to implement this legitimacy. This scenario may occur in cases where the government's mining regulations create barriers for miners, particularly those from marginalized groups who have limited access to services and resources, making it challenging to obtain permits or licences. Furthermore, the legal framework may lack clarity regarding the permissibility of subleasing or tributing activities in mining operations. This legitimacy is often considered favourably by buyers from formal markets, who then opt to buy gold produced by these informal artisanal miners.

BOX 16. DEFINITION OF LEGITIMATE ASM

"Legitimate refers, *among others*, to artisanal and small-scale mining that is consistent with applicable laws. When the applicable legal framework is not enforced, or in the absence of such a framework, the assessment of the legitimacy of artisanal and small-scale mining will take into account the good faith efforts of artisanal and small-scale miners and enterprises to operate within the applicable legal framework (where it exists) as well as their engagement in opportunities for formalization as they become available (bearing in mind that in most cases, artisanal and small-scale miners have very limited or no capacity, technical ability or sufficient financial resources to do so)."

Source: OECD, 2016, p. 69.

At Merian Mine in Suriname, Newmont exemplifies this kind of interface (Veiga et al., 2022). The LSMO wanted to support community ASGM projects to manage demands by the local community to have access to mineralized ground. This approach was also attempted by Goldfields at Damang Mine in Ghana; however, the scheme suffered setbacks because it was under-subscribed and was overrun by a rush of illegal miners wanting to benefit from the company's generosity (Aubynn, 2009). Even though this arrangement of having artisanal miners operate on an LSMO concession was not provided for in the law, all key actors tolerated the intervention because it provided an opportunity to pilot a co-habitation arrangement.

It is not clear if the arrangements cited in this type of interface included tailings reprocessing. However, it is highly unlikely that these agreements would have included tailings generated by recent LSMO activities, as the residual gold in those tailings would have most likely been too low to constitute a gold resource. There is also no clarity on whether special arrangements would have been made with regard to the liability for the tailings produced by ASGM activities. If the letter of the law was strictly followed with regard to the obligation of the LSMO mine rights holder, it is likely that the LSMO would ultimately be liable for the management of the tailings produced. The same liability would also apply if tailings were included in the gold resource the LSMO offered to the ASGMO; however, this is highly unlikely unless the tailings were old and produced at a time when gold-extraction methods were not as efficient.

8.1.2.4 ASGM Linked to Criminality on LSM Concession

In this scenario, ASGM activities closely linked to criminality may occur within the LSM concession area, and these activities may have started before or after the LSMO. These activities are both illegal and associated with violent criminal behaviour.

In this scenario, LSMOs are confronted with significant security and reputational risks. LSMOs also face significant risks due to potential environmental damage and safety hazards arising from poorly managed tailings associated with criminal ASGM activities, with potential legal liabilities. The government faces severe security challenges and enforcement difficulties.

The difference between this illegal mining and the informal mining described in section 8.1.2.3 is that in this interface, the ASGM is not conferred any legitimacy, largely because of the perceived close association with criminal activities, such as gang violence, terrorist activity, and human rights abuses, as well as the illicit trading of the resulting gold. These kinds of ASGM

activities linked with criminality have been reported at LSMOs in developing countries such as Ghana, Mali, Zimbabwe, and South Africa. In South Africa, the illegal gold miners who invade South African gold-mining operations are colloquially referred to "zama-zama." In addition, the money laundering, smuggling, extortion, corruption, and other illicit financial transactions that may accompany illegal ASGMOs contribute to an environment that is especially unsafe for women and jeopardizes their safety, with an increased prevalence of gender-based violence and human trafficking (IGF, 2022). The responses of LSMOs, governments, and other actors include security actions using private as well as public security forces.

Tailings management and reprocessing in this type of interface dominated by criminality is mostly concerned with risk management—stopping or reducing the criminal activities. These illegal activities are indiscriminate with what they target, and even though the most notorious activities are underground, tailings on the surface are also a factor. It is reported that criminal activities include bringing the "cherry-picked" gold ore to be processed in informal settlements, often generating poorly stored tailings that contain mercury.

8.1.3 LSM-ASGM Interface and the Gender Dynamics in ASGM Tailings Management and Reprocessing

Specific gender dynamics are active in the interplay between LSM and ASGM and vary between the different types of interfaces, with specific gender impacts. These gendered impacts need to be addressed in ways that ensure gender equality while minimizing negative impacts and maximizing developmental outcomes for women and girls. The interplay is summarized in Box 17.

BOX 17. GENDER DYNAMICS OF THE LSM-ASGM INTERFACE

The gender dynamics in ASGM tailings management and reprocessing, as they interface with LSM, are largely a reflection of gender dynamics in the ASGM sector broadly and manifest in several ways.

Formal ASGM parallel to the LSMO

Women are under-represented because of gender inequity in accessing opportunities. For example, women's education levels and limited access to capital make it difficult for them to apply for ASGM permits. Laws might also be blind to the gender dynamics present in both LSM and ASGM. When laws are gender blind, processes such as formalization can further marginalize women or put them at a disadvantage when compared to groups with more access to opportunities.

Formal ASGM on LSM concessions

Women are excluded from participating equitably because they are often left out of negotiations to access the coexistence opportunities. The structures that negotiate these coexistence interventions are dominated by men (LSMOs, government, ASM associations, community and traditional leaders), and unless deliberate efforts are made to include women, they will continue to be left out. LSMOs with strong gender and diversity programs can often influence progressive outcomes in terms of gender equality and women's empowerment. Including women in mining associations and strengthening the role and agency of women's initiatives and women's associations in these arrangements would make a positive impact on their inclusion.

Informal ASGM on LSM concessions

The entrenched gender inequalities manifest more often in the informal interface. Since this illegal mining is tolerated, there are no structures to address the gender inequalities. Women typically reprocess the waste of the male miners. The LSMOs and the governments may turn a blind eye to these activities, but they cannot be seen to be engaging the informal miners because they are illegal according to the strict letter of the law and also because the line between informality and criminality is blurred. However, these informal situations are increasingly being considered for formalization, whereby the ASGM activities would be recognized, and the conditions of the permits include providing access to mineral resources and support structures to enable women miners' efforts to formalize.

ASGM linked to criminality on LSM concessions

This interface is very challenging, and as in most social situations, women bear the brunt of the worst impacts. The gender inequalities observed in the informal interface are worse in the interface where these activities are linked to criminality. As is true for criminal ASM in general, women's roles are affected by gender-based violence, trafficking, and exclusion from the beneficial parts of the value chain. In trying to access tailings, women not only suffer discrimination, exploitation, and abuse by their male counterparts, but security responses from LSMOs and government regulators often have worse consequences for women. Current structures turn a blind eye to women's potential role to act as agents of peacebuilding and conflict resolution as promoted by the Women, Peace and Security agenda of the United Nations Security Council Resolution, S/RES/1325 (2000).

8.2 Considerations on LSM Tailings-Management Protocols and Their Implications for ASGM

Industrial mining produces a large amount of waste, and the volume of waste material produced per unit of commodity is increasing due to declining ore grades. The United States Geological Survey estimates that only 14% of mined material makes it to processing; the rest is waste rock (Baker et al., 2020). Considering a feed grade of 1 to 8 g/t (which is the range for open pits and underground mines), 99.9992% to 99.9999% of processed material ends up in tailings. The Global Tailings Review estimates that there are 8,500 active, inactive, or closed tailings facilities around the world containing approximately 217 km^3 of tailings (Oberle et al., 2019). Each year, mines generate over 12.3 km^3 in new tailings and over 20% of all global tailings come from gold production (Oberle et al., 2019). Considering the large volumes of tailings and waste that mining produces and is expected to produce in the future as mineral reserves deplete and the grade quality decreases, tailings disposal and management are commonly identified as the most important sources of environmental impact for industrial mining operations (Vick, 1990).

LSMOs typically dispose of and manage tailings using four methods:

1. Tailings storage facilities: Most commonly, LSMOs pump their tailings into surface dams, where the material dries and then is restored with grass and other vegetation. However, tailings dams have been known to fail, releasing toxic waste into nearby water systems, decimating plant life and animal ecosystems, and poisoning and, in

some instances, killing people in nearby communities (Earthworks & MiningWatch Canada, 2012).

2. Aqueous dumping: Mining companies also deposit tailings directly into oceans, rivers, and streams, which adversely affects complex ecological systems.
3. Dry stacking: In this method, the water content of the waste is reduced to about 15%, and the tailings (which now resemble moist soil) are dumped into a liner that is compacted and then discarded into a covered landfill. Although dry stacking is considered a safer waste-management technique, it can still negatively impact the environment—dry tailings degrade air quality and can pollute groundwater and surface water through toxic seepage over time (Save the Boundary Waters, n.d.).
4. Backfilling: Alternatively, tailings are combined with a binder, such as cement, and then used to fill voids in underground operations. This method is considered the safest form of tailings disposal, but by definition cannot apply to open-pit mining.

Unlike informal ASGM operators, LSM operators are duty-bound to national regulations, environmental protection protocols, and corporate lenders' ESG policies (and those of their shareholders) to uphold high standards of waste management throughout the mine's life cycle. However, these regulations have proven insufficient, as the rate of serious tailings facility failures has increased over time, and the environmental and health impacts of tailings facility failures have also compounded. Over half (36 of 55) of serious tailings dam failures in the past 70 years have occurred in the past 30 years, i.e., between 1990 and 2019 (Humphreys, 2020). The most fatal of these failures occurred in 2019, when the tailings dam collapsed at Vale's Corrego de Feijao mine in Brumadinho, Brazil, claiming 272 lives and releasing about 9.7 million cubic metres of toxic waste into the environment (Morrill et al., 2022. This catastrophic failure prompted industry reform and, in 2020, UNEP, Principles for Responsible Investment, and the International Council on Mining and Metals (ICMM) developed the Global Industry Standard on Tailings Management (GISTM), with a multidisciplinary expert panel and a multistakeholder advisory group. The GISTM consists of 15 principles and 77 auditable requirements that apply to tailings facilities, both existing and yet to be built. It integrates social, environmental, and technical standards which are to be implemented throughout the tailings facility life cycle, from site selection, design, and construction through management and monitoring, to closure and post-closure. The GISTM and other tailings management protocols provided in Table 3 apply only to medium- and large-scale mining operators and make no reference to ASM. Nevertheless, the body of knowledge can offer some takeaways for ASGM, set out in detail in Table 3.

TABLE 3. LSM tailings management protocols and their implications for ASGM

Standards		Implications for ASGM
Tailings management protocols		
International Organization for Standardization (ISO) Mine Closure and Reclamation Terminology Mine Closure and Reclamation Management Planning ISO 21795-2:2021	ISO 21795-2:2021 provides guidance for mine closure and reclamation planning applicable to both new and operating mines. The overarching objective is to promote consistency and quality in planning for mine closure and reclamation internationally and to minimize the impacts caused by mines during the closure life cycle. Tailings and waste management are discussed in detail in the "Closure and Reclamation of a Mine Site" section of the guidance.	Access to resources: Mine closure and the closure of related tailings storage facilities should take into account potential value creation through reprocessing and alternative uses of waste. Managing illegal ASM-LSM interface Downscaling of good practices with respect to planning and managing tailings storage. This includes linking licensing granting and renewal to the submission of Mine Closure Plans (including tailings and waste management). Use of archived LSMO mine closure to advise ASGM operators on ambient environmental considerations.
ISO Environmental Management Systems – ISO 14001:2015	ISO 14001 is the international standard for designing and implementing an environmental management system. The standard provides a checklist for implementing good environmental practice and policies. Companies can apply for 14001 certification and some mines have received certification. Although ISO 14001 does not explicitly refer to tailings management, it would have to be included in the environmental management system of a mine.	Downscaling of good environmental practices, e.g., checklist of requirements of the Environmental Management Plan, more efficient provision and usage of rehabilitation monetary guarantees. Use of archived LSMO EIAs and Risk Management Plan to inform strategic regional ESIAs. Evaluation of residual value in mine waste and tailings, including possible exploitation by the ASM sector.

Standards		Implications for ASGM
Guidance		
ICMM: GISTM Conformance Protocols	The conformance protocols help operators and independent third parties assess the implementation of the GISTM requirements. They map to the Standard's 77 requirements using 219 clear and concise criteria.	Having a sector protocol is effective and provides consistency in performance while providing a framework to provide support to the sector. A structured permitting approach lays out clear roles and responsibilities. Tailings management is an involved and costly exercise for which the ASGM sector will need support. Innovative approaches linked to the overall management of the ASGM sector will be required.
ICMM: Tailings Management: Good Practice Guide	It provides guidance on good governance and engineering practices that will support continual improvement in the management of tailings facilities and help foster and strengthen a corporate safety culture. To support implementation of the guide, ICMM has developed a series of training materials aimed at building capacity within the wider industry, raising awareness at the mine-site level of why tailings management is important and illustrating what good governance and engineering practices look like.	Downscaling and adapting some of governance and engineering practices for ASGM instead of "reinventing the wheel." Given the current trend toward co-existence between ASGM and LSM, LSM operators could consider mentoring neighbouring ASGM operators. Through ICMM, an industry LSM support initiative for the ASGM sector could be developed.
UN Economic Commission for Europe (UNECE) Safety guidelines and good practices for tailings management facilities	UNECE member countries jointly developed safety guidelines and good practices for tailings management facilities under two UNECE Conventions: the Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention) and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention).	These guidelines could be extended to the ASGM sector and linked to other UN initiatives such as the Global Environmental Facility planetGOLD program. The impacts of ASGM tailings management on transboundary waterbodies requires regional collaboration.

Standards		Implications for ASGM
European Commission Best Available Techniques Reference Document for the Management of Waste from Extractive Industries	This guide provides technical information for the best available techniques in relation to mine waste. The objective of this guide is to provide European mine operators, governments and other stakeholders with up-to-date information and data on the management of extractive waste.	Opportunity to extract best practices for application in the ASGM sector, e.g., mapping and characterization of mine waste for risk management as well as for valorization from reprocessing and reuse.
Earthworks; Mining Watch Canada and London Mining Network Safety First: Guidelines for Responsible Mine Tailings Management V.2	The Safety First V.2 Guidelines provide a holistic community-focused conservationist best practice guide for tailings design, management, and regulations.	Opportunity to extract best practices that could be adapted for the ASGM sector.
UN Environment & GRID – Arendal Mine Tailings Storage: Safety Is No Accident	This guidance is a rapid-response assessment that focuses on safety first and provides recommendations in the areas of knowledge, technology, innovation and people; failure prevention; and crisis response.	Opportunity to extract best practices that could be adapted for the ASGM sector.
The Mining Association of Canada: A Guide to the Management of Tailings Facilities – Version 3.2	This guide provides guidance on responsible tailings management, helps companies develop and implement site-specific tailings-management systems, and improves consistency of application of engineering and management principles to tailings management.	Opportunity to extract good practices that could be adapted for the ASGM sector.

