

The Implementation of the Global Industry Standard on Tailings Management (GISTM) in Hydro Bauxite and Alumina

Paulo Henrique Alfenas da Silva¹, Stefani Oliveira², Débora Magalhães Chácara³, Lynnne Ferraz⁴, Hécio José Prazeres Filho⁵, Paschoal Cataldi⁶ and Raphael Vieira da Costa⁷

1. Senior Geotechnical Consultant

4. Planning Engineer

6. Executive Manager

7. Director of Technology

Hydro Bauxite & Alumina, Belém, Brazil

2. Geotechnical Engineer,

Hydro Bauxite & Alumina, Barcarena, Brazil

3. Responsible Tailings Facility Engineer

5. Technical Senior Manager

Hydro Bauxite & Alumina, Paragominas, Brazil

Corresponding author: paulo.alfenas@hydro.com

<https://doi.org/10.71659/icsoba2024-bx010>

Abstract

The Global Industry Standard on Tailings Management (GISTM) endeavors to achieve “zero harm to people and the environment” [1]. The GISTM is a sturdy framework, underpinned by a plan-do-check-act approach to tailings management, developed to improve the safety and sustainability of tailings facilities in the industry.

It changed the mining industry's approach to accountability, transparency, and safeguarding the rights of project-affected people. The Standard was launched in August 2020 by the Principle for Responsible Investment (PRI) in partnership with the UNEP Finance Initiative and UN Global Compact, the United Nations Environmental Program (UNEP), and the International Council on Mining & Minerals (ICMM). The standard is framed into six topic areas, 15 principles, and 77 requirements. The project-affected people standards are addressed in Topic I. Topic II demands from the operators the development of knowledge about the social, environmental, and local economic context for a given tailings facility. Topic III deals with the standards for designing, constructing, operating, maintaining, monitoring, and closing tailings facilities. In addition, Topic IV focuses on management and governance on a continuous basis. Emergency preparedness and response plans (EPRP) are covered in Topic V, while Topic VI requires the operator to publicly disclose relevant information about tailings facilities to strengthen public accountability. Members of the ICMM committed to implementing GISTM by August 5th, 2023, at tailings facilities (TFs) with “extreme” and “very high” consequence classification and to its other TFs by August 5th, 2025. This paper will present Hydro Bauxite and Alumina’s pathway to successfully implement GISTM at all TFs located at the Alunorte alumina refinery and Paragominas bauxite mine in the Brazilian state of Pará. The Hydro B&A’s implementation process was based on the GISTM Conformance Protocols [2] and has been assessed and confirmed through a self-assessment. The self-assessment demonstrated that Hydro B&A is well-positioned to continuously pursue best practices, enhance tailings safety and environmental stewardship, and be committed to fostering sustainable industrial operations and building trust in practitioners, communities, and investors.

Keywords: Global Industry Standard on Tailings Management, Global Standard, Conformance, Implementation, Tailings.

1. Introduction

The Standard was launched in August 2020 by the United Nations Environmental Program (UNEP), the Principle for Responsible Investment (PRI), an investor initiative in partnership with the UNEP Finance Initiative and UN Global Compact, and the International Council on Mining & Minerals (ICMM). The tragedy that occurred at Vale’s Córrego do Feijão mine in Brumadinho on 25 January 2019 triggered the novel, decisive, and appropriate creation of a Global Standard that aims to enhance the safety of TFs across the globe by establishing clear expectations of safety and responsible performance.

The Standard was launched on 5 August 2020 with the ultimate goal of “zero harm to people and the environment” [1]. It sets a benchmark for achieving adequate technical, social, and environmental practices for tailings management.

The ICMM members have committed all “Extreme” and “Very High” consequence classification tailings facilities to be *in conformance* with the global standard by August 2023 and all other facilities by August 2025 [1]. The Standard structure comprises six Topic Areas, 15 principles, and 77 requirements. Topic I focuses on project-affected people. Topic II requires Operators to develop knowledge about the social, environmental, and local economic context of a tailing facility. Topic III raises standards for designing, constructing, operating, maintaining, monitoring, and closing tailings facilities. Topic IV focuses on ongoing management and governance. Topic V covers emergency preparedness and response plans, while topic VI requires public disclosure of information about tailings facilities to support public accountability. The facilities deemed to be in safe closure are exempt from the Standard.

The *conformance* status is achieved when the operator can demonstrate that systems and processes are in place to implement all applicable requirements of the Standard, not in conflict with the law. The operator can demonstrate its conformance through a self-assessment, where he confirms the systems and practices relating to implementation are in place, or through a third-party independent validation, which relies on a cross-check confirmation of the assertions made in self-assessments based on reasonable and authentic evidence [1].

