



Mining and Mineral
Resources Division
**Ministry of
Energy and Mines**

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY BREACH

August 4, 2014

Investigation Report
of the Chief Inspector of Mines

November 30, 2015

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In addition to these direct (or “proximate”) causes of the failure and breach, a number of defenses were either defeated or not present. A defense can intervene and break a causal chain, mitigating or preventing an undesired outcome.

Failed defenses include site investigations that were not conducted with sufficient detail, requests by the Regulator for information or clarification that were discounted, adequacy of site supervision and risk identification, missing procedures, misplaced confidence, mistaken belief, and organizational voids in key management areas.

1.7. FINDINGS OF THE CHIEF INSPECTOR

It is the responsibility of the Chief Inspector of Mines to make formal determinations regarding any event investigated pursuant to the *Mines Act*. A finding is a considered, objective conclusion issued by the Chief Inspector based on his assessment and consideration of the facts and analyses conducted as part of the investigation.

IT IS THE FINDING OF THE CHIEF INSPECTOR THAT:

- 1 a structural failure of the Mount Polley Mine tailings storage facility Perimeter Embankment occurred at approximately 11:40 pm on August 3, 2014; that the failure led to a major and ongoing erosion breach at approximately 1:08 am on August 4, 2014; and further that the breach resulted in uncontrolled release of tailings and process water into the environment.
- 2 undesired consequences beyond the mine site resulted directly from the breach, affecting the environment, the mining industry, First Nations, and the citizens of British Columbia.
- 3 the structural failure of the embankment occurred because of three proximate causes: an uncharacterized glaciolacustrine unit in the native soil foundation of the dam structure; an over-steepening of the downstream slope of the dam, coupled with the constructed height; and an unfilled excavation at the toe of the embankment at the site of the failure.
- 4 the mechanism of the structural failure was a sliding failure through the lightly overconsolidated glaciolacustrine clay unit (UGLU) located approximately ten metres into the foundation. The failure caused the embankment crest to drop approximately 5 metres, and can be considered the initiating event of the breach of the tailings dam.
- 5 MPMC and its engineering consultants did not fully recognize and manage geotechnical and water management risks associated with the design, construction, factor of safety, and operation of the tailings storage facility.

FINDINGS RELEVANT TO FOUNDATION SOILS

- 6 adequate studies of the embankment foundation were not conducted on the Perimeter Embankment, and site investigations for the Perimeter Embankment did not meet generally accepted standards of practice for embankment structures. There was an assumed degree of certainty that the foundation soils were dense and strong, which was not supported by a robust understanding of the foundation characteristics.
- 7 initial site investigations at the Perimeter Embankment foundation did not include adequate geotechnical characterization of soils at depth, and further, no subsequent site investigations were conducted on the Perimeter Embankment until 2011; drillholes were widely spaced and were principally for the placement of instrumentation and the assessment of lower glaciolacustrine soils.

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- 8** although the upper glaciolacustrine unit (UGLU) was detected during site investigations, its significance remained unrecognized, and the risk associated with the extent and characterization of strength of this layer was a proximate cause of the embankment failure. Multiple opportunities to review and characterize the foundation soils arose, either in response to queries by Government inspectors, or available in extant drillcore records; but these opportunities were unnoticed, ignored, and/or discounted.

FINDINGS RELATED TO SUPERNATANT WATER AND BEACH ADEQUACY

- 9** the structural failure of the embankment alone did not cause the breach, but coupled with the condition of the tailings pond — with insufficient beaches and too much supernatant water — a progressive erosional failure of the embankment rapidly widened into a complete breach.
- 10** adequate beaches could not be continuously maintained primarily as a result of surplus supernatant water.
- 11** an adequate water management plan did not exist. Mount Polley Mining Corporation failed in its management of the water balance with respect to long term planning, including site integration, effective treatment, discharge plans and permits. There was no qualified individual responsible for the water balance, and MPMC did not adequately characterize the risk of surplus supernatant water, which had been compounding since the mine reopened in 2005.