Standards		Implications for ASGM
Asia-Pacific Economic Cooperation Mine Closure Checklist for Governments	The objective of the Mine Closure Checklist for Governments is to provide policy-makers in the Asia-Pacific Economic Cooperation region with the essential elements of a successful mine-closure governance framework based on leading international guidelines and standards, as well as international experience. This checklist is designed to provide a logical, sequential series of steps that will allow policy-makers to identify gaps in their current mine-closure framework and identify how to address those gaps.	Opportunity to extract best practices that could be adapted for the ASGM sector.
Technical guidance		
International Commission on Large Dams (ICOLD) Bulletin 153: Sustainable Design and Post-Closure Performance of Tailings Dams	ICOLD is the professional organization for dam engineering. It is an international forum for knowledge sharing and dam engineering best practices. Bulletin 153 provides guidance on sustainable closure principles, sustainable design considerations and long-term monitoring of tailings dams.	Good practice sharing with the ASGM sector, particularly since in some countries the regulation of large tailings facilities is included under large dams and falls under the jurisdiction of water authorities.
ICOLD Tailings Dam Design Technology Update – Bulletin 181	Bulletin 181 provides updates regarding tailings properties and technology related to dewatering and disposal and the technical design of confining dams.	Good practice sharing with the ASGM sector, particularly since in some countries the regulation of large tailings facilities is included under large dams and falls under the jurisdiction of water authorities.
ICOLD Recommendations for operation, maintenance and rehabilitation – Bulletin 168	Bulletin 168 provides guidance on the maintenance and rehabilitation of tailings facilities.	Good practice sharing with the ASGM sector, particularly since in some countries the regulation of large tailings facilities is included under large dams and falls under the jurisdiction of water authorities.

Standards		Implications for ASGM
ICOLD Dam safety management: operational phase of the dam life cycle – Bulletin 154	Bulletin 154 guides operators on the development and implementation of dam safety management systems in the operation phase.	Good practice sharing with the ASGM sector, particularly since in some countries the regulation of large tailings facilities is included under large dams and falls under the jurisdiction of water authorities.
Initiatives		
Global Minerals Professional Alliance Global Action on Tailings	Global Minerals Professional Alliance is a membership association for minerals professionals around the world. The Global Action on Tailings is an initiative of the Global Minerals Professional Alliance that engages and connects technical experts to advance discussions and solutions relating to tailings management, reprocessing, and repurposing, ultimately driving toward tailings elimination.	A mentorship program could be established to support the ASGM sector in tailings management through governments and donor-funded initiatives.
GRID-Arendal Global Tailings Dam Portal Project	The Global Tailings Portal is a searchable public database with detailed information on more than 1,700 mine tailings dams around the world.	Establishment of a similar database for the ASGM sector.
UNEP & ICMM The Cyanide Code	The Cyanide Code is a voluntary industry program focused on the safe management of cyanide that is produced, transported, and used for the recovery of gold and silver, and on mill tailings and leaching solutions. The code has nine principles, all of which have specific recommended standards of practice. The signatories of the Cyanide Code have 3 years to abide by best practices and are audited and certified by the International Cyanide Management Institute.	Good practices should be transferred to the ASGM sector and linked to the ASGM initiatives under the Minamata Convention (e.g., good practice recommendations on cyanidation of mercury tailings in the UNEP Guidance on ASGM tailings; UNEP, 2021b).

Standards		Implications for ASGM
European Institute of Innovation and Technology Raw Materials STINGS – Supervision of Tailings by an Integrated Novel Approach to Combine Ground-based and Spaceborne Sensordata	STINGS is an innovation project funded by European Institute of Innovation and Technology Raw Materials to establish a ground- and space-borne remote sensing and analysis system to effectively and cost-effectively monitor critical ground infrastructure stability and content, primarily focusing on mining tailings dams. It is dedicated to increasing the safety standards related to tailings operations with an extended monitoring and early-warning system for the identification of operational impacts and environmental risks.	The remote sensing approaches could be applied to assessing and tracking ASGM tailings in remote and difficult-to-access areas.

The lessons from the interface between ASGM and LSM provide opportunities for better management of ASGM tailings management and reprocessing.

9.0 Recommendations

This section provides an overview of best practice recommendations, including in ASGM tailings management and reprocessing. It identifies the reprehensible practices and offer a set of recommendations and solutions to mitigate their impact or to eliminate them entirely.

Issue: Irresponsible Chemical Use

Recommendations:

- The best way to manage mercury-containing tailings is to not generate them in the first place.
- ASGM operators should use the lowest possible concentration of cyanide to reduce risks to wildlife from exposures to tailings and to water quality from potential seepage.
- Sensitization campaigns on the safe use of chemicals and mercury-free techniques should be conducted with ASGM miners and processors.
- Financing options for mercury-free alternatives and to improve Occupational Heath and Safety in ASGM should be made available through financial institutions.
- Processors should be required to buy all mining-related hazardous chemicals, including mercury and cyanide, to the extent they are legally permitted, directly from the government or a government-approved chemical distributor in order to track and trace chemical use. Distribution should be mindful of the different obstacles women and men face when trying to access services equitably and address these barriers.
- Processors should also be provided with training on the risks of chemicals and their safe use, handling, and transport, including on specific processes and the use of proper personal protective equipment adapted to the chemical considered. Penalties should be imposed on people who buy, sell, and use chemicals without safeguards.

These recommended actions will increase transparency and traceability of chemical use in ASM. They will also ensure that banned or unauthorized chemicals are not being used in ASGM, thereby limiting toxic exposure and boosting health and safety.

Issue: Mercury Use and Whole Ore Amalgamation

Recommendations:

- ASGM operators should be educated and made acutely aware of the severe risks associated with whole ore amalgamation to discourage the misuse of this technique.
- Governments and development partners should provide ASGM operators with training on less-mercury-intensive or mercury-free techniques. Information should be accessible and shared in a culturally appropriate way to reach all gender and age groups involved in ASGM.
- Alternative techniques include concentrate amalgamation; chlorination; the use of mercury-free equipment such as sluice boxes (Cleangold, n.d.), shaking tables (JXSC, n.d.), and centrifuges; or the safe use of mercury with a retort stand, fume hood, and condenser to recover the mercury, which can then be reused.

These recommended actions will reduce the amount of mercury that is released directly into both the tailings and the environment and will reduce the risk of short- and long-term harm to ASGM operators and local communities.

Issue: Unsafe Chemical Leaching

Recommendations:

- Cyanide should only be used by organized and trained miners who can comply with chemical management codes.
- ASGM operators should be encouraged to use cyanide safely, where legally permitted and when appropriate capacity exists, after inclusive training on the risks presented by cyanide.
- ASGM processors should be motivated to use safeguards when using cyanide, such as securing vats and tanks using impermeable sheeting and coverings. Operators should either be provided with designated areas, far away from residential or agricultural land and waterbodies, to conduct processing activities or encouraged to use centralized processing facilities with leaching services, as they tend to be better able to ensure sound practices.

These recommendations will reduce the potential for cyanide spills and environmental and human harm. Mine sites should create emergency response plans that include protocols for early detection, containment, and swift mitigation of any spill incidents.

Tailings Management

Issue: Poor Tailings Management

Recommendations:

- Ensure miners' participation and build interventions on the formalization efforts.
- Allocate financial mechanisms and responsibilities to ensure the sound management of tailings.

- Review legal and regulatory frameworks to identify gaps and propose improvements with respect to tailings management.
- Inform the community about the presence of mercury-contaminated tailings and the associated risks.
- Sensitization and awareness campaigns need to be conducted with ASGM miners, processors, and local communities on the safe management of tailings and the risks posed by improper tailings management.
- As part of permitting systems, formal ASGM operators should be required to submit a tailings management plan that should detail how the operator will transport, dispose of, restore, and remediate the mine site.
- Creating a specialized tailings framework will ensure that permitted miners acknowledge the importance of tailings management. It could also act as a motivating factor for government officials to monitor and enforce waste-management regulations.
- Permitting processes should be designed to be accessible to women to support their integration into formalized activities. This inclusive design would involve giving women access to information and resources to understand the management and safe disposal or remediation of tailings.
- Formalization schemes should be supported by strategic environmental and social assessments to integrate environmental, social, health, safety, and cultural issues into mining and tailings management planning at the regional level prior to granting permits.

Issue: Dumping Tailings into Water Sources

Recommendations:

- ASGM operators should be educated about the negative impacts of dumping tailings into water sources. They should also be provided with a suitable alternative, such as a regional tailings dump, or a centralized processing centre where miners can bring their tailings to be safely managed.
- Tailings contaminated with mercury should not be dumped into streams or in flood-prone areas.

A greater focus needs to be paid to the impacts of disposing of tailings into water sources, as these sources impact all aspects of daily life, including food security and physical health. Interventions to curb this practice are key to ensuring that waterbodies are not filled with chemicals and/or filled with silt.

Issue: Mixing of Mercury-Contaminated Tailings with Mercury-Free Tailings

Recommendations:

- ASGM operators employing mercury-free techniques should be encouraged to keep their tailings separate from mercury-laden tailings. This could be achieved through the disbursal of tailings storage tanks or equipment (sheeting, covers, and cement) needed to build safe tailings ponds.

- Centralized processing centres could also conduct tests on tailings to ensure that contaminated tailings do not mix with mercury-free tailings.

Keeping mercury-laden tailings away from mercury-free tailings would ultimately reduce the volume of mercury-contaminated tailings and reduce mercury pollution.

Issue: Exposed Tailings Ponds

Recommendations:

- Formal miners could be required to construct appropriate tailings ponds or dams prior to commencing mining activities as part of their permitting obligations.
- Miners should ensure tailings structures are constructed away from human settlements, grazing and farming areas, and waterbodies, as well as outside flood areas.
- Existing and projected tailings ponds should be clearly identified and fenced to exclude animals and humans.
- Ponds and impoundments must be constructed and managed to ensure that rainfall or local flooding does not result in release of cyanide-contaminated effluent.
- Alternatively, governments or development partners could build centralized tailings storage facilities where the tailings are stored safely.

Issue: Lack of Knowledge about Existing Tailings

Recommendations:

- Use geospatial tools, e.g., GIS, to keep track of the locations and characteristics of mercury-containing tailings.
- Use remote sensing to identify and track the spatial evolution of existing tailings over time.
- Use periodic sampling and characterization of the tailings to monitor changes.

Issue: Unsafe Transportation of Tailings

Recommendations:

- ASGM operators must be educated on safe transportation practices, i.e., that the tailings must always be covered and that sheeting must be used to reduce chemical contamination, dust pollution, and seepage.
- Processors or governments with centralized processing centres could provide tailings collection services using vehicles that are equipped to haul tailings.

These recommendations aim to reduce the exposure of local communities to tailings, dust, and other toxic chemicals that could seep into the soil and groundwater.

Tailings Reprocessing and Valorization

Issue: Mercury-Laden Tailings and Cyanide Leaching

Recommendations:

- Sensitization and awareness campaigns need to be conducted with ASGM miners and processors on the mixing of mercury-laden and mercury-free tailings and the risks of using cyanide on mercury-laden tailings.
- Research, development, and piloting of mercury-free technologies should be encouraged in the ASGM sector.
- Processing centres should provide ASGM miners access to mercury-free technologies to limit the use of mercury.
- Processors must be mandated to conduct mercury removal before cyanidation.
- ASGM operators must be encouraged to use mercury-free techniques during the ore processing stage or must be taught to remove mercury from the tailings before performing cyanidation. Applicable methods include the use of copper plates (Pure Earth, 2023b) or other metal plates (Health Europa, 2018), flotation (Kianinia et al., 2017), distillation (Opiso et al., 2018), activated carbon adsorption (Sousa et al., 2010), froth flotation (Pure Earth, 2022), and gravimetric techniques (Baena et al., 2021). The development of economically viable mercury removal techniques must be encouraged.
- Additionally, centralized processing should test the tailings for mercury, and if mercury is present, it should be removed occur prior to cyanidation. Removing mercury prior to cyanidation is the only way to ensure that harmful mercury-cyanide complexes are not produced and do not enter the environment.
- Recovered mercury should be safely disposed of.

Issue: Incentivization of Tailings Reprocessing

Recommendation:

- Governments could consider setting up processing plants to reprocess tailings or supporting their establishment. This could not only ensure that the tailings are processed in an environmentally friendly way, but the government would be able to access pricing mechanisms directly, which would allow it to better monitor operations between related parties.

Issue: Critical Minerals in ASGM Tailings

Recommendations:

- ASGM tailings are potentially a source of critical minerals, which could influence their management.
- Tailings should be mapped and surveyed to understand the potential for secondary mineral extraction.
- Skills development, training, and information need to be provided to ASGM operators to enable them to extract valuable materials from gold tailings.

Issue: Valorization of ASM Tailings

Recommendations:

- Governments should closely monitor the minerals that are extracted from reprocessing the tailings, particularly co-products and by-products that can be economically extracted, such as industrial sand, zinc, copper, and silver.
- Another potential route for safe tailings management is the recycling of tailings. Gold tailings are primarily composed of silica, which can be used to make concrete pavers (Balegamire et al., 2022), bricks (Adajar et al., 2021), or other construction materials. This recycling potential offers governments and ASGM operators the opportunity to elongate the ASM value chain, which will benefit local economies and communities. Additionally, recycling tailings will help mitigate some of the negative environmental impacts related to tailings storage and disposal.

Mine-Site Management

Issue: Limited Restoration and Remediation of Mine Sites

Recommendations:

- Government, ASGM stakeholders, and financial institutions should work together to develop funding for plant decommissioning.
- ASGM regulators must enforce mine closure and cyanide plant decommissioning policies and regulations, which should be tailored for the ASGM sector. Additionally, regulators should organize educational sessions focused on the benefits of restoration and future restored land-use possibilities.
- Regulators should engage and support ASGM communities in the design and implementation of restoration plans. Restoration should ensure physical and chemical stability of the area to allow post-restauration land use. Physical stability might include surface grading and revegetation to reduce erosion.
- Government should allocate funding or establish partnerships with stakeholders to support ASGM operators, particularly informal ones, in conducting restoration and remediation activities post-mining. This initiative would facilitate the prompt filling of excavations at extraction sites, reducing risks to humans and livestock, while also combating soil erosion and preventing further land degradation.
- Governments must work with ASGM operators to help them rehabilitate the mine site, conduct physical restoration activities (such as backfilling pits) or chemical restoration activities (which involve treating the soil with chemicals to remove contaminants).

Additionally, innovative new restoration and remediation methods are emerging. Bioremediation, for example, uses living organisms that are genetically engineered to convert tailings into material that is safe for disposal (Jayapal et al., 2023).[5] Using such methods, the

[5] The creation of a dedicated tailings framework will ensure that permitted miners acknowledge the importance of tailings management. It could also act as a motivating factor for government officials to monitor and enforce waste-management regulations.

land can be restored to an acceptable level so that it can be used for alternative activities such as agriculture or for residential purposes.

It is necessary to establish a remediation and restoration fund for the responsible government department to conduct mine-closure activities in the event that ASGM operators are unable to conduct these activities.

Partnerships with LSM to remediate ASM sites should be explored as part of coexistence models.

Issue: LSM-ASGM Interface

Recommendations:

- LSMOs should be encouraged to work with ASGM operators (through skills transfer, technology transfer, and tributing arrangements); this could enhance how tailings are created and managed in ASGM.
- Industrial mine operators are held accountable by various standards, guidance documents, and interventions. This body of knowledge offers various lessons for the management of ASGM tailings.
- Tailings management frameworks in ASM can draw on best practices from existing LSM guidance documents.