The possible outcomes for an individual requirement assessment are ‘Meets’, ‘Partially Meets’, and ‘Does not Meet’. In specific situations, a requirement may be ‘Not Applicable’ (Table 1).

Table 1. Description of conformance levels [2].

Conformance Level	Description of outcome
Meets	Systems and/or practices related to the Requirement have been implemented, and there is sufficient evidence to demonstrate that the Requirement is being met.
Partially meets	Systems and/or practices related to meeting the Requirement have been only partially implemented. Gaps or weaknesses persist that may contribute to an inability to meet the Requirement, or insufficient verifiable evidence has been provided to demonstrate that the activity is aligned to the Requirement.
Does not meet	Systems and/or practices required to support implementation of the Requirement are not in place, or are not being implemented, or cannot be evidenced.
Not applicable	The specific Requirement is not applicable to the context of the asset.

ICMM members have committed that all applicable criteria should achieve the level of conformance “Meets” by the deadlines. Given the timeline for implementing the Standard – August 2023 to “Extreme” or “Very High” and August 2025 for all other consequence classification TFs – the members should, at a minimum, demonstrate conformance based on self-assessment and provide independent validation as soon as reasonably practicable.

2. Hydro Bauxite & Alumina’s Tailings and Residues Facilities

Hydro Bauxite and Alumina’s business area in Brazil comprises the Paragominas bauxite mine and the Alunorte alumina refinery. Upstream the value chain of aluminum, the tailings generated by the beneficiation process at Mineração Paragominas are stored in two tailings facilities, namely the Valley System and the Tailings Drying Area (TDA), previously referred to as the Plateau Reservoir (RP1). On the other hand, the bauxite residue generated from the bauxite refining process at Alunorte refinery is filtered and disposed of in dry filtered residue stacks known as Solid Residue Deposits DRS1 and DRS2. A summary of the Hydro B&A’s tailings facilities and a general description are presented below.

2.1 Bauxite Residue Disposal Area – DRS1

The Alunorte refinery began operations in July 1995 and, since then, has relied on the DRS1 (Figure 1) to store the residue generated from the bauxite refining process for alumina production. DRS1 is in the North of Brazil in the city of Barcarena, Pará. DRS1 was constructed in 1994 and underwent 11 expansions. The facility is 46.6 m high and is being progressively closed and rehabilitated. At its final stage, the deposit will reach the maximum storage capacity of 65 Mm³. The water is managed in the facility through a system composed of five basins connected by channels, spillways, and pumping stations designed to event a 10 000-year return period. The contact runoff is treated in the Industrial Effluent Treatment Plant to meet the applicable environmental conditions before discharge. The system is lined with HDPE geomembrane to mitigate foundation seepage [3].

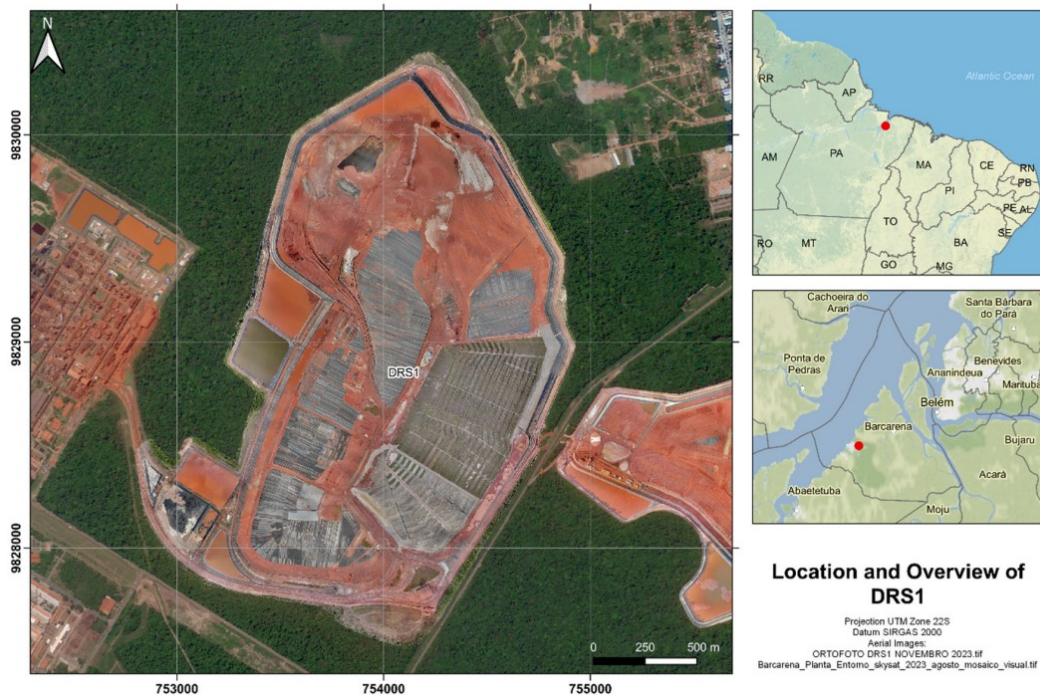


Figure 1. Bauxite Residue Disposal Area – DRS1 [3].

2.2 Bauxite Residue Disposal Area – DRS2

The dry-filtered residue stack DRS2 was constructed in 2015 (Figure 2). The facility designed and built to replace DRS1 is a press filter residues dry stack. DRS2 is located aside from the DRS1. The press-filtered residue is transported by pipe conveyor, reclaimed at the transport piles by dozer, and transported to the piles by trucks. Then, the residue is dumped, spread, and compacted by tamping compactors, optimizing the facility's storage capacity and achieving higher safety standards. The facility is 24 m high. At its final stage, the deposit will reach the maximum storage capacity of 25 Mm³, at a final height of 71 m. The water management comprises two basins connected to channels, spillways, and pumping stations capable of dealing with 10 000-years of return period rainfall events. Likewise, the water is treated before final discharge in the environment. The stack, basins, and channels are also lined with HDPE geomembrane [3].



Figure 2. Bauxite Residue Disposal Area – DRS2 [3].

2.3 Tailing Drying Area – TDA

The TDA of Mineração Paragominas S.A. consists of four disposal quadrants (TDA-A, TDA-B, TDA-C, and TDA-D), shown in Figure 3, delimited by internal and peripheral dikes and is responsible for the temporary drying of the tailings generated from the beneficiation of bauxite ore. The facility is 13.5 m high and has a maximum temporary storage capacity of 10.5 Mm³. The novel methodology developed by Hydro B&A, named tailings dry backfill, is employed at the TDA. The technology consists of excavating the dried bauxite tailings and transporting them to the mined-out areas, where the tailings are permanently stored and covered by overburden. The process is part of the mine reclamation, land forming, and rehabilitation. TDA is located approximately 70 km southwest of the municipality of Paragominas, in the northeastern of Pará [3].

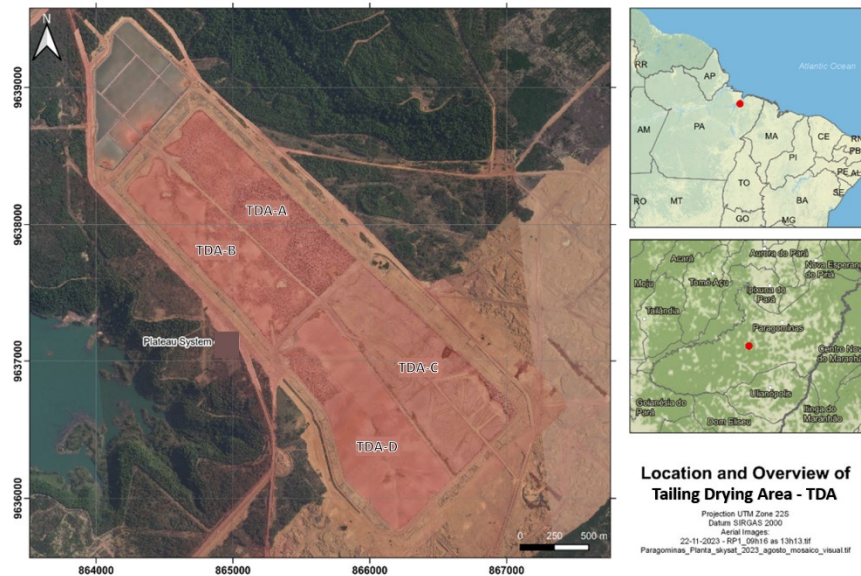


Figure 3. Tailing Drying Area - TDA [3].

2.4 Valley Dam

The Valley tailings facility (Figure 4) comprises the B1, B5, and B6 dams, along with an auxiliary dike (B3) and a contour channel. Its purpose is the disposal of tailings from the beneficiation of bauxite ore. The system has operated since 2006 and receives bauxite tailings following cycles to maximize drying and consolidation. The facilities' heights are 31.8 m (B1), 37 m (B5), and 13 m (B6), and the maximum tailing storage capacity is 51.5 Mm³. The Valley facility is also at Mineração Paragominas S.A, Paragominas, Pará [3].