Social Considerations

Gender Concerns

- Women in ASGM tend to perform dangerous, lower-earning, and physically demanding tasks along the value chain. They are also particularly at risk from the impacts of toxic chemical exposure.
- Government and development agencies should work with women and their associations to educate them on safe chemical use and support them in using personal protective equipment and safer techniques by providing access to finance initiatives.
- Women in ASGM should also receive support from governments and development agencies so that they are able to conduct their activities in safe environments outside of their homes without having to take their children with them. Targeted programs to support women in ASGM processing should be created so that they can account for the specific socio-cultural circumstances of women and ensure that they are not crowded out by male miners. These programs could include gender-sensitive training and capacity building, the promotion of women in leadership positions, the establishment of women's groups, access to finance initiatives, child-care support, health and safety interventions, advocacy and policy support, and community engagement programs.
- In the implementation of new, more efficient ore processing techniques that may result in reduced gold content in tailings, it is crucial to incorporate a gender perspective. Special attention should be given to ensure that women, if they are primarily engaged in tailings mining, are not disproportionately affected by potential

changes in tailings composition. Gender-sensitive policies and strategies should be developed to address any challenges or disparities that may arise in the context of evolving ore processing methods. This approach will promote equitable benefits and opportunities for all participants in the sector.

- Supporting women in their activities along the value chain can improve their ability to benefit from ASGM mining, including reprocessing of tailings; reduce their vulnerability to poverty and food insecurity, exploitation, and abuse; and more broadly contribute to the sustainable development of the sector.

Child Labour Concerns

- Children are sometimes active participants in the ASGM value chain. They may perform dangerous and gruelling tasks, such as transporting, hand sorting, and performing mercury amalgamation on the gold tailings.
- The International Labour Organization's Convention No. 138 (the Minimum Age Convention) sets the minimum age for work for children at 15 years and provides a range of protections to those working children. This minimum age applies only to work that is not defined as one of the worst forms of child labour, including hazardous work, which is prohibited for persons below the age of 18 years.
- To eliminate child labour in ASGM, a first step would be for governments to ratify international conventions that regulate it. National legislation that seeks to eliminate child labour needs to be enacted, and sensitization interventions need to be developed. Local and national governments must monitor and stop child labour in ASGM settings by enforcing regulations.
- The drivers of child labour are complex and diverse. However, poverty is widely regarded to be a major contributing factor to the existence of child labour in ASGM. The long-term solutions to the problem of child labour lie in sustained economic growth leading to social progress, particularly poverty alleviation and universal education.
- The economic drivers of child labour are complicated, as many children may participate in ASGM to supplement family income or contribute to the productivity of a family-owned mine site. However, eliminating child labour is key to the sustainable and responsible development of ASGM.

Policy and Regulatory Considerations

Lack of International and Regional Support

The production and processing of tailings is a matter of global importance because it can produce many negative social, environmental, and health impacts. However, ASM tailings management has not been prioritized by the international community: its governance is currently limited to two chemical-focused guidance documents.

Recommendation: The creation of an international ASM-specific tailings management standard that is operationalized with sensitization programs and interventions is necessary for sound tailings management.

Most regional blocs do not have frameworks that provide for ASM, let alone tailings management. Regional covenants and protocols are important because they drive the synthesizing of national frameworks to a regionally accepted standard.

Recommendations:

- Urgently develop comprehensive regional frameworks for ASM, with a specific emphasis on tailings management, to standardize regulations, promote cooperation, and improve ASM governance across member states.
- Support regional organizations in building the capacity of member states to effectively implement and enforce these regional frameworks. This support includes providing training and technical assistance while sharing best practices.
- Promote the exchange of information and experiences among regional blocs that have successfully implemented ASM and tailings management frameworks. This sharing of knowledge can expedite the development and adoption of effective regional standards.

Informality of ASM

Sound tailings management is hindered by informality. Legislation and other tailings management frameworks can only be applied to formal operators.

Recommendations:

- Governments and other stakeholders have to advance and support the formalization of the ASM sector to improve tailings management. This support should be mindful of the obstacles faced by the most marginalized groups and be designed to overcome obstacles they face in accessing services and resources.
- Formalization could be advanced through streamlined processes, institutional support, capacity building, information sharing, the creation of ASM zones, and the creation of favourable legislation.
- Governments are encouraged to use different non-tax policy responses to promote formalization, such as access to credit facilities for ASM miners.

Lack of Fiscal Tools for the ASM Sector

Fiscal incentives are necessary to support formalization and tailing reprocessing. Tax incentives can be implemented to encourage reprocessing, the adoption of environmental best practices, and the dissemination of clean technologies in the ASGM sector (Masson et al., 2013).

Recommendations:

- Tax incentives could be provided to operations using environmental best practices, including cleaner technologies and mercury-free processing alternatives, which are normally agreed upon during the concession process.
- Exemption from import taxes for environmentally friendly mining and mineral-processing equipment should be strongly considered.

- Governments could decide to temporarily exempt gold miners and processors from taxes regarding ASGM tailings-related transactions. Once a certain degree of formalization is achieved, resource-rich countries are better placed to adapt existing tax frameworks for ASGM tailings.
- Over a period of transition (from exemption to full taxation), governments could consider granting tax incentives to the actors that reprocess the tailings to extract gold.

Lack of Regional Fiscal Harmonization for ASM

Neighbouring resource-rich countries might consider harmonization of ASGM taxes. This will prevent miners from smuggling both ore and tailings into jurisdictions that charge lower taxes or none at all (International Monetary Fund, 2013).

Lack of National Frameworks in ASGM Tailings Management

Most national frameworks provide for tailings management under their mining code or environmental regulations. However, most countries have not adopted ASM-specific tailings-management or waste-management provisions, which has resulted in confusion about the duties and obligations of ASM operators.

Recommendations:

- Legal frameworks that contain specific provisions for ASM tailings and mine-waste management outlining the duties and obligations of ASM operators need to be created.
- Extension services that train and capacitate ASM operators or government departments that undertake tailings management activities are needed.
- Although legislation exists for tailings management within national frameworks, most countries have not adopted ASM-specific tailings management provisions. Furthermore, enforcement mechanisms are limited, which has resulted in widespread negative impacts stemming from poor tailings management. Additionally, there is a general lack of awareness that laws and policies related to ASM tailings management exist.
- Monitoring and enforcement in ASM generally need to be strengthened to limit the negative impacts of ASM and encourage best practices in the sector.
- Government stakeholders must be provided with training and up-to-date information on legislation related to ASM.
- Institutional support is key to improving tailings management for ASGM operators who are constrained by limited capacity and capital.
- Centralized institutions that support the sound management of tailings, such as processing plants, disposal sites, and buying centres, need to be created.
- Most national frameworks do not explicitly support the reprocessing of tailings through processing licences and support programs. This is a missed opportunity because governments could collect extra taxes on the sale of tailings. Licensing also offers governments greater oversight of the sector and could enhance enforcement and better practice.

- Governments should create legal provisions to support the reprocessing of tailings, including by developing processing licences separate from primary mining licences, enacting legislation that allows for the sale of tailings, and creating a fiscal regime that can be applied to the sale of tailings.
- It is advisable to incorporate the Minamata ASGM NAPs as an integral component within national ASGM frameworks.
- Recognizing the Minamata NAPs and aligning them with existing national strategies can enhance the effectiveness of efforts to reduce mercury use, improve environmental sustainability, and promote safer and more responsible ASGM practices.
- Coordination and cooperation between government agencies, international organizations, and local stakeholders should be encouraged to ensure the successful integration of Minamata NAPs into the broader ASGM governance framework.

10.0 Conclusion

In summary, ASM is a catalyst for global sustainable development as well as national economic development. It is a vital source of raw mineral inputs that are sought by different industries. Artisanal gold mining employs approximately 20 million people in 80 countries around the world. It also produces one fifth of the world's newly produced gold annually.

On the other hand, alluvial or hard rock ASGM produces tailings that often contain dangerous chemicals, such as mercury, cyanide, petroleum by-products, and sulfuric acid. These contaminants pollute waterbodies, threaten potable water supplies, poison agriculture and aquaculture, impact food supplies and human health, and do irreparable harm to natural ecosystems. Due to the informal and sometimes seasonal or migratory characteristics of ASGM, artisanal miners do not follow environmental standards or waste-management protocols, and they often move on, leaving their tailings behind in poorly constructed tailings ponds without following any containment, restoration, or remediation practices.

ASGM is the single largest source of anthropogenic mercury emissions. Since the promulgation of the Minamata Convention, the use of mercury in ASGM has received considerable attention. However, the regulation of tailings that are often laden with mercury and other toxins has not garnered the international attention it requires. As such, the international governance of ASGM tailings is currently limited to two chemical-focused guidance documents—UNEP's *Sound Tailings Management in Artisanal and Small-scale Gold Mining* (UNEP, 2021b), and planetGOLD's *Best Management Practices for Cyanide Use in the Small- Scale Gold Mining Sector* (2021).

Regional governance frameworks can contribute to a better managed ASGM sector. Regional covenants and strategies often pave the way for state-level legislation. Currently, tailings-management and reprocessing regulations are broadly handled by regional environmental protection frameworks or waste-management strategies. However, regional organizations have not yet created clear guidelines for ASGM tailings disposal or management. Moreover, many regional blocs have yet to include ASM as a strategic priority area.

National laws set the minimum standards for best practices, emphasizing the duties and responsibilities of ASGM stakeholders. Although ASM is defined and provided for in the laws of most ASGM countries, tailings management and reprocessing have not been prioritized as key policy areas. Most countries have not created ASGM-specific tailings-management and

disposal frameworks and have instead chosen to apply their pre-existing industrial mining codes and attendant environmental laws to ASGM. This approach increases the burden for ASGM operators, thereby increasing the risk of non-compliance. As a result, most countries miss out on the benefits that could be generated from tailings reprocessing.

LSM operators are duty bound to national regulations, environmental protection protocols, and corporate ESG policies to uphold high standards of tailings management and waste disposal throughout the mine's life cycle. However, due to inadequate tailings management, several LSM tailings facilities have failed over time, prompting the creation of the GISTM. The GISTM and the various other technical standards and guidance documents that have been developed for medium- and large-scale mining operators can guide the creation of best practice guidelines for ASGM. Working with LSM operators can also enhance the management of ASGM tailings and prevent conflicts between LSMO and ASGMO.

References

Abdulai, A. G. (2017, June 1). *Findings: Competitive politics and the challenge of combating illegal mining in Ghana*. Effective States and Inclusive Development. https://www.effective-states.org/beyond-the-resource-curse-the-political-economy-of-mining-and-inclusive-development-in-ghana/

Adajar, M. A., Beltran, H. E., Calicdan, C. A., Duran, T. R., Ramos, C. D., & Galupino, J. (2021). *Assessment of gold mine tailings as based geopolymer binder in concrete*. DLSU Research Congress 2021 Manila, Philippines. https://www.researchgate.net/publication/353380297_Assessment_of_Gold_Mine_Tailings_as_Based_Geopolymer_Binder_in_Concrete

Adebayo, T.-H. (2022, April 24). Osun in the mud as mining greed intensifies. *Premium Times*. https://www.premiumtimesng.com/news/headlines/525526-special-report-osun-in-the-mud-as-mining-greed-intensifies.html

Adewumi, A. J., & Laniyan, T. A. (2020). Contamination, sources and risk assessments of metals in media from Anka artisanal gold mining area, Northwest Nigeria. *Science of the Total Environment, 718*, 137235. https://doi.org/10.1016/j.scitotenv.2020.137235

Adu-Baffour, F., Daum, T., & Birner, R. (2021). Governance challenges of small-scale gold mining in Ghana: Insights from a process net-map study. *Land Use Policy, 102*(3–4), Article 105271. https://www.researchgate.net/publication/348408787_Governance_challenges_of_small-scale_gold_mining_in_Ghana_Insights_from_a_process_net-map_study

African Minerals Development Centre. (n.d.). *Artisanal and small-scale mining: Policy guidance for the Country Mining Vision*.https://knowledge.uneca.org/ASM/sites/default/files/docs/ASMPolicyGuidance.pdf

Araya, N., Mamani Quiñonez, O., Cisternas, L. A., & Kraslawski, A. (2021). Sustainable Development Goals in Mine Tailings Management: Targets and Indicators. *Materials Proceedings, 5*(1), 82.

Association of Southeast Asian Nations. (2022). *Strengthening ASEAN cooperation in minerals: Development prospects of ASEAN minerals cooperation (DPAMC)*. https://asean.org/wp-content/uploads/2022/04/DPAMC-Report-Public-version_final-1.pdf

Aubynn, A. (2009). Sustainable solution or a marriage of inconvenience? The coexistence of large-scale mining and artisanal and small-scale mining on the Abosso Goldfields concession in Western Ghana. *Resources Policy 34*(1), 64–70. https://doi.org/10.1016/j.resourpol.2008.04.002

Baena, O. J. R., Aristizabal, G., Pimentel, M. S., Flórez, C. A., & Argumedo, C. E. (2021). Waste management and the elimination of mercury in tailings from artisanal and small-scale gold mining in the Andes municipality of Antioquia, Colombia. *Mine Water and the Environment, 40*(1), 250–256. https://www.researchgate.net/profile/Mateo-Pimentel/publication/344778403_Waste_Management_and_the_Elimination_of_Mercury_in_Tailings_from_Artisanal_and_Small-Scale_Gold_Mining_in_the_Andes_Municipality_of_Antioquia_Colombia/links/6064e26fa6fdccad3f61fb8e/Waste-Management-and-the-Elimination-of-Mercury-in-Tailings-from-Artisanal-and-Small-Scale-Gold-Mining-in-the-Andes-Municipality-of-Antioquia-Colombia.pdf

Baker, E., Davies, M., Fourie, A., Mudd, G., & Thygesen, K. (2020). Chapter II: Mine tailings facilities: Overview and industry trends. In B. Oberle, D. Brereton, & A. Mihaylova (Eds.), *Towards zero harm: A compendium of papers prepared for the Global Tailings Review* (pp. 14–24). Global Tailings Review. https://globaltailingsreview.org/wp-content/uploads/2020/09/Ch-II-Mine-Tailings-Facilities_Overview-and-Industry-Trends.pdf

Balegamire, C., Nkuba, B., & Dable, P. (2022). Production of gold mine tailings based concrete pavers by substitution of natural river sand in Misisi, Eastern Congo. *Cleaner Engineering and Technology, 7*, Article 100427.

Bartrem, C., von Lindern, I., von Braun, M., & Tirima, S. (2022). Climate change, conflict, and resource extraction: Analyses of Nigerian artisanal mining communities and ominous global trends. *Annals of Global Health, 88*(1), 17. https://doi.org/10.5334/aogh.3547

Batista, M.J., Carvalho, J., Tychsen, J. (Eds.). (2022). *Manual de exploração mineira artesanal e de pequena escala para a região da África Austral*. Laboratório Nacional de Energia e Geologia – Lisbon/Portugal and Geological Survey of Denmark and Greenland.

Betancur-Corredor, B., Loaiza-Usuga, J. C., Denich, M., & Borgemeister, C. (2018). Gold mining as a potential driver of development in Colombia: Challenges and opportunities. *Journal of Cleaner Production, 199*, 538–553.