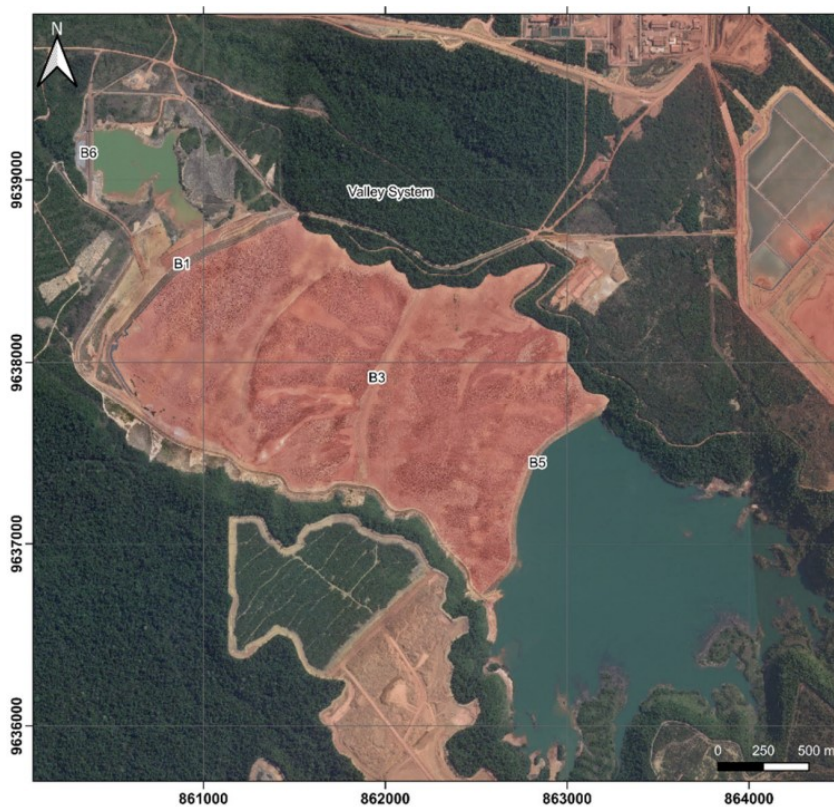


Figure 4. Tailing Drying Area - TDA [3].

3. The Pathway to Conformance

The Conformance Protocol published by ICMM in 2021 [2] is a result of collaborative work done by individuals and groups from consulting teams ERM, Kohn Crippen Berger Ltd (KCB), ICMM members from Alcoa, Anglo American, Anglo Gold Ashanti, Antofagasta Minerals S.A, Barrick, BHP, CODELCO, Freeport-McMoRan, Glencore, Fold Fields, Hydro, Minsur, MMG, Newcrest, Newmont, Orano, Polyus, Rio Tinto, Sibanye Stillwater, South32, Teck and Vale, and led by ICMM team.

The Conformance Protocol maps to the 77 Requirements of the Standard using clear and concise criteria (209) to be assessed, translating them into examples of conformance. The criteria in the Conformance Protocol are derived from and faithfully reflect the language of the Standard to support implementation and enable conformance against all applicable requirements to be assessed. So, the operator can use it to conduct self-assessments. The protocols can also support third-party auditors to independently confirm whether a facility is in conformance with the Standard.

As a member of ICMM, Hydro B&A has committed to implementing GISTM to all “extreme” and “very high” consequence classification tailings facilities by August 5, 2023, and to its other TFs by August 5, 2025. Hydro B&A has no facility classified as an “extreme” consequence classification.

The process of implementing the Global Standard began in 2020 following its publication. The challenges faced during the process were related to the lack of a tested implementation methodology, the need for a levelled understanding of the requirements, and the strong multidisciplinary interaction demanded by the relatively short deadlines.

The pathway for implementing the GISTM at Hydro Bauxite and Alumina started with the standardization of the implementation process led by the teams B&A Residues, Geotechnics, PMO, and Technology. The process comprised the following stages: interpretation, gap assessment, check and Balance, cross-check audit, and final sign-off.

3.1 The Gap Assessment

The B&A division from Hydro started the gap assessment by forming a group responsible for interpreting the standard requirements supported by the “Conformance Protocols.” At this stage, the multidisciplinary group was formed with experts from Sustainability and Social Impacts, Human Rights, Technology, Engagement and Dialogue, Project Management Office (PMO), Geotechnics, Bauxite Residue Disposal Area’s Operation, Legal, Legacy Assets, Sustainability Corporate, Health, Safety and Environment, Communication, Audit and Investigation, and Environmental, Social and Governance (ESG). The PMO led the process, and the representatives from the abovementioned areas addressed specific topics, as presented in Table 2.

Once the common understanding was achieved, the teams performed a gap assessment. The gap assessment preliminarily mapped the criteria and requirements with limited evidence. This process named two key practitioners, one indicated as responsible and a second as the reviewer, both expert practitioners from related areas.

The technology team, supported by the geotechnics and the RTFEs, led the check-and-balance process. At this stage, the gap assessment’s results and evidence were validated. An action plan was developed to address the identified gaps and opportunities. In total, 297 actions were appointed to address these gaps (Figure 5). Most actions were related to the topics six (41 actions), four (36 actions), eight (34 actions), five (29 actions) and ten (23 actions), respectively. The topics

with fewer actions raised were 15 (4 actions) and 12 (6 actions). Additionally, 16 actions were related to two or more requirements. The working group followed up on the actions until they achieved the “meet” level of conformance stated in Table 1 for all applicable requirements, including the public disclosure of information about tailings facilities to support public accountability.

Table 2. Multidisciplinary working groups.

Topic	GISTM Principles		Area												
			Sustainability and Social Impact	Human Rights	Technology Engagement and	Geotechnics	Tailings Engineers	Legal	Legacy Assets	Sustainability	HSE	Communication	ESG	Audit and Investigation	PMO
Communities (I)	1	Human Rights and Engagement	x	x	x										x
Integrated Knowledge Base (II)	2	Interdisciplinary Knowledge			x	x	x								x
	3	Informed Decision-making			x	x	x						x		x
Design, Construction, Operation and Monitoring (III)	4	Risk Reduction			x	x	x						x		x
	5	Design			x	x	x								x
	6	Lifecycle Risk Management			x	x	x								x
	7	Lifecycle Monitoring			x	x	x								x
Management and Governance (IV)	8	Policies, Systems & Accountability	x		x					x			x		x
	9	Engineer of Records			x		x								x
	10	Review Levels			x	x	x								x
	11	Organizational Culture			x					x			x		x
	12	Protections			x							x		x	x
Emergency Response (V)	13	Emergency Response			x	x	x	x			x	x			x
	14	Long-term Recovery			x		x	x							x
Disclosure (VI)	15	Public Disclosure			x	x	x	x	x	x	x	x			x

Figure 6 shows the progress of completing the actions and the conformance level at the four milestones set for Q4/2022, Q1/2023, Q2/2023, and Q3/2023 (August 5th, 2023) for DRS1 and DRS2 bauxite residue disposal areas and Valley and TDA tailings facilities.

The requirements that demanded the longest time to conclude were the requirements 4.8, 10.4, 4.1, and 6.3 related to the EoR, 6.4 and 6.5 regarding the Operational, Maintenance, and Surveillance updates, 5.4 and 10.1 addressing risk assessment, 4.3, 4.7, 5.7, 7.1, 8.2, and 8.3 related to Accountable Executive approval and sign-off, and 15.1 related to public disclosure. The conformance status was achieved in Q2/2023.

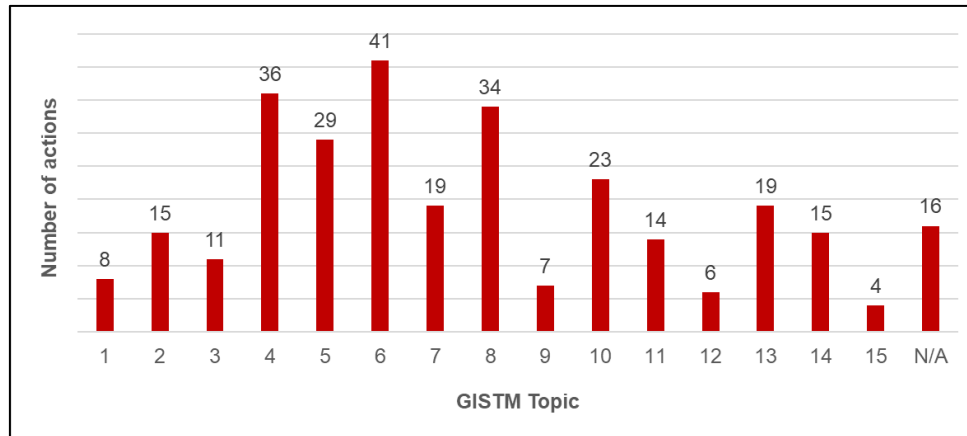


Figure 5. Number of Actions Raised during the Self-assessment per GISTM Topic.