Bickham, E., & Brandstaetter, H. (2022). *Lessons learned on managing the interface between large-scale and artisanal and small-scale gold mining*. World Gold Council. https://www.gold.org/esg/artisanal-and-small-scale-gold-mining

Blow, S. (2019, January 20). *Who are the palliris?* Bolivian Express. https://bolivianexpress.org/blog/posts/who-are-the-palliris?fbclid=IwAR1RKRtdTJ_A4og6kaP8ABnXSWeEg9SlmzH3BHr3CLihpYc5_Q48QhfoB3Y

Breytenbach, M. (2016, October 14). *Gold tailings retreatment an attractive proposition in current environment*. Mining Weekly. https://www.miningweekly.com/print-version/south-africa-has-absolute-potential-for-vibrant-sustainable-tailings-projects-industry-players-2016-10-14

Brugger, F., Müller, S., Zanetti, J., Winkler, M., Knoblauch, A., & Wehrli, B. (2018). *Small-scale gold mining in Burkina Faso: Health effects, environmental burden and socio-economic interactions with agriculture* (Project report). ETH Zurich.

Bugmann, A., Brugger, F., Zongo, T., & Van der Merwe, A. (2022). "Doing ASGM without mercury is like trying to make omelets without eggs." Understanding the persistence of mercury use among artisanal gold miners in Burkina Faso. *Environmental Science & Policy, 133*, 87–97. https://www.research-collection.ethz.ch/bitstream/handle/20.500.11850/540686/3/1-s2.0-S146290112200096X-main.pdf

Cabreza, V. (2017, October 19). *Cyanide turns river blue in Benguet Mine Town*. Philippine Daily Inquirer. https://newsinfo.inquirer.net/939086/cyanide-turns-river-blue-in-benguet-mine-town

Casey, J. (2021, October 12). *"Informal, not illegal": Inside Kenya's artisanal mining industry*. Mining Technology. https://www.mining-technology.com/features/kenya-artisanal-mining/

Charles, N., & Tychsen, J. (Eds.). (2023). Artisanal mining in French-speaking Central, North and East Africa. Geological Survey of Denmark and Greenland and Geological Survey of France. (La mine artisanale en Afrique Centrale, du Nord et de l'Est francophones. Service géologique du Danemark et du Groenland et Service géologique de la France) (BRGM), 488 p.

Chasanah, U., Nuraini, Y., & Handayanto, E. (2018). The potential of mercury-resistant bacteria isolated from small-scale Gold Mine tailings for accumulation of mercury. *Journal of Ecological Engineering, 19*(2), 236–245. doi:10.12911/22998993/83565

Cleangold. (n.d.). *Mercury free gold mining*. https://www.cleangold.com/

Cobbinah, I. J., Gbedemah, G. M. K., Nurudeen, Z. K., Saim, A. K., & Amankwah, R. K. (2021). Characterisation of small-scale gold mining tailings in the western region of Ghana. *Ghana Mining Journal, 21*(2), 27–32.

Colombia. (2020). *A Proposal of a Standard Practice for the Reprocessing of Mining Tailings*. Ministry of Mining and Energy. Government of Colombia. https://www.minenergia.gov.co/static/cursos-mineria/src/document/PROPUESTA LINEAMIENTOS TÉCNICOS DE POLÍTICA DE BUENAS PRÁCTICAS - PRESAS DE RELAVES.pdf

Cordy, P., Maxson, P., Quispe, N., & Merino, D. (2022). *Basic Guidelines for the Interim Storage, Handling and Transportation of Mercury in Peru.* Artisanal Gold Council. https://www.planetgold.org/sites/default/files/AGC.%202022.%20Basic-Guidelines-for-Interim-Storage-EN.pdf

Deutsche Gesellschaft für Internationale Zusammenarbeit. (2022). *Financial-fiscal modeling for small-scale mining: Project: "Regional cooperation for the sustainable management of mining resources in the Andean countries".* (Modelamiento financiero-fiscal para la minería de pequeña escala : Proyecto "Cooperación regional para la gestión sustentable de los recursos mineros en los países andinos").. https://minsus.net/Media-Publicaciones/modelo-financiero-y-fiscal-para-mineria-de-pequena-escala/

Dladla, S. D., & Ramsamy, S. (2022). Practical steps to Global Industry Standard on Tailings Management (GISTM) compliance for operational tailings storage facilities in South Africa. *Journal of the Southern African Institute of Mining and Metallurgy, 122*(6), 283–290.

Drace, K., Kiefer, A. M., Veiga, M. M., Williams, M. K., Ascari, B., Knapper, K. A., Logan, K. M., Breslin, V. M., Skidmore, A., Bolt, D. A., & Geist, G. (2012). Mercury-free, small-scale artisanal gold mining in Mozambique: Utilization of magnets to isolate gold at clean tech mine. *Journal of Cleaner Production, 32*, 88–95. https://www.researchgate.net/publication/257408840_Mercury-free_small-scale_artisanal_gold_mining_in_Mozambique_Utilization_of_magnets_to_isolate_gold_at_clean_tech_mine

Durance, M. V., Botané, P., & Cailleau, A. (2010). Reprocessing of a French Guyana operation's tailings using flotation for gold concentration. *Mining, Metallurgy & Exploration, 27*(2), 55–59. https://doi.org/10.1007/BF03402379

Earthworks & MiningWatch Canada. (2012). *Troubled waters: How mine waste dumping is poisoning our oceans, rivers and lakes*. https://earthworks.org/wp-content/uploads/2021/09/Troubled-Waters_FINAL.pdf

East African Community. (2017). East African Community Gazette, No. 5. http://kenyalaw.org/kl/fileadmin/pdfdownloads/EALA_Legislation/EASTAFRICANCOMMUNITYMININGBILL2017.pdf

East African Community (2006). Protocol on Environment and Natural Resources Management,2006. http://repository.eac.int/bitstream/handle/11671/1638/EAC%20PROTOCOL%20ON%20ENVIRONMENT%20AND%20NATURAL%20RES%20MGMT.pdf?sequence=1&isAllowed=y

Economic Commission for Africa. (2017). *Africa mining vision: African minerals governance framework*. https://archive.uneca.org/sites/default/files/PublicationFiles/african_mining_vision_african_mineral_governance_framework.pdf

Economic Community of West African States (ECOWAS). (2019). Model Mining and Minerals Development Act. https://www.ecowas.int/publication_category/legal-texts/

Environmental Authority of Arequipa Province (ARMA). (2014). *Standards for the management of tailings from small-scale processing plants that use leaching*. Government of Peru. https://arma.regionarequipa.gob.pe/uploads/docs/270.pdf

Environmental Law Institute. (2014). *Artisanal and small-scale gold mining in Nigeria: Recommendations to address mercury and lead exposure*. https://www.eli.org/sites/default/files/eli-pubs/nigeria-asgm-assessment-final-report.pdf

Esdaile, L. J., & Chalker, J. M. (2018). The mercury problem in artisanal and small-scale gold mining. *Chemistry: A European Journal, 24*(27), 6905–6916. https://doi.org/10.1002/chem.201704840

Extractive Industries Transparency Initiative. (2022). *Coverage of artisanal and small-scale mining (ASM) in EITI reporting*. https://eiti.org/guidance-notes/coverage-artisanal-and-small-scale-mining-asm-eiti-reporting#:~:text=While%20EITI%20reporting%20traditionally%20focuses,economic%20significance%20of%20the%20extractive

Funoh, K. N., Nkwemoh, C. A., Chupezi, J. T., & Moupou, M. (2017). Artisanal gold mining and its adverse impacts on the Ngoyla-Mintom Forest Massif, Cameroon. *International Journal of Resource and Environmental Management, 2*(1), 3–24. https://www.researchgate.net/publication/321167383_ARTISANAL_GOLD_MINING_AND_ITS_ADVERSE_IMPACTS_ON_THE_NGOYLA-MINTOM_FOREST_MASSIF_CAMEROON

Geenen, S., & Marijsse, S. (2020). The Democratic Republic of Congo: From stones in the river to diving for dollars. In B. Verbrugge & S. Geenen (Eds.), *Global gold production touching ground* (pp. 263–281). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-38486-9_14

Geoscience Australia. (2023). *Critical minerals at Geoscience Australia*. https://www.ga.gov.au/scientific-topics/minerals/critical-minerals

Gibb, H., & O'Leary, K. G. (2014). Mercury exposure and health impacts among individuals in the artisanal and small-scale gold mining community: A comprehensive review. *Environmental Health Perspectives, 122*(7), 667–672. https://doi.org/10.1289/ehp.1307864

Global Initiative Against Transnational Organized Crime. (2022a) *Assessing South Africa's organized crime risk*. https://globalinitiative.net/analysis/assessing-south-africa-organized-crime-risk/

Global Initiative Against Transnational Organized Crime. (2022b). *Sodium cyanide in Kenya's gold market: Controlling a toxic chemical in the context of criminality and corruption* (Risk Bulletin #24). https://riskbulletins.globalinitiative.net/esa-obs-024/01-sodium-cyanide-in-kenyas-gold-market.html

Health Europa. (2018, November 21). *Have we found a new way of removing toxic mercury from contaminated water supply?* https://www.healtheuropa.com/removing-toxic-mercury-contaminated-water-supply/89079/

Hilson, G., Bartels, E., & Hu, Y. (2022). Brick by brick, block by block: Building a sustainable formalization strategy for small-scale gold mining in Ghana. *Environmental Science & Policy, 135*, 207–225. https://doi.org/https://doi.org/10.1016/j.envsci.2022.04.006

Hruschka, F. (2015). *Comparative analysis of ASM strategies in four countries of Africa, Asia and Latin America*. Estelle Levin Ltd. https://delvedatabase.org/resources/comparative-analysis-of-asm-strategies-in-four-countries-of-africa-asia-and-latin-america

Hsu-Kim, H., C. S. Eckley, D. Achá, X. Feng, C. C. Gilmour, S. Jonsson, and C. P. J. Mitchell. 2018. Challenges and opportunities for managing aquatic mercury pollution in altered landscapes. Ambio 47:141-169. Huang, K., Li, J., Li, Y., & Li, G. (2020). Recycling of mercury from tailings of gold amalgamation by simultaneous sulfidation and reduction. *Waste Management, 106*, 135–142.

Humphreys, D. (2020). Mining productivity and the fourth industrial revolution. *Mineral Economics, 33*(1–2), 115–125. https://ideas.repec.org/a/spr/minecn/v33y2020i1d10.1007_s13563-019-00172-9.html

Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2017a). *Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues*. International Institute for Sustainable Development. https://www.iisd.org/system/files/publications/igf-asm-global-trends.pdf

Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. (2017b). *IGF guidance for governments: Managing artisanal and small-scale mining*. International Institute for Sustainable Development. https://www.iisd.org/publications/report/igf-guidance-governments-managing-artisanal-and-small-scale-mining

Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. (2022). *Illicit financial flows and conflict in artisanal and small-scale gold mining: Burkina Faso, Mali, and Niger*. International Institute for Sustainable Development. https://www.iisd.org/publications/report/illicit-financial-flows-conflict-artisanal-small-scale-gold-mining

International Monetary Fund. (2013). *Tax coordination, tax competition, and revenue mobilization in the West African Economic and Monetary Union*. https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Tax-Coordination-Tax-Competition-and-Revenue-Mobilization-in-the-West-African-Economic-and-40756

Jayapal, A., Chaterjee, T., & Sahariah, B. P. (2023). Bioremediation techniques for the treatment of mine tailings: A review. *Soil Ecology Letters, 5*(2), Article 220149. http://dx.doi.org/10.1007/s42832-022-0149-z

JXSC. (n.d.). *Gemini shaking table*. https://www.jxscmachine.com/gravity-separator/gemini-shaking-table/

Kaboré, A. F., & Ariyaratne, A. (2020). *Challenges and opportunities for women at artisanal gold mining sites in Burkina Faso*. planetGOLD. https://www.planetgold.org/challenges-and-opportunities-women-artisanal-gold-mining-sites-burkina-faso

Kaslow, L. (2022). *About 72% of gold miners poisoned with mercury at artisanal mining sites in Cameroon*. Mongabay Environmental News. https://news.mongabay.com/2022/11/about-72-of-gold-miners-poisoned-with-mercury-at-artisanal-mining-sites-in-cameroon/

Kecojevic, V., & Komljenovic, D. (2007). Environmental impacts of mineral resource exploitation and use. *Journal of Cleaner Production, 15*(8–9), 838–854.

Kianinia, Y., Khalesi, M. R., Seyedhakimi, A., & Soltani, F. (2017). Flotation of mercury from the tailings of the Agh-Darreh gold processing plant, Iran. *Journal of the Southern African Institute of Mining and Metallurgy, 117*(1), 83–88. https://dx.doi.org/10.17159/2411-9717/2017/v117n1a12

Kinyondo, A., & Huggins, C. (2020). 'Centres of excellence' for artisanal and small-scale gold mining in Tanzania: Assumptions around artisanal entrepreneurship and formalization. *The Extractive Industries and Society, 7*(2), 758–766. https://doi.org/https://doi.org/10.1016/j.exis.2020.03.011

Kinyondo, A., & Huggins, C. (2021). State-led efforts to reduce environmental impacts of artisanal and small-scale mining in Tanzania: Implications for fulfilment of the Sustainable Development Goals. *Environmental Science & Policy, 120*, 157–164. https://doi.org/10.1016/j.envsci.2021.02.017

Kocman, D., S. J. Wilson, H. M. Amos, K. H. Telmer, F. Steenhuisen, E. M. Sunderland, R. P. Mason, P. Outridge, and M. Horvat. 2017. Toward an Assessment of the Global Inventory of Present-Day Mercury Releases to Freshwater Environments. International Journal of Environmental Research and Public Health 14:138.

Krisnayanti, B., Anderson, C., Sukartono, S., Afandi, Y., Suheri, H., & Ekawanti, A. (2016). Phytomining for Artisanal Gold Mine Tailings Management. *Minerals (Basel, Switzerland), 6*(3), 84. doi:10.3390/min6030084

Larrabure Moreyra, G. P. (2022). *Design of hydrometallurgical stages for reprocessing artisanal mine tailings from Madre de Dios* [Thesis for professional title]. Universidad de Ingeniería y Tecnología. Repositorio Institucional UTEC. http://repositorio.utec.edu.pe/handle/20.500.12815/282

Leung, A. M. R., & Lu, J. L. (2016). Environmental health and safety hazards of Indigenous small-scale gold mining using cyanidation in the Philippines. *Environmental Health Insights, 10*, EHI-S38459. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4978203/

Leung, A. M. R., & Lu, J. L. D. (2022). Work process and hazard analysis in small-scale gold mining in Northern Philippines. *Acta Medica Philippina, 56*(1). https://actamedicaphilippina.upm.edu.ph/index.php/acta/article/view/3871

Levin-Nally, E., & Jacot, C. (2019). *ASM formalisation: Mongolia's five ingredients for success*. Levin Sources. https://www.levinsources.com/knowledge-centre/insights/asm-formalisation-mongolias-five-ingredients-for-success

Lobos, V., & Partidario, M. (2014). Theory versus practice in strategic environmental assessment (SEA). *Environmental Impact Assessment Review, 48*, 34–46. https://doi.org/10.1016/j.eiar.2014.04.004

MacDonald, K. F., Lund, M. A., Blanchette, M. L., & McCullough, C. D. (2014). Regulation of artisanal small scale gold mining (ASGM) in Ghana and Indonesia as currently implemented fails to adequately protect aquatic ecosystems. *Proceedings of the International Mine Water Association (IMWA) Congress, Colorado, USA* (pp. 401–405). https://www.researchgate.net/publication/283427405_Regulation_of_artisanal_small_scale_gold_mining_ASGM_in_Ghana_and_Indonesia_as_currently_implemented_fails_to_adequately_protect_aquatic_ecosystems

Maglambayan, V. B., Murao, S., Corpus, T. J. C., Sera, K., Futatsugawa, S., & Tsuji, M. (2005, June). Mercury contamination associated with small-scale gold mining in the Upper Ambalanga River, Benguet, Philippines from river sediment sampling. *Conference Proceedings of Asia-Pacific Learning Event* (pp. 7–12).

Malone, A., Figueroa, L., Wang, W., Smith, N. M., Ranville, J. F., Vuono, D. C., Zapata, F. D. A., Paredes, L. M., Sharp, J. O., & Bellona, C. (2023). Transitional dynamics from mercury to cyanide-based processing in artisanal and small-scale gold mining: Social, economic, geochemical, and environmental considerations. *Science of The Total Environment, 898*, p. 165492. https://doi.org/10.1016/j.scitotenv.2023.165492

Marcelo-Silva, J., Ramabu, M., & Siebert, S. J. (2023). Phytoremediation and nurse potential of aloe plants on mine tailings. *International Journal of Environmental Research and Public Health, 20*(2), 1521. https://doi.org/10.3390%2Fijerph20021521

Marshall, B. G., & Veiga, M. M. (2017). Formalization of artisanal miners: Stop the train, we need to get off! *The Extractive Industries and Society,* 4(2), 300–303. https://doi.org/10.1016/j.exis.2017.02.004

Martinez, G., Smith, N. M., & Malone, A. (2021). Formalization is just the beginning: Analyzing post-formalization successes and challenges in Peru's small-scale gold mining sector. *Resources Policy, 74*, 102390. https://doi.org/10.1016/j.resourpol.2021.102390

Masson, M., Walter, M., & Priester, M. (2013). *Incentivizing clean technology in the mining sector in Latin America and the Caribbean: The role of public mining institutions* (Inter-American Development Bank Energy Division (ENE) technical note no. IDB-TN-612). https://publications.iadb.org/en/publication/11895/incentivizing-clean-technology-mining-sector-latin-america-and-caribbean-role

Mathis, A., Grelo, E., & Peregovich, B. (2005, September 18–24). *Special Training for Small Scale Gold Miners In Pará and Amapá* (Brazil) [Conference presentation]. Communities and Small Scale Mining (CASM) 5th Annual General Meeting and Learning Event, Salvador de Bahia, Brazil. https://artisanalmining.org/Repository/01/The_CASM_Files/CASM_Meetings_International/2005_Salvador_AGM/Presentations/55-Para-Amapa-Peregovich.pdf

Mbula, R., & Byron, I. (2019, October 9). *Kenya: Govt. closes over 40 artisanal gold mines for poor workplace health & safety conditions*. Business & Human Rights Resource Centre. https://www.business-humanrights.org/en/latest-news/kenya-govt-closes-over-40-artisanal-gold-mines-for-poor-workplace-health-safety-conditions/

McDonald, S. (2023, April 3). *Three key takeaways on gender and mining in Colombia*. LandLinks. https://www.land-links.org/2023/04/three-key-takeaways-on-gender-and-mining-in-colombia/

Mensah, A. K., & Tuokuu, F. X. D. (2023). Polluting our rivers in search of gold: How sustainable are reforms to stop informal miners from returning to mining sites in Ghana? *Frontiers in Environmental Science, 11*, 583. https://doi.org/10.3389/fenvs.2023.1154091

Merket, H. (2018). *Mapping artisanal and small-scale mining in Northwest Tanzania: A survey on its nature, scope and impact*. International Peace Information Service vzw. https://www.researchgate.net/publication/330761521_Mapping_artisanal_and_small-scale_mining_in_northwest_Tanzania_A_survey_on_its_nature_scope_and_impact

Minerals Commission of Ghana. (2021). *Small scale and community mining: Operational manual.* https://www.mincom.gov.gh/wp-content/uploads/2021/11/Small-Scale-and-Community-Mining-Operational-Manual-Sep.-2021-1.pdf

Mining Data Online. (n.d.). *Mine waste solutions.* https://miningdataonline.com/property/4602/Mine-Waste-Solutions.aspx

Ministry of Energy and Mines. (1995). *Environmental guideline for tailings management (Guía ambiental para el manejo de relaves mineros).* Peru. https://biblioteca.spda.org.pe/biblioteca/catalogo/ver.php?id=4436

Ministry of Energy Transition, Mines, and Quarries. (2024, January 2). *Launching of the Mine Tailings Treatment Plant: Another step towards the optimal exploitation of our mining resources (Lancement des travaux de l'Usine de traitement des résidus miniers : un pas de plus vers l'exploitation optimum de nos ressources minières)* [Press release]. Burkina Faso. https://www.energie-mines.gov.bf/accueil/details?tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Bnews%5D=412&cHash=fdac71ff0ae54b251f8abba16472f96b

Ministry of Environment and Forestry. (2022). *National Action Plan for artisanal and small-scale gold mining in Kenya.* Republic of Kenya. https://www.environment.go.ke/wp-content/uploads/2022/12/National-Action-Plan.pdf

Montt, G. (2018). Too polluted to work? The gendered correlates of air pollution on hours worked. IZA *Journal of Labor Economics, 7*(7). https://izajole.springeropen.com/articles/10.1186/s40172-018-0067-6

Morrill, J., Chambers, D., Emerman, S., Harkinson, R., Kneen, J., Lapointe, U., Maest, A., Milanez, B., Personius, P., Sampat, P., & Turgeon, R. (2022). *Safety first: Guidelines for responsible mine tailings management.* Earthworks, MiningWatch Canada & London Mining Network.

Mubarik, A. (2017, May 13). *Ghana: 60% of water bodies polluted due to illegal mining and other activities; say authorities.* Pulse. https://www.pulse.com.gh/news/galamsey-60-of-ghanas-water-bodies-polluted-water-resources-commission/3xs9j84

Mutagwaba, W., Bosco Tindyebwa, J., Makanta, V., Kaballega, D., & Maeda, G. (2018). *Artisanal and small-scale mining in Tanzania—Evidence to inform an "action dialogue."* (Research report). International Institute for Environment and Development. https://www.iied.org/sites/default/files/pdfs/migrate/16641IIED.pdf

NAP.Mineração / USP. (2022, December 13). *Coexistence: An innovative solution for ASGM in Latin America* [Video]. YouTube. https://www.youtube.com/watch?v=5pFjJ82XWOc

National Mining Agency. (2021). Resolution 85/2021 of the Brazilian National Mining Agency. Government of Brazil. https://www.gov.br/anm/pt-br/resolucao-da-anm-ganha-selo-de-qualidade-regulatoria-do-ministerio-da-economia/resolucao-anm-no-85-02-12-2021.pdf/@@download/file

Natural Resources Defense Council. (n.d.). *The Philippines: Ga'ang mining area, Balbalan municipality, Kalinga province.* https://wedocs.unep.org/bitstream/handle/20.500.11822/11585/ASGMFlyer_ThePhilippines.pdf?sequence=1&isAllowed=y

Ngounouno, M. A., Ngueyep, L. L. M., Kingni, S. T., Neba Nforsoh, S., & Ngounouno, I. (2021). Evaluation of the impact of gold mining activities on the waters and sediments of Lom River, Wakaso, Cameroon and the restorative effect of Moringa Oleifera seeds. *Applied Water Science, 11*, Article 113. https://doi.org/10.1007/s13201-021-01445-x

Nhlengethwa, K., & Hein, K. A. (2015). Zama-Zama mining in the Durban Deep/Roodepoort area of Johannesburg, South Africa: An invasive or alternative livelihood? *The Extractive Industries and Society, 2*(1), 1–3. https://static1.squarespace.com/static/5d35c969bf839d00013ab2dc/t/62d5ec06308a0d42783e84ae/1658186774507/Zama-Zama+mining+in+the+Durban+DeepRoodepoort+area+of+ZA.pdf.pdf

Nikiema H. S., Naré, C., Somda, A., Samoura, K., & Kaboré, E. B. (2020). Analyse comparative des textes juridiques applicables à l'exploitation minière artisanale de l'or dans l'espace UEMOA: Contribution au projet pilote de conception et promotion des pratiques vertueuses dans l'exploitation artisanale de l'or en Afrique de l'Ouest. - Comparative analysis of artisanal gold mining legal frameworks in the UEMOA countries: Contribution to the pilot project on design and promotion of best practices in artisanal gold mining in West Africa. International Institute For Sustainable Development. https://www.iisd.org/system/files/publications/miniere-artisanale-uemoa.pdf

Nurfitriani, S., Arisoesilaningsih, E., Nuraini, Y., & Handayanto, E. (2020). Bioaccumulation of mercury by bacteria isolated from small scale gold mining tailings in lombok, Indonesia. *Journal of Ecological Engineering, 21*(6), 127–136. doi:10.12911/22998993/123247

Oberle, B., Mihaylova, A., & Hackett, A. (2019) Chapter I. Global Tailings Review at a glance: History and overview. In *Towards zero harm: A compendium of papers prepared for the Global Tailings Review* (pp. 2–13). https://globaltailingsreview.org/wp-content/uploads/2020/09/Ch-I-Global-Tailings-Review-at-a-Glance_History-and-Overview.pdf

Obrist, D., J. L. Kirk, L. Zhang, E. M. Sunderland, M. Jiskra, and N. E. Selin. 2018. A review of global environmental mercury processes in response to human and natural perturbations: Changes of emissions, climate, and land use. Ambio 47:116-140.

Ondayo, M. A., Watts, M. J., Hamilton, E. M., Mitchell, C., Mankelow, J., & Osano, O. (2023). Artisanal gold mining in Kakamega and Vihiga counties, Kenya: Potential human exposure and health risk. *Environmental Geochemistry and Health, 45*, 1–23. https://link.springer.com/article/10.1007/s10653-023-01647-z

Opiso, E. M., Aseneiro, J. P. J., Banda, M. H. T., & Tabelin, C. B. (2018). Solid-phase partitioning of mercury in artisanal gold mine tailings from selected key areas in Mindanao, Philippines, and its implications for mercury detoxification. *Waste Management & Research, 36*(3), 269–276. https://journals.sagepub.com/doi/pdf/10.1177/0734242X17753534

Organisation for Economic Co-operation and Development. (2016). *OECD due diligence guidance for responsible supply chains of minerals from conflict-affected and high-risk areas: Third edition*. http://dx.doi.org/10.1787/9789264252479-en

Outridge, P. M., R. P. Mason, F. Wang, S. Guerrero, and L. E. Heimbürger-Boavida. 2018. Updated Global and Oceanic Mercury Budgets for the United Nations Global Mercury Assessment 2018. Environmental Science & Technology 52:11466-11477

planetGOLD. (n.d.). *Burkina Faso*. https://www.planetgold.org/burkinafaso

planetGOLD. (2021). *Best Management Practices for Cyanide Use in the Small-Scale Gold Mining Sector*. https://www.planetgold.org/best-management-practices-cyanide-use-small-scale-gold-mining-sector

planetGOLD Indonesia. (2020). *The potential market for financial products in Indonesia's ASGM (artisanal small scale gold mining) sector.* https://www.planetgold.org/sites/default/files/Fact%20Sheet_The%20Potential%20Market%20for%20Financial%20Products%20in%20Indonesia%E2%80%99s%20ASGM%20%28Artisanal%20Small%20Scale%20Gold%20Mining%29%20Sector.pdf

Price, L. C. (2015, February 17). *Photos: Child miners exposed to toxic chemicals in illegal gold mines.* PBS News Hour. https://www.pbs.org/newshour/nation/quicksilver-gold-threaten-health-philippines

Pure Earth. (2022). *Promoting responsible recovery and handling of mercury from contaminated artisanal gold mining tailings in Colombia: Technical protocol for the responsible management of mercury-contaminated tailings in Colombia.* https://www.pureearth.org/wp-content/uploads/2022/04/Technical_Protocol_Tailing_Management_Colombia_Draft_Final_AUTHORS.pdf

Pure Earth. (2023a). *Promoting responsible recovery and handling of mercury from contaminated artisanal gold mining tailings in Colombia: technical report on mercury recovery from tailings.* https://www.pureearth.org/wp-content/uploads/2023/03/Recovery_Mercury_Tecnologias_Colombia_Workshop_Final_Draft_AUTHORS_Disclaimer.pdf

Pure Earth. (2023b, January 24). *Pure Earth wins grand challenge for innovation to reduce mercury.* Resolucion Directoral No 19-97-EM/DGAA (1997). https://view.officeapps.live.com/op/view.aspx?src=http%3A%2F%2Fintranet2.minem.gob.pe%2Fweb%2Farchivos%2Fdgm%2Flegislacion%2FR.D.N_019-1997-EM-DGAA.doc&wdOrigin=BROWSELINK

Rodríguez-Novoa, F., & Holley, E. (2022). Coexistence between large-scale mining (LSM) and artisanal and small-scale mining (ASM) in Perú and Colombia. *Resources Policy, 80*, 103162. https://doi.org/10.1016/j.resourpol.2022.103162

Reuters. (2013). *Africa's local banks offer mining lifeline where others fear to tread.* Reuters. https://www.reuters.com/article/africa-banks-mining-idUSL6N0JQ3DV20131212

Sarker, S. K., Haque, N., Bhuiyan, M., Bruckard, W., & Pramanik, B. K. (2022). Recovery of strategically important critical minerals from mine tailings. Journal of Environmental Chemical Engineering, 10(3), Article 107622.

Save the Boundary Waters. (n.d.). *Twin Metals project goes from bad to worse.* https://www.savetheboundarywaters.org/sites/default/files/attachments/dry-stacking_2_page_factsheet.pdf

Seccatore, J., Veiga, M., Origliasso, C., Marin, T., & De Tomi, G. (2014). An estimation of the artisanal small-scale production of gold in the world. *Science of the Total Environment, 496*, 662–667. https://pubmed.ncbi.nlm.nih.gov/24867677/

See, D. A. (2023, February 4). *EMB-CAR warns public against chemical contamination of Itogon Waterways.* Herald Express. https://baguioheraldexpressonline.com/emb-car-warns-public-against-chemical-contamination-of-itogon-waterways/

Siaw, D., Ofosu, G., & Sarpong, D. (2023). Cocoa production, farmlands, and the galamsey: Examining current and emerging trends in the ASM-agriculture nexus. *Journal of Rural Studies, 101*, Article 103044. https://www.sciencedirect.com/science/article/pii/S0743016723001109

Sibanye-Stillwater. (2023). *Tailings management.* https://www.sibanyestillwater.com/sustainability/environment/tailings-management/

Smith, N. M., Smith, J. M., John, Z. Q., & Teschner, B. A. (2017). Promises and perceptions in the Guianas: The making of an artisanal and small-scale mining reserve. *Resources Policy, 51*, https://doi.org/10.1016/j.resourpol.2016.11.006

Solidaridad. (2023, August 10). *Innovating for financial inclusion: Specialised loan product gives artisanal miners a boost*. https://www.solidaridadnetwork.org/news/paving-the-way-to-credit-formal-markets-for-small-scale-miners-in-peru/

Sousa, R. N., Veiga, M. M., Klein, B., Telmer, K., Gunson, A. J., & Bernaudat, L. (2010). Strategies for reducing the environmental impact of reprocessing mercury-contaminated tailings in the artisanal and small-scale gold mining sector: insights from Tapajos River Basin, Brazil. *Journal of Cleaner Production, 18*(16–17), 1757–1766.Sturmes, D. (2020). *Offering an alternative to full-ore mercury amalgamation*. The Impact Facility. https://www.theimpactfacility.com/offering-an-alternative-to-full-ore-mercury-amalgamation/

Streets, D. G., H. M. Horowitz, D. J. Jacob, Z. Lu, L. Levin, A. F. H. ter Schure, and E. M. Sunderland. 2017. Total Mercury Released to the Environment by Human Activities. Environmental Science & Technology 51:5969-5977.