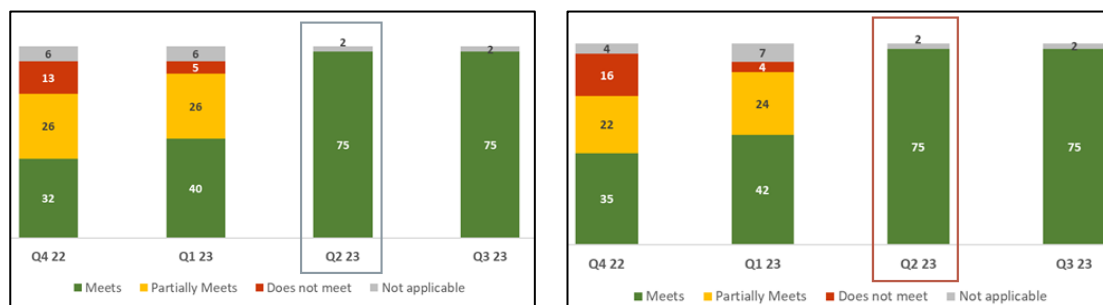


Figure 6. Progress of the Action Plan Conclusion and Adherence to the Conformance Level at Hydro B&A (left DRS1 and DRS2, right Valley and TDA).

The implementation was followed by the cross-check audit on Q3/2023 performed by the Corporate Sustainability team named by the Accountable Executive. A risk-based approach was taken when selecting which requirements should be audited in detail. This process was finished on May 30th.

The implementation process concluded with the successful implementation of the applicable requirements. It was finished with the sign-off from the Hydro B&A’s Accountable Executive on 5 July 2023, within the committed deadline.

3.2 Governance Framework

As per Topic IV – Management and Governance, the operator is required to: “establish policies, systems and accountabilities to support the safety and integrity of the tailings facility; appoint and empower an engineer of records; establish and implement levels of review as part of a strong quality and risk management system for all phases of the tailings facility lifecycle, including closure; develop an organizational culture that promotes learning, communication and early problem recognition; and establish a process for reporting and addressing concerns and implement whistleblower protections” [1].

Hydro B&A’s approach included creating and publishing a global tailings management policy, establishing the Independent Tailings Review Committee (ITRC), referred to in the GISTM as the Independent Tailings Review Board (ITRB), and creating the external and internal roles of Engineer of Records (EoR) and Responsible Tailings Facility Engineer (RTFE), respectively.

The tailings management policy aims to reinforce the commitment to the best practices of tailings management to protect the health and safety of people, host communities, and the environment.

This global policy applies to any operation and location that Norsk Hydro directly controls, providing direction and commitment for the management and governance of the facilities. The policy covers (i) Governance, management, and competency; (ii) Environment, safety, and community; and (iii) Engagement, training, and transparency [4].

The Hydro B&A's ITRC, EoR, and RTFE are regulated by specific Terms of Reference (ToR) developed before the roles were created.

The ITRC's terms of reference describe its roles, responsibilities, membership, organizational interfaces, reporting, and structure. The Committee is intended to function as an advisory body to the Accountable Executive, providing technical and independent evaluations of the design concept, construction, operation, management, and closure of the facilities.

The EoR and RTFE terms of reference define responsibilities and standardize the roles across the business areas. The ToR provides orientation on the scope and interactions between the internal and external roles and establishes the criteria for selection in terms of competencies and reporting.

Figure 7 presents the organizational structure related to the GISTM in Norsk Hydro, including Hydro Bauxite & Alumina.