Streets, D. G., H. M. Horowitz, Z. Lu, L. Levin, C. P. Thackray, and E. M. Sunderland. 2019. Global and regional trends in mercury emissions and concentrations, 2010–2015. Atmospheric Environment 201:417-427.

Sundseth, K., J. M. Pacyna, E. G. Pacyna, N. Pirrone, and R. J. Thorne. 2017. Global Sources and Pathways of Mercury in the Context of Human Health. International Journal of Environmental Research and Public Health 14:105.

Swiss Agency for Development and Cooperation. (2011). SDC experiences with formalization and responsible environmental practices in artisanal and small-scale gold mining in Latin America and Asia (Mongolia). https://www.unep.org/globalmercurypartnership/resources/report/sdc-experiences-formalization-and-responsible-environmental-practices-artisanal

Taj, M. (2020, June 26). *Meet the women who scavenge for gold at the top of the world*. Reuters. https://widerimage.reuters.com/story/meet-the-women-who-scavenge-for-gold-at-the-top-of-the-world

Tampushi, L. L., Onyari, J. M., & Muthama, N. J. (2022). Assessing social and environmental impacts of artisanal and small-scale gold mining practices in Lolgorian, Kenya. *European Journal of Sustainable Development Research, 6*(3), Article em0192. https://doi.org/10.21601/ejosdr/12153

Telmer, K., & Veiga, M. M. (2009). World emissions of mercury from artisanal and small scale gold mining. In R. Mason & N. Pirrone (Eds.). *Mercury fate and transport in the global atmosphere* (pp. 131-172). Springer.

Therivel, R., & Paridario, M. R. (2013). *The practice of strategic environmental assessment*. Routledge.

Timsina, S., Hardy, N. G., Woodbury, D. J., Ashton, M. S., Cook-Patton, S. C., Pasternack, R., & Martin, M. P. (2022). Tropical surface gold mining: A review of ecological impacts and restoration strategies. *Land Degradation and Development, 33*(18), 3661–3674. doi:10.1002/ldr.4430

Twala, P. (2023). Analysis of the developmental potential of artisanal and small-scale mining: A strategy for South Africa [Doctoral dissertation] Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg.

Tychsen, J. (2023). *Artisanal and small-scale mining handbook for English-speaking Eastern and Northern African Regions*. Geological Survey of Denmark and Greenland.

Union économique et monétaire ouest-africaine. (2023). Regulation No. 18/2003/CM/UEMOA On The Adoption Of The UEMOA Community Mining Code (Reglement N°18/2003/CM/UEMOA portant adoption du code minier communautaire de l'UEMOA). http://www.uemoa.int/fr/reglement-ndeg182003cmuemoa-portant-adoption-du-code-minier-communautaire-de-luemoa

United Nations Environment Programme. (n.d.). *National Action Plans*. Global Mercury Partnership. https://www.unep.org/globalmercurypartnership/what-we-do/artisanal-and-small-scale-gold-mining-asgm/national-action-plans

United Nations Environment Programme. Global Mercury Partnership. (n.d.). *Insights from ASGM National Action Plans*. https://www.unep.org/globalmercurypartnership/insights-asgm-national-action-plans

United Nations Environment Programme. (2012). *Reducing mercury use in artisanal and small-scale gold mining: A practical guide*. https://wedocs.unep.org/handle/20.500.11822/11524

United Nations Environment Programme. (2014). *Minamata Convention on Mercury (text and annexes)*. https://minamataconvention.org/en/documents/minamata-convention-mercury-text-and-annexes

United Nations Environment Programme. (2021a). Incorporating gender dimensions into national strategy setting in chemicals management for Minamata Convention National Action Plans for artisanal and small-scale gold mining and Stockholm Convention national implementation plan. Economy Division, Chemicals and Health Branch Knowledge and Risk Unit. https://wedocs.unep.org/bitstream/handle/20.500.11822/36587/GenderNAP.pdf?sequence=3&isAllowed=y

United Nations Environment Programme. (2021b). *Sound tailings management in artisanal and small-scale gold mining – Technical document*. https://minamataconvention.org/en/documents/guidance-document-management-artisanal-and-small-scale-gold-mining-tailings

United Nations Environment Programme. (2021c). Update to the guidance document for the preparation of a National Action Plan to reduce and, where feasible, eliminate mercury use in artisanal and small-scale gold mining. https://www.mercuryconvention.org/sites/default/files/documents/working_document/4_6_ASGM_Guidance.English.pdf

United Nations Environment Programme. (2022a). *MC-4/6: Mercury waste thresholds* (UNEP/MC/COP.4/Dec.6). Minamata Convention on Mercury. https://minamataconvention.org/sites/default/files/documents/decision/4_Dec6_Waste.English.pdf

United Nations Environment Programme. (2022b). *MC-4/29: Article 7: Artisanal and small-scale gold mining: update to the guidance document for the preparation of a national action plan to reduce and, where feasible, eliminate mercury use in artisanal and small-scale gold mining* (UNEP/MC/COP.4/29). Minamata Convention on Mercury. https://minamataconvention.org/sites/default/files/documents/final_report/4_29_ASGM_Guidance.English.pdf

United Nations Environment Programme. (2023). UNEP NAP Data Platform. https://minamataconvention.org/en/parties/national-action-plans

United Nations Security Council. (2000, October 31). Resolution 1325. https://peacemaker.un.org/sites/peacemaker.un.org/files/SC_ResolutionWomenPeaceSecurity_SRES1325%282000%29%28english_0.pdf

Veiga, M. M. (2015). Mercury in artisanal and small-scale mining: The challenges and ways forward. In D. A. Kaden & T. L. Rose (Eds.), *Environmental and health issues in unconventional oil and gas development* (pp. 273–286). CRC Press.

Veiga, M. M., Baker, R., & Klein, B. (2004). Challenges and opportunities for the sustainable use and management of mercury in Latin America. *Ambio, 33*(6), 363–370.

Veiga, M. M., & Fadina, O. (2020). A review of the failed attempts to curb mercury use at artisanal gold mines and a proposed solution. *The Extractive Industries and Society, 7*(3), https://doi.org/10.1016/j.exis.2020.06.023

Veiga, M. M., Maxson, P. A., & Hylander, L. D. (2006). Origin and consumption of mercury in small-scale gold mining. *Journal of Cleaner Production, 14*(3–4), 436–447.

Veiga, M. M., Tarra, Jorge A., Restrepo-Baena, O J., & de Tomi, G. (2022). Coexistence of artisanal gold mining with companies in Latin America. *The Extractive Industries and Society, 12*, 3–4.

Velásquez, J. R., Schwartz, M., Phipps, L. M., Restrepo-Baena, O. J., Lucena, J., & Smits, K. M. (2022). A review of the environmental and health implications of recycling mine tailings for construction purposes in artisanal and small-scale mining communities. *The Extractive Industries and Society, 9*, Article 101019.

Verbrugge, B., Lanzano, C., & Libassi, M. (2021). The cyanide revolution: Efficiency gains and exclusion in artisanal-and small-scale gold mining. *Geoforum, 126*, 267–276.

Vergara-Murillo, F., González-Ospino, S., Cepeda-Ortega, N., Pomares-Herrera, F., & Johnson-Restrepo, B. (2022). Adverse health effects and mercury exposure in a Colombian artisanal and small-scale gold mining community. *Toxics, 10*(12), 723. MDPI AG. http://dx.doi.org/10.3390/toxics10120723

Vick, S. G. (1990). *Planning, design, and analysis of tailings dams*. BiTech Publishers Ltd.

World Bank. (2020). *2020 State of the artisanal and small-scale mining sector*. https://delvedatabase.org/resources/2020-state-of-the-artisanal-and-small-scale-mining-sector

World Health Organization. (2016). *Environmental and occupational health hazards associated with artisanal and small-scale gold mining*. https://www.who.int/publications/i/item/9789241510271

World Wildlife Fund. (2021). *Mercury and gold mining in the Guianas—cooperate or fail*. ID4D. https://ideas4development.org/en/mercury-and-gold-mining-in-the-guianas-cooperate-or-fail/

Zolnikov, T. R., & Ramirez Ortiz, D. (2018). A systematic review on the management and treatment of mercury in artisanal gold mining. *Science of The Total Environment, 633*, 816–824. https://doi.org/10.1016/j.scitotenv.2018.03.241

Appendix A. Legislation of selected countries

Brazil

- Mining Code (Decree-Law 227/1967)
- Federal Law 12.305/2021 (National policy for solid residues management)
- Decree No. 9,406/2018 (Regulation to Mining Code) Resolution ANM 85/2021
- Resolution ANM 68/2021 (Regulation for mine closure plans)

Burkina Faso

- Decree 2018-1017 (November 16, 2018) for the organization of artisanal miners (Décret 2018-1017 du 16 novembre 2018 portant organisation des exploitations artisanales)
- Décret n°2017 0036/PRES/PM/MEMC/MATDSI/MINEFID/MEEVCC/MCIA du 26 janvier 2017 portant gestion des titres miniers et autorisations
- Décret n° 2020-0790/PRES/PM/MMC/MDHPC/MINEFID du 24 septembre 2020 portant dispositif de prévention et de réparation des violations
- Law no. 006-2013 (on the Code for the Environment)
- Law 036-2015/CNT dated 26 June 2015 portant Code minier du Burkina Faso
- Décret 2017-047 Artisanal mine sites rehabilitation fund (Décret 2017-047 Fonds de réhabilitation des sites miniers artisanaux)
- Decree 2015-1420 Establishing ANEEMAS: The National Agency for the Supervision of Artisanal and Semi-Mechanized Mining Operations (Décret 2015-1420 Agence Nationale d'Encadrement des Exploitations Minières Artisanales et Semi-mécanisées [ANEEMAS])

Cameroon

- Law No. 96/12 of 05 August 1996 Relating To Environmental Management (Loi cadre relative à la Gestion de l'Environnement Loi n°96/12 du 5 aout 1996)
- Law No. 2016/017 of 14 December 2016on the Mining Code (Loi N°2016-17 Du 14 Décembre 2016 portant code minier)

Colombia

- Mining Code (Law 685/2001)
- Law 2250/2022

Ecuador

- Law 45/2009 "Mining Law"
- The Ministerial Agreement No. 37/2014, modified in 2016 "Environmental Regulations for Mining Activities"

- The Executive Decree No. 120/2009 “Special Regime for ASM activities”
- The Ministerial Agreement 15/2015 “Guideline for beneficiation plants and tailings”
- Ghana
- Environmental Assessment Regulations, 1999
- Minerals and Mining Act, 2006 Act 703
- Minerals And Mining (Health, Safety and Technical) Regulations, 2012 (L.I. 2182)
- Regulation 71—Plans of Dams, Lakes, Waste Dumps
- Regulation 107—Mine Waste Rock Dump
- Regulation 108—Discontinuance of Waste Dumps
- Regulation 241—Environmental Management of Processing Plant
- Regulation 242—Tailing Pipelines of Processing Plants That Use Cyanide
- Regulation 265—Tailings Storage Facility Impoundment
- Regulation 286—Closure of Waste Dumps
- Regulation 480—Environmental Protection Provisions for Small-Scale Mining
- Regulation 515—Code of Safe Working Practice

Honduras

- Mining Law (Decree 238/2012)
- Decree 292/1998 (Amendment of Mining Law)
- Decree 109-2019 (Amendment of Mining Law)

Kenya

- The Environmental Management and Coordination Act 1999 (EMCA) Amended 2015
- The Mining Act, No. 12 of 2016

Mongolia

- Mining Code (amended in 2010)
- ASM Regulation 308 (2010)
- Environmental Protection Law of Mongolia (1995)
- Decree #A/04 of MET (2014)
- Joint Order of the Minister of Mines and Heavy Industry, Minister of Environment and Tourism, August 28, 2019 No. A/181, A/458 - Approval of Rehabilitation and Closure Procedures for Mines, Mining and Concentration Industries
- Regulation on Extraction of Minerals by Artisanal and Small-scale Mining (2017), (ASM Regulation 151)

Nigeria

- Minerals and Mining Regulations (2011)

- National Environmental (Mining and Processing of Coal, Ores and Industrial Minerals) Regulations, 2009 S. I. No. 31
- The Environmental Impact Assessment Act, 1992 (as amended by EIA Act CAP E12 LFN 2004)
- The Minerals and Mining Act (2007)
- The Minerals and Mining (Health, Safety and Technical) Regulations, 2012 (L.I. 2182)

Peru

- Supreme Decree N° 014-92-EM, 2022 (General Mining Law)
- Law 28271 (Regulation of the identification of environmental impacts of the mining activity)
- Law 31211 (Regulation of the final destination of mine tailings)
- Law 28964 (Regulation of responsibility for inspection of mining activities)
- Law 27651 (National policy for the formalization of the artisanal mining sector)

The Philippines

- Presidential Decree No. 1586 (1982): Establishing An Environmental Impact Statement System Including Other Environmental Management Related Measures And For Other Purposes
- RA No. 7076 (the People's Small-Scale Mining Act of 1991)

Sierra Leone

- The Extractive Industries Revenue Act, 2018

South Africa

- The Draft Artisanal and Small-Scale Mining Policy, 2021
- The National Environmental Agreement: Waste Act, 2008 (Act No. 59 Of 2008) - Regulations Regarding the Planning and Management of Residue Stockpiles and Residue Deposits from a Prospecting, Mining, Exploration or Production Operation
- South African National Standard SANS 10286
- Mine Health and Safety Act No. 29 of 1996

Tanzania

- The Environmental Management Act, 2004
- The Mining Act, Revised Edition, 2019

Uganda

- The Mining and Minerals Act, 2022

Zimbabwe

- Finance Act, 2021- Article No 7

Appendix B. Regional ASGM Tailings Management

Regional bloc	Countries	ASGM tailings provisions
Africa		
Union économique et monétaire ouest-africaine (UEMOA)	Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo	Additional Act No. 01/2000 of December 14, 2000, on the adoption of the UEMOA's common mining policy (Acte additionnel n°01/2000 du 14 décembre 2000 portant adoption de la politique minière commune de l'UEMOA) states the general objectives of the common mining policy and the creation of a favourable climate for mining investments; the diversification of mining production; on-site processing of mineral substances; the coexistence of industrial mines and artisanal mining; and the preservation of the environment. Article 11 of the Regulation No. 18/2003/CM/UEMOA On The Adoption Of The UEMOA Community Mining Code (Reglement N°18/2003/Cm/Uemoa Portant Adoption Du Code Minier Communautaire De L'uemoa), states: "The health and safety rules applicable to prospecting, research, and exploitation of mineral substances, to the transport, storage, and use of explosive substances and dangerous products, to the protection of the environment, to the rehabilitation of exploited sites and to the conservation of the forestry and archaeological heritage shall be laid down by mining regulations within the Union." (UEMOA, 2023) Applicants are also required to carry out environmental impact studies for the operating phase, comply with environmental regulations, and implement a monitoring plan and an environmental rehabilitation program. The UEMOA Community Mining Code was adopted in June 2023.

Regional bloc	Countries	ASGM tailings provisions
Economic Community of West African States (ECOWAS)	Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo	Directive C/DIR.3/5/09 on the harmonization of guiding principles and policies for the mining sector of the ECOWAS adopted in July 2009 does not contain specific provisions on ASGM tailings management but it does contain a chapter on environmental protection and a chapter on human rights. The ECOWAS Model Mining and Development Act states that member states should adopt international best practices for waste management and that operators are responsible for preventing and managing spillages. It also explicitly mentions that small-scale miners are prohibited from buying and using mercury.
East African Community (EAC)	Burundi, Democratic Republic of Congo, Kenya, Rwanda, South Sudan, Tanzania, and Uganda	The EAC Mining Bill 2017 states that ASM should be enacted in a safe, efficient, and environmentally sustainable manner. The bill also has dedicated sections for environmental protection and management and mine closure and rehabilitation in which it asserts that mineral rights holders must submit a social impact assessment, environmental risk assessment, and a social and environmental plan that includes the consumption and return of clean water to the ecosystem; conduct progressive rehabilitation; and submit mine-closure and rehabilitation plans that include environmental closure. EAC member states are party to the Eastern Africa Regional Framework Agreement on Air Pollution, and they have agreed to develop actionable targets to address air pollution in several key areas, including mining. Additionally, under Article 28 of the Protocol on Environment and Natural Resources on Management of Chemicals, the EAC members commit to developing and harmonizing policies, laws, and strategies to protect human health and the environment against the adverse effects of toxic chemicals and products containing toxic chemicals. In Article 29, the EAC members pledge to develop and harmonize policies relating to the illegal dumping or trafficking and transboundary movement of hazardous wastes and other wastes.

Regional bloc	Countries	ASGM tailings provisions
Southern African Development Community (SADC)	Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe	The SADC Protocol of Mining, 2000 states that member states should support small-scale mining and that a balance must be struck between mineral development and sustainable environmental protection. The SADC Protocol on Environmental Management for Sustainable Development (2006) applies to natural resource management in SADC member countries and asserts that state parties shall avoid the generation of waste and where it is not possible waste must be reused or recycled and disposed of in an environmentally sound manner. The protocol also applies a "polluter pays" principle for remediating and preventing environmental and health damage. It also affirms that state parties must take a "cradle to the grave" approach, where environmental and health and safety impacts are considered throughout the life cycle of a policy, program, process, etc. Article 6: Waste and Pollution and Article 7: Chemical Management apply to tailings management and state that parties must adopt the appropriate legislation for waste and chemical management and disposal as stipulated in the Basel Convention and other relevant conventions. It also outlaws the dumping of waste on land, sea, and internal waters. Article 10: Sustainable Land Management provides for environmentally sound, sustainable land-use and tenure practices, including the remediation, reclamation, and rehabilitation of degraded ecosystems.
The Arab Maghreb Union, the Community of Sahel–Saharan States, the Common Market for Eastern and Southern Africa, the Economic Community of Central African States, and the Intergovernmental Authority on Development do not have any policies and frameworks that govern mining, ASM, or tailings management.		

Regional bloc	Countries	ASGM tailings provisions
Asia		
Association of Southeast Asian Nations (ASEAN)	Brunei, Myanmar, Cambodia, Timor-Leste, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam	*The Strengthening ASEAN Cooperation in Minerals: Development Prospects of ASEAN Minerals Cooperation* report (ASEAN, 2022) provides recommendations to its member countries on sustainable mineral development. The recommendations include a greater commitment to enhancing the environmental, social, and economic dimensions of ASM. The report recognizes the importance of tailings management and suggests that member states show greater concern for tailings management and adopt the Global Industry Standard on Tailings Management (GISTM). Furthermore, it states that members should make a greater effort to develop a circular economy in mining, which entails not only reprocessing ore but reusing mine waste and tailings. The ASEAN-IGF minerals cooperation workplan 2022–2024, which aims to enhance the sustainability of mining in ASEAN by incorporating best practices into national and regional frameworks, highlights ASM, mine closure, and environmental management as key focal areas for strategy development (ASEAN, 2022).
The Regional Comprehensive Economic Partnership Agreement does not have any policies and frameworks that govern mining, ASM, or tailings management.		
Latin American Countries		
Amazon Cooperation Treaty Organization	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela	There are no active regional mining or tailings-specific frameworks in place in Latin America. However, in 2023, the Colombian government presented a proposal to the Amazon Cooperation Treaty Organization to cease illegal mining in the Amazon region by 2030. This proposal is still under discussion by the countries involved in the Amazon Cooperation Treaty Organization. Regarding Mexico, the North American Agreement on Environmental Cooperation (parallel to NAFTA, now United States–Mexico–Canada Agreement) has fast-tracked increasingly stringent mining environmental regulations in the country, but without a specific focus on gold tailings.

Regional bloc	Countries	ASGM tailings provisions
		In addition, UNEP reports that the Intergovernmental Network on Chemicals and Waste for Latin America and the Caribbean was established in 2016, with the main objective of strengthening the sound management of chemicals and waste through regional cooperation and the exchange of information and experiences among countries.

Appendix C. National ASGM Tailings Management Frameworks

Country	Is ASM legal and provided for in the law?	Is the use of mercury by ASM permitted or prohibited?	Is the use of cyanide by ASM permitted or prohibited?	Has country submitted an NAP?	Does the mining framework provide for tailings management?	Does the legal framework provide for tailings reprocessing or contain special provisions for a processing licence?	Is there ASM-specific tailings management legislation?	Are there environmental protocols that apply to ASM tailings management?
Brazil	✓	Prohibited	Permitted	Under development	✓	✓	✗	✗
Burkina Faso	✓	Prohibited	Prohibited	✓	✓	✓	✗	✓
Cameroon	✓	Prohibited	Prohibited	✗	✓	✗	✗	✓
Chile	✓	No data	No data	✗	✓	✗	✓	✓
Colombia	✓	Prohibited	Permitted	✗	✓	✓	✓	✗
Ecuador	✓	Prohibited	Permitted	✓	✓	✓	✗	✗
Ghana	✓	Permitted	Prohibited	✓	✓	✓	✓	✓
Honduras	✓	Permitted	Permitted	✗	✓	✗	✗	✓
Kenya	✓	Prohibited	Prohibited	✓	✓	✓	✗	✓
Mongolia	✓	Prohibited	Prohibited	✓	✓	✓	✗	✗

Country	Is ASM legal and provided for in the law?	Is the use of mercury by ASM permitted or prohibited?	Is the use of cyanide by ASM permitted or prohibited?	Has country submitted an NAP?	Does the mining framework provide for tailings management?	Does the legal framework provide for tailings reprocessing or contain special provisions for a processing licence?	Is there ASM-specific tailings management legislation?	Are there environmental protocols that apply to ASM tailings management?
Nigeria	✓	Permitted	Permitted	✓	✓	✗	✗	✓
Peru	✓	Permitted	Permitted	✗	✓	✓	✗	✗
Philippines	✓	Prohibited	Permitted	✗	✓	✓	✗	✓
South Africa	ASM is illegal	Prohibited	Prohibited	✗	✓	✗	✗	✗
Tanzania	✓	Permitted	Prohibited	✓	✓	✓	✓	✓

Source: Research survey results and UNEP-NAP submissions.

Appendix D. Detailed Legal Framework

Brazil

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Mercury is prohibited and cyanide is permitted.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? The licensing provisions for tailings processing are the same as for standard ore processing.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

There is a mining tailings management legislation, but it is not specific for ASM. ASM mining permit holders are required to dispose tailings and waste in an environmentally sound manner in accordance with Brazilian legislation. In addition, ASGM operators are required to provide a Solid Waste Management Plan (PGRS) (Federal Law 12.305 of 2010, Article 13) and a Mine Closure Plan (PFM) (Resolution ANM 68, of 2021, Article 3).

Are there environmental protocols that apply to ASM tailings management?

The specific environmental protocol applicable is the requirements to issue a Solid Waste Management Plan (PGRS) according to Federal Law 12.305 of 2010, Article 13.

Burkina Faso

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Both mercury and cyanide are prohibited.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? Law 036-2015/CNT dated 26 June 2015, Article 5, precludes activities defined as artisanal exploitation of mineral substances from processing materials extracted from a mineral deposit. Whereas, small-scale mining exploitation includes the mining exploitation of dumps, mining slag heaps, and quarry waste, and artisanal exploitation.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

Law 036-2015/CNT dated 26 June 2015

Article 25: provides for the creation of a mining fund for the rehabilitation protection artisanal mining sites and the fight against the use of chemicals.

Article 76: The holder of an artisanal operating permit of mineral substances must operate the mineral substances rationally, with respect to health and safety standards at work, preserve the environment, and market products in accordance with the regulations in force.

Article 78: The renewal of a permit is subject to the rehabilitation of the operated or the forsaken area. For this purpose, a bond for the rehabilitation of operating deposits is payable by the holder in order to guarantee the implementation of this obligation.

Décret-2018-1017-du-16-novembre-2018-portant-organisation-des-exploitations-artisanales.

décret n°2017 0036/PRES/PM/MEMC/MATDSI/MINEFID/MEEVCC/MCIA du 26 janvier 2017 portant gestion des titres miniers et autorisations

décret n° 2020-0790/PRES/PM/MMC/MDHPC/MINEFID du 24 septembre 2020 portant dispositif de prévention et de réparation des violations

Are there environmental protocols that apply to ASM tailings management?

Law no. 006-2013 (on the Code for the Environment)

Cameroon

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Both mercury and cyanide are prohibited.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? No.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

Law No. 2016/017 Of 14 December 2016 On The Mining Code/ Code Miner Loi N°2016-17 Du 14 Décembre 2016

Article 30 (1) provides for a body responsible for the monitoring and supervision of all activities derived from non-industrial and semi-mechanized non-industrial mining, this

includes implementing all the measures related to the rehabilitation of non-industrial and semi-mechanized non-industrial mining.

Article 135 (2): With the exception of non-industrial operators (artisanal) all other miners have to conduct an environmental and social impact assessment; a hazard and risk assessment and an environmental management plan.

Article 136: Each operator shall be responsible for the restoration, rehabilitation and closure of mining and quarry sites

Article 137: In order to ensure mining and quarry resources in line with environmental titles shall be the rational use of mineral and quarry protection, holders of responsible for:

- preventing geohazards and geodisasters; preventing or minimizing the discharge of waste in protecting fauna and flora;
- promoting or maintaining the general health of the reducing waste;
- disposing of non-recycled waste in such manner as to ensure safety of the environment, after
- informing and receiving the approval of the authorities in charge of mining and the environment;
- managing waste in accordance with the laws and regulations in force.

Are there environmental protocols that apply to ASM tailings management?

Law No. 96/12 Of 05 August 1996 Relating To Environmental Management/ Loi cadre relative à la Gestion de l'Environnement Loi n°96/12 du 5 aout 1996

Article 37: (1) Holders of mining permits or quarrying permits shall rehabilitate the exploited sites.

2) However, holders of mining permits and quarrying permits may choose to pay the financial cost of rehabilitation carried out by the competent Administration.

The amount of and the terms and conditions for paying the relevant charges shall be laid down by an enabling decree of this law.

The corresponding sums shall be paid to the Fund provided for by this law and shall not be earmarked for other uses

Article 67: (1) Mining resources and quarries shall be explored and exploited in an ecologically rational manner, making allowance for environmental considerations. (2) These activities shall be carried out in keeping with the provisions of the laws in force.

Chile

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? n/a

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? No.

Is there ASM-specific tailings management legislation? Yes.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

Law 27651/2002 regulates ASM and Resolution 0814/2019 deals with the requirement for mining operators (all scales) to present a Mineral Waste Management Plan.

Are there environmental protocols that apply to ASM tailings management?

The recently approved Decree 2, Article 1 of 2023 establishes the new National Environmental Protocol for mining that includes ASGM in item 1.

Colombia

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Mercury is prohibited and cyanide is permitted.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? No.

Is there ASM-specific tailings management legislation? Yes.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

Law 2250 was issued in 2022 and it is now undergoing regulation to provide more detailed guidelines. The law specifically focuses on formalizing ASGM practices at all levels, although it does not fully address responsibilities, tailings ownership, and the storage and disposal of mercury. Pure Earth has submitted proposals to the Ministry of Mines, including protocols and analyses for tailings management, property, and mercury disposal.

Are there environmental protocols that apply to ASM tailings management?

The national protocol for environmental protection that applies to ASGM is established in Resolution 90719/2014 and 40359/2016. These protocols represent the coordination between the Ministry of Mines and Ministry of Environmental Control to ensure responsible practices in small-scale mining.

Ecuador

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Mercury is prohibited and cyanide is permitted.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? The licensing provisions for tailings processing are the same as for standard ore processing.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

There is a mining tailings management legislation, but it is not specific for ASM. There is a national inventory for ASGM, which includes a record of productive associations.

Are there environmental protocols that apply to ASM tailings management?

The main environmental protocols are the Regulations of the Environmental Code published in the official registry 507/2019, articles 432, 434, and 436. In addition, there is the Environmental Regulations of mining activities published in the Ministry Agreement 37, last modified in 2021.

Ghana

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Mercury is permitted and cyanide is prohibited.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? Yes.

Is there ASM-specific tailings management legislation? Yes.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

Minerals and Mining Act, 2006 Act 703

Article 46: Subject to this Act and Regulations made under this Act, a mining lease authorizes the holder, the holder's agents and employees and a person authorized by the holder, in accordance with this Act, to enter upon the land the subject of the mining lease, to (d) stack or dump a mineral or waste product as approved in the holder's Environmental Impact Statement.

Article 93: A person licensed under Section 82 may win, mine and produce minerals by an effective and efficient method and shall observe good mining practices, health and safety rules and pay due regard to the protection of the environment during mining.

Minerals And Mining (Health, Safety and Technical) Regulations, 2012 (L.I. 2182)

Regulation 472—General duties of small-scale miners

1. The holder of a small-scale mining licence shall not undertake any activity or carry out any operation within a mining concession if that holder has not submitted an application as set out in Form Thirty-Five of the First Schedule, for approval and the issue of a Small Scale Mining Operating Permit, to the Inspectorate Division.
2. The Inspectorate Division may approve and issue a Small Scale Mining Operating Permit as set out in Form Thirty-Six of the First Schedule to the applicant if the applicant
    i. submits a plan showing the boundaries of the small-scale mining concession; and
    ii. submits a plan showing how the applicant intends to carry out the mining operations; and
    iii. explains how the applicant intends to rehabilitate the mined area.
3. The holder of a small-scale mining licence may only start operations after the area within the mining concession where that holder intends to start the mining operations has been inspected by the Inspectorate Division on request by the holder.