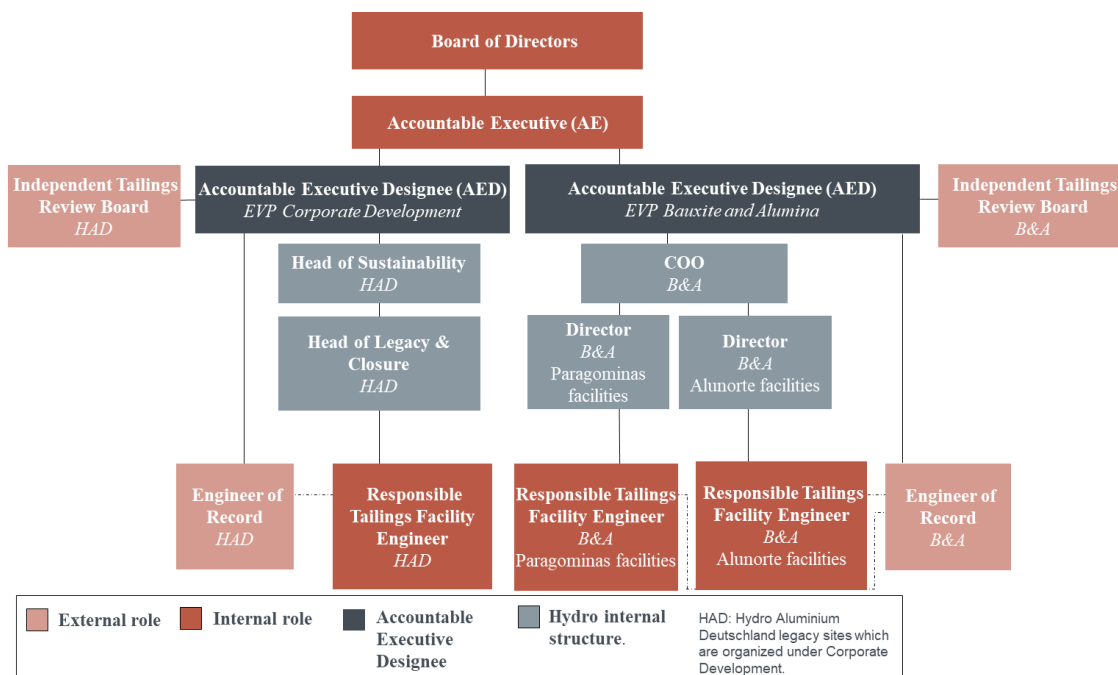


Figure 7. Organizational structure related to the GISTM in Norsk Hydro.

3.3 The Tailings Management System

The Tailings Management System (TMS) developed is framed into lines of defense, aiming to enhance the communication, risk management and controls, and design of the TFs, clarifying the roles and responsibilities related to the tailings management.

The TMS has an integrated view of governance and focuses on long-term performance, safety, management, and risk assessment of activities related to tailing facilities. It is based on the performance and processes defined according to a Plan-Do-Check-Act program. The TMS is underpinned by directives and procedures aligned with the tailings management policy.

The TMS includes the following elements:

- The organizational structure is presented in the lines of defense.
- The directives framework, including the technical and global policy for tailings management.
- The description of the roles and responsibilities related to the tailings management.
- The communication and reports.
- A RACI matrix (*Responsible - Accountable – Consulted – Informed*).

As illustrated in Figure 8, the activities related to Tailings management are supported by an efficient organizational structure with required competencies, transparent decision-making processes, and access to the project's essential data.

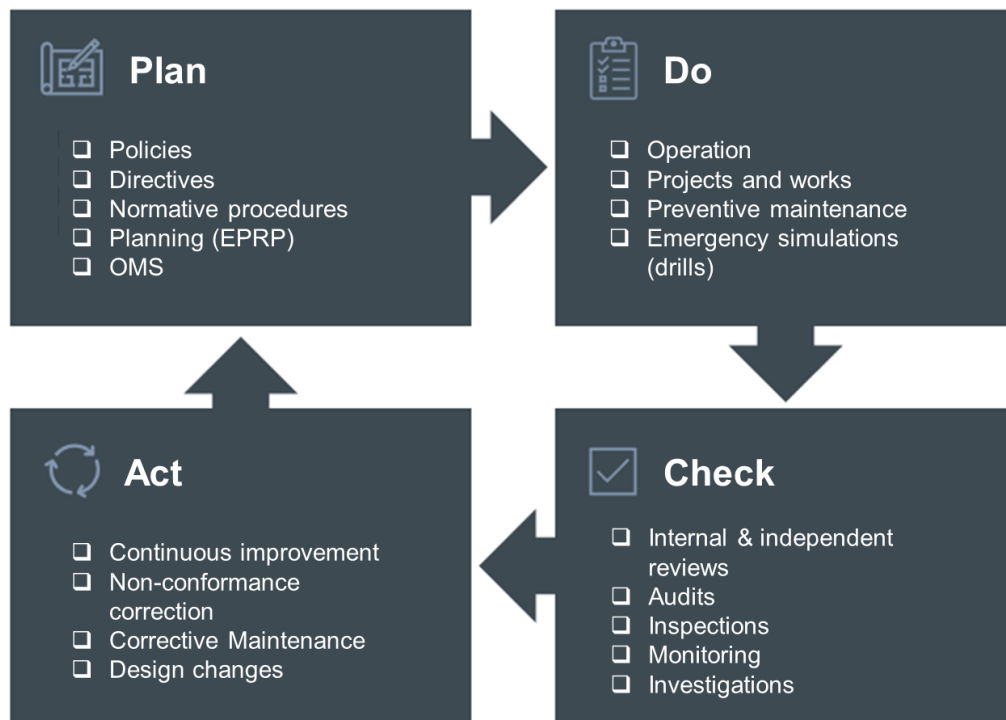


Figure 8. PDCA applied to Tailings Management at Hydro B&A.

The RACI matrix, presented in the TMS, lists the ten macro processes (Figure 9) comprising 80 activities involving tailings facilities' lifecycle. These include Governance and Management, Studies and Projects, Operation, Construction, Maintenance and Safety, Surveillance, Geotechnical Monitoring, Risk, Emergency Plans, and Independent Review.