Regulation 480—Environmental protection provisions for small-scale mining

1. The holder of a small-scale mining licence shall
    i. rehabilitate and revegetate land which is no longer used for mining within one month after termination of activities on the land.
    ii. within one month after the abandonment of the mine, backfill disused trenches, excavations and pits in a manner that prevents the accumulation of stagnant water.
2. The Chief Inspector of Mines shall conduct a final inspection of the abandoned mine after rehabilitation work at that mine is completed and shall if satisfied with the rehabilitation, issue a rehabilitation certificate as set out in Form Thirty-Seven of the First Schedule to the holder of the licence to that mine.

Are there environmental protocols that apply to ASM tailings management?

Environmental Assessment Regulations, 1999

Regulation 3) Undertakings For Which Environmental Impact Assessment (EIA) Is Mandatory:

11. MINING

a. mining and processing of minerals in areas where the mining lease covers a total area in excess of 10 hectares;

Section 14 (1) An environmental impact statement for mining and other extractive industry shall include reclamation plans.

Honduras

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Both mercury and cyanide are permitted.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? No.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

The obligations of mining operators, including ASGM, for tailings management are established in the General Law of Mining published in Decree 292/98, Article 57.

Are there environmental protocols that apply to ASM tailings management?

Law 238-2012 (General Mining Law) specifies the requirements for the environmental management of ASM operations (articles 91 and 94).

Kenya

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Both mercury and cyanide are prohibited.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? Remining tailings are provided for under the Mining Code:

> "Mineral" means a geological substance whether in solid, liquid or gaseous form occurring naturally in or on the earth, in or under water, in mine waste or tailings and includes the minerals specified in the First Schedule but does not include petroleum, hydrocarbon gases or groundwater;
>
> Article 102: the applicant, with the consent of the licence holder, is applying for a licence that would permit the applicant to work a mine dump or mine waste and tailings on the land but not to undertake any other mining operation on the land.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

The Mining Act, No. 12 of 2016

Article 98 (1): A holder of an artisanal permit may mine and Operations of produce minerals in an effective and efficient method.

(2) The holder of an artisanal permit shall observe good mining practices, health and safety rules and pay due regard to the protection of the environment.

Article (181): an application for a prospecting license, a retention license, or a mining license shall provide a bond or some other financial security in this section called an environmental protection bond sufficient to cover the costs associated with the implementation of the environmental and rehabilitation obligations of the holder under this Act.

Are there environmental protocols that apply to ASM tailings management?

The Environmental Management and Coordination Act 1999 (EMCA) Amended 2015

Section 58(1), (4).

Projects to undergo environmental impact assessment

(5): Mining, including quarrying and open-cast extraction of—

(k) extracting alluvial gold with use of mercury.

68. Environmental audit

1. The Authority shall be responsible for carrying out environmental audit of all activities that are likely to have significant effect on the environment.

72. Water pollution prohibition

1. Any person, who upon the coming into force of this Act, discharges or applies any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permits any person to dump or discharge such matter into the aquatic environment in contravention of water pollution control standards established under this Part shall be guilty of an offence and liable to imprisonment for a term not exceeding two years or to a fine not exceeding one million shillings or to both such imprisonment and fine.
2. A person found guilty under subsection (1) shall, in addition to any sentence or fine imposed on him—
    i. pay the cost of the removal of any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants, including the costs of restoration of the damaged environment, which may be incurred by a Government agency or organ in that respect;
    ii. pay third parties reparation, cost of restoration, restitution or compensation as may be determined by a court of law on application by such third parties.

87. Prohibition against dangerous handling and disposal of wastes

1. No person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such manner as to cause pollution to the environment or ill health to any person.
4. Every person whose activities generate wastes shall employ measures essential to minimize wastes through treatment reclamation and recycling

88. Application for waste licence

1. Any person intending to transport wastes within Kenya, operate a wastes disposal site or plant or to generate hazardous waste, shall prior to transporting the wastes, commencing with the operation of a wastes disposal site or plant or generating hazardous wastes, as the case may be, apply to the Authority in writing for the grant of an appropriate licence.

Mongolia

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Both mercury and cyanide are prohibited.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? Regulation on extraction of minerals by small-scale mining allows for the mining of mine waste. Law on Minerals Article 4.1.23 defines ASM as: "Engaging in small-scale mining means operations of unregistered partnership as specified in Article 481.1 of the Civil Code or by partnerships specified in Article 35 or a cooperative specified in Article 36.4 of the Civil Code conducted for the purpose of extracting mineral resources in economically non-viable deposits or in derivative deposits arising from mining and technological waste."

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

Regulation on Extraction of Minerals by Artisanal and Small-scale Mining (2017) - (ASM Regulation 151)

Does not adequately cover the legal obligations of artisanal miners for environmental protection.

Joint Order of the Minister of Mines and Heavy Industry, Minister Of Environment And Tourism

August 28, 2019

No. A/181, A/458 - Approval Of Rehabilitation And Closure Procedures For Mines, Mining And Concentration Industries

Provides detail of the documents for the closure management plan but does not include waste management.

Decree #A/04 of MET (2014)

Requires ASM operators to place deposit in the soum environmental rehabilitation fund as collateral prior to commencing extraction in case the miners do not rehabilitate the area; however, information about this fund is lacking.

Are there environmental protocols that apply to ASM tailings management?

The Environmental Protection Law of Mongolia (1995) does not explicitly cover mining.

Nigeria

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Both mercury and cyanide are permitted.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? No.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

The Minerals and Mining Act (2007)

Article 90(2) states: All lease holders shall carry out effective rehabilitation of the mined-out areas to the satisfaction of the Mines Environmental Compliance Department and pay prescribed rehabilitation fee, proportionate to their profits as a way to defray further cost of rehabilitation and reclamation.

Article 91(h) states that the government shall provide extension services, including: the provision of EIA report and detailed guidelines on waste and tailing disposal.

Article 126:

1. The Minister may by regulations prescribe the quantity of tailing that may be deposited in any natural watercourse by a lessee under this Act.
2. No mineral titleholder shall, without permission obtained on application by it in writing to the Mines Inspectorate Department, deposit a greater quantity of tailings in any natural watercourse than that prescribed by regulations.

Minerals And Mining Regulations (2011)

Article 125(1): Every title holder or mine operator shall:

1. provide an effective management system for his tailings throughout the period of operation;

2. make adequate arrangements to protect the general public, particularly the host community from the risks associated with tailings storage;
3. ensure that tailings are properly treated before they are discharged into the watercourse;
4. ensure proper treatment of mine waste before final disposal to prevent air and water pollution and contamination;
5. provide adequate measures to minimize the effect of air pollution.

Article 154 states: Every type of license holder is required to submit:

1. submission of signed and approved Community Development Agreement before the commencement of operation;
2. submission of approved Environmental Impact Assessment;
3. submission of approved Environmental Impact Assessment Statement;
4. submission of approved environmental Protection and Rehabilitation Program;
5. submission of approved Environmental Protection and Rehabilitation Fund Implementation Timetable; and
6. submission of an approved mine design to Mines Inspectorate Department with details of environmental concerns.

Are there environmental protocols that apply to ASM tailings management?

The Environmental Impact Assessment Act, 1992 (as amended by EIA Act CAP E12 LFN 2004)

Under this act only a mining lease covers a total area in excess of 250 hectares; (b) ore processing, including concentrating for aluminium, copper, gold or tantalum; (c) sand dredging involving an area of 50 hectares or more must submit an EIA.

National Environmental (Mining and Processing of Coal, Ores and Industrial Minerals) Regulations, 2009 S. I. No. 31

Article 10(3): Tailings containing heavy metals or other toxic materials or substances shall be treated and disposed of in a government-approved designated site or landfill.

(4) Mine water containing heavy metals or other toxic materials or substances shall be treated to acceptable levels before disposal.

Schedule 4-Polluter-Pays Principle, Regulation 13(2)

- The owner or operator of a facility shall submit to the Agency an insurance bond for Reclamation plan.
- The compensation plan shall contain the following components; (i) a description of the location of the tailings impoundment area and the habitat/environment affected by the deposit.

Peru

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Both mercury and cyanide are permitted.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? The licensing provisions for tailings processing are the same as for standard ore processing.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

There is a mining tailings management legislation, but it is not specific for ASM. Law 28271 and Law 31211 are regulations for the remediation of mining passives that include ASM. Additionally, the state agency Organism for supervision of the Investment in Mining and Energy enforces monitoring and oversight norms (Law 28964, Article 1).

Are there environmental protocols that apply to ASM tailings management?

The environmental protocols are Law 28271 and Law 31211 that establish regulations for the remediation of mining-related environmental liabilities that include ASM.

The Philippines

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Mercury is prohibited and cyanide is permitted.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? RA No. 7076 (the People's Small-Scale Mining Act of 1991) states:

> Section 3 (i) "Processor" refers to a person issued a license to engage in the treatment of minerals or ore-bearing materials such as by gravity concentration, leaching, benefication, cyanidation, cutting, sizing, polishing and other similar activities.
>
> (j) "License" refers to the privilege granted to a person to legitimately pursue his occupation as a small-scale miner or processor under this Act;
>
> Section 16. Ownership of Millings. – The small-scale mining contractor shall be the owner of all millings produced from the contract area. He may sell the millings or have them processed in any custom mill in the area: provided, that, if the small-scale mining

contractor decide to sell its millings, the claim owner shall have a pre-emptive right to purchase said millings at the prevailing market price.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

RA No. 7076 (the People's Small-Scale Mining Act of 1991)

Section 13: states that the holder of a small-scale mining contract must comply with pertinent rules and regulations on environmental protection and conservation, particularly those on tree-cutting mineral-processing and pollution control.

Section 20: People's Small-Scale Mining Protection Fund. There is hereby created a People's Small-Scale Mining Protection Fund which shall be fifteen percent (15%) of the national government's share due the Government which shall be used primarily for information dissemination and training of small-scale miners on safety, health and environmental protection, and the establishment of mine rescue and recovery teams including the procurement of rescue equipment necessary in cases of emergencies such as landslides, tunnel collapse, or the like.

Are there environmental protocols that apply to ASM tailings management?

Presidential Decree No. 1586: Establishing An Environmental Impact Statement System Including Other Environmental Management Related Measures And For Other Purposes

Section 2. Environmental Impact Statement System. There is hereby established a Environmental Impact Statement System founded and based on the environmental impact statement required, under Section 4 of Presidential Decree No. 1151, of all agencies and instrumentalities of the national government, including government-owned or controlled corporations, as well as private corporations, firms and entities for every proposed project and undertaking which significantly affect the quality of the environment.

South Africa

Is ASM legal and provided for in the law? No, ASM is not legally recognized.

Is the use of chemicals by ASM permitted or prohibited? Both mercury and cyanide are prohibited.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? The Draft Artisanal And Small-Scale Mining Policy, 2021 mentions the creation of a framework for ASM to have access to the mining of tailings dumps and historic residue deposits and stockpiles.

Is there ASM-specific tailings management legislation? No.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

ASM is not legally recognized; the Draft Artisanal And Small-Scale Mining Policy, 2021 has been published for implementation but does not include tailings management.

Are there environmental protocols that apply to ASM tailings management?

The National Environmental Agreement: Waste Act, 2008 (Act No. 59 Of 2008) - Regulations Regarding The Planning And Management Of Residue Stockpiles And Residue Deposits from a Prospecting, Mining, Exploration or Production Operation does not provide for ASM.

Tanzania

Is ASM legal and provided for in the law? Yes.

Is the use of chemicals by ASM permitted or prohibited? Mercury is permitted and cyanide is prohibited.

Does the mining framework provide for tailings management? Yes.

Does the legal framework provide for tailings reprocessing, or contain special provisions for a processing licence? Yes. The Mining Act, Revised Edition, 2019, states "60.-(1) A person who is not entitled to process minerals in any area within or outside the area subject to a mineral right may apply to the Commission for a licence for processing minerals."

Is there ASM-specific tailings management legislation? Yes.

What are the duties of ASGM operators to manage tailings as per national mining frameworks?

The Mining Act, Revised Edition, 2019

Section 54 (3): An application for a primary mining licence shall contain: (d) environmental investigations and social study and an environmental protection plan as described in the relevant regulation.

Section 55 (3): A primary mining licence to mine minerals granted under this section shall confer on the holder the exclusive right, subject to this Act and the Regulations including the Regulations applicable to safety and the protection of the environment, to carry on prospecting and mining operations in the mining area, and for that purpose the holder, his servants and agents (being persons not disqualified under subsection (2) of Section 8 from holding a primary mining licence) may, in particular- (d) stack or dump any mineral or waste product in compliance with the applicable regulations.

107.-(1) The licence holder and any other person who exercise or perform functions, duties or powers under this Act in relation to mining operations shall comply with environmental principles and safeguards prescribed in the Environmental Management Act and other relevant laws.(2) The licence holder and contractor shall ensure that the management of production, transportation, storage, treatment and disposal of waste arising out of mining

operations is carried out in accordance with environmental principles and safeguards prescribed under the Environmental Management Act and other relevant written laws.

Are there environmental protocols that apply to ASM tailings management?

The Environmental Management Act, 2004

Section 105 (2): The Strategic Environmental Assessment provided for under sub-section (1), shall assess the area marked for development including the following- (h) potential environmental and social impacts of mining or petroleum development or hydro-electric power or any major water projects; and (i) recommendations for land reclamation and limitations on development in different areas.

Section 171 (1): Without prejudice to the exercise of his powers under the Mining Act, 1998, the Commissioner for Minerals through Sector Environment Coordinator responsible for mining shall forward to the Council as public records, copies of the following documents relating to the environment- d: such environmental management plans, or proposals for prevention of pollution, or plans for treatment of waste, or plans for reclamation of land and water resources, or plans for minimising the adverse effects on the environment resulting from mining operations, that may be prepared by applicants for special mining licences;

Management of Hazardous Waste (133)

1. It shall be an offence to import into or export from Tanzania, hazardous waste without a permit granted by the Minister.
2. Where hazardous waste is to be exported from Tanzania it shall be necessary for a person intending to export such waste to obtain a written permit issued by a competent authority of the receiving country. (3) No person shall transport hazardous waste within or through Tanzania without a permit granted by the Minister.
4. The Minister may make regulations prescribing the following:
    i. best possible ways to manage various types of hazardous wastes and appropriate penalties to any contravention;
    ii. responsibility and liability of person involved in any generation, transportation, export and disposal of hazardous wastes;
    iii. notification procedures in transportation and disposal of hazardous wastes;
    iv. any reporting requirement in implementation of international conventions on hazardous waste and in cases of incidents that may have potential to cause damage to human health, living beings and the environment;
    v. licensed disposal facilities for hazardous wastes;
    vi. responsibility and liability of person or group of persons that have caused contamination of the environmental ecosystem or owners of such sites;
    vii. criteria for classification of sites contaminates with hazardous wastes; and
    viii. clean-up sites contaminated with hazardous waste.

5. The Minister may prescribe criteria for the classification of hazardous wastes with regard to determining their –
    i. hazardous nature;
    ii. corrosive nature;
    iii. carcinogenic nature;
    iv. flammable nature;
    v. persistent nature;
    vi. toxic nature;
    vii. explosive nature; and
    viii. radioactive nature.

IGF

INTERGOVERNMENTAL FORUM
on Mining, Minerals, Metals and
Sustainable Development