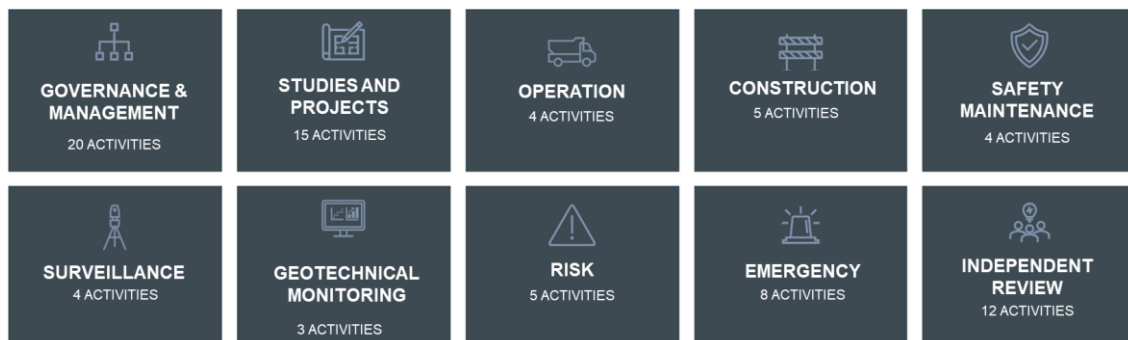


Figure 9. The Macro Processes Composing Hydro B&A's TMS.

3.4 The Public Disclosure

Principle 15 of GISTM sets requirements on public disclosure and access to information about tailings facilities to support public accountability. Requirement 15.1 asks Operators “to publish and regularly update information on their commitment to safe tailings facility management, implementation of its tailings governance framework, its organization-wide policies, standards or approaches to the design, construction, monitoring, and closure of tailings facilities” [1].

Hydro B&A publicly disclosed a report [3] summarizing the individual description of the tailings facilities, the consequence classification, the summary of the risk assessment findings relevant to the tailings facilities, the impact assessment, and the human exposure and vulnerabilities to tailings credible failure scenarios, a description of the design for all phases of the facility lifecycle including current and final height, the summary of the annual performance reviews and dam safety reviews, including the mitigation actions to attend the ALARP criteria (as low as reasonably practicable), a summary of the relevant findings of the social and environmental monitoring program and the summary of the Emergency Preparedness Response Plan including the credible flow failure scenarios from the breach analysis, and the emergency measures that applies to project affected people. It also included the dates of the most recent and following independent reviews and the confirmation of the adequate financial capacity to cover estimated costs for the tailings facilities closure and reclamation.

4. Conclusions

As described in this paper, Hydro Bauxite & Alumina has successfully implemented GISTM by August 5th, 2023, to all “very high” consequence classification facilities, as committed as ICMM member.

The paper demonstrated the pathway to successfully implement GISTM at all tailings facilities at the Alunorte alumina refinery and Paragominas bauxite mine in the Brazilian state of Pará. The process comprised the creation and nurturing of multidisciplinary working groups for Interpretation, gap assessment, check and Balance, cross-check audit, and final sign-off.

This paper focused on governance improvements, including the creation of the Independent Tailings Review Committee, the Engineering of Records, the Responsible Tailings Facility Engineers roles, the TMS, and the global tailings management policy addressing governance, management, and competency, environment, safety, and community, engagement, training, and transparency.

The implementation has been assessed and confirmed through a self-assessment in line with the GISTM Conformance Protocol. It was demonstrated that Hydro B&A is well positioned to continuously pursue best practices, enhance tailings safety and environmental stewardship, being committed to fostering sustainable industrial operations and building trust in practitioners, communities, and investors.

5. References

1. International Council on Mining & Metals (ICMM), Global industry standard on tailings management, *ICMM Website*, https://globaltailingsreview.org/wp-content/uploads/2020/08/global-industry-standard_EN.pdf (accessed on 19 March 2024).
2. International Council on Mining & Metals (ICMM), Global conformance protocols: global standards on tailings management, *ICMM Website*, <https://www.icmm.com/website/publications/pdfs/environmental->

- [stewardship/2021/tailings_conformance-protocols.pdf?cb=21097](https://www.hydro.com/globalassets/04-stewardship/2021/tailings_conformance-protocols.pdf?cb=21097) (accessed on 19 March 2024).
3. Hydro, Global industry standard on tailings management (GISTM) public disclosure report, *HYDRO Global Site*, <https://www.hydro.com/globalassets/04-sustainability/gistm-public-disclosure-pdf.pdf> (accessed on 19 March 2024).
 4. Hydro, Tailings management policy, *HYDRO Global Site*, https://www.hydro.com/globalassets/08-about-hydro/corporate-governance/tailings-management-policy_publication.pdf (accessed on 19 March 2024).