FINDINGS RELEVANT TO MPMC MANAGEMENT

- 12** it was the responsibility of Mount Polley Mining Corporation to maintain a safe structure, irrespective of the Mine's reliance on external geotechnical engineering expertise. Mount Polley Mining Corporation did not meet this responsibility.
- 13** delegation of engineering tasks to a contractor with the skills, knowledge, and abilities to perform a required task — even when the contractor is licensed and regulated as a professional engineer by APEGBC — does not release the Permittee from this responsibility. The responsibility resides with the mine; it cannot be delegated.
- 14** Mount Polley Mining Corporation did not recognize the risk of the excavation for the buttress foundation, resulting in a small reduction in the FoS. This work was not recognized as a substantial departure from the approved work plan by MPMC, and the Chief Inspector was not notified.
- 15** Mount Polley Mining Corporation did not identify or manage risks associated with changing Engineers of Record at the tailings storage facility.
- 16** concerns regarding steep slope, dam construction material availability, buttress subexcavation, and supervision were identified by employees but not elevated for action by MPMC management.
- 17** the mine failed to conduct a risk assessment, in accordance with *Towards Sustainable Mining* (TSM) guidelines developed by the Mining Association of Canada (MAC), which may have been sufficient to identify concerns about the steep geometry, the toe sub-excavation left open and unfilled, and the absence of sufficient site investigations.

FINDING RELEVANT TO MEM

- 18** the Regulator works within the bounds of professional reliance; but the implementation of professional reliance is not adequately structured or formalized in policy.

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1.8. LESSONS LEARNED

In addition, the Chief Inspector recognizes the opportunity to learn, benefit and evolve from the hard-earned lessons of the Mount Polley TSF failure of August 4, 2014. The Chief Inspector identified a number of such lessons for the benefit of the mine operator, the mining industry, associated professional organizations, and the Regulator itself. These lessons are presented in Chapter 12.

1.9. RECOMMENDATIONS OF THE INVESTIGATION

The Chief Inspector has developed a series of seven recommendations on the basis of the investigation directed toward the mining operator (MPMC), mining industry, professional organizations and the regulator.

1.9.1. RECOMMENDATIONS FOR THE MINING OPERATOR

RECOMMENDATION 1: PROPONENT GOVERNANCE

Recommendation 1-1: Mine Dam Safety Manager

Any mine with tailings storage facilities (TSFs) should have a qualified individual designated as a mine dam safety manager responsible for oversight of planning, design, operation, construction and maintenance, and surveillance of the TSF, and associated site-wide water management. The individual must possess the requisite knowledge, skills, and abilities to perform these responsibilities. Functions of this role may include coordinating relevant parties involved with the TSF (*e.g.*, consultants, contractors); ensuring appropriate approval of all activities has been obtained; maintaining compliance with applicable permit conditions, *Mines Act*, and Code; life-of-mine planning for water, waste and tailings management; site integration; integration of the OMS and MERP; and consideration of potential factors that may influence tailings dam safety.

A qualified individual in this role may prevent a TSF failure or breach by anticipating, recognizing and preventing conditions from developing that could impact the safety of the tailings dam.

Recommendation 1-2: Water Balance Management

Water management and water balance issues for mining projects must be designed by a qualified professional. These issues require the integration of relevant mine departments. Mine operators should designate a responsible qualified individual to oversee site-wide water management and water balance.

A qualified professional design and a qualified individual to oversee the water balance and water management plan will be able to anticipate site conditions and long-term considerations towards water management. Effective water management may prevent a structural failure from developing into a breach.

Recommendation 1-3: TSF Operations, Maintenance and Surveillance Manual

The mine manager should ensure the Operation, Maintenance and Surveillance manual (OMS) required by the Code for all impoundments adheres to applicable CDA and MAC guidelines. Additional guidance for the OMS should include incorporation of an annual risk assessment/risk management plan and relevant findings of an independent technical review board. The OMS emergency response section should be written so that it can be effectively utilized during an emergency, and should be integrated into the Mine Emergency Response Plan (MERP).

An effective and well-implemented OMS will make all related personnel more attuned to hazard identification and mitigation, knowledgeable in potential downstream consequences, and capable in emergency response.

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Recommendation 1-4: Mine Emergency Response Plan

The mine manager must ensure that the Mine Emergency Response Plan (MERP) adheres to applicable regulations, is maintained on a regular basis for currency, incorporates appropriate response measures to emergencies including those involving the TSF, and is written and distributed in such format as to serve as a procedural guide during an emergency or other event. Site emergency response plans should be practiced and integrated across possible eventualities on the mine site allowing for coordination of resources. Training should also be provided to improve effective emergency response.

An effective MERP gives responding site personnel an actionable plan to implement during an emergency, which can be instrumental in protecting lives and the environment.

Recommendation 1-5: Risk Recognition and Communication

All mine personnel have a role to play in recognizing and reporting risk conditions, especially those that could affect health, safety and environmental protection; and should be educated in the recognition of conditions and events that could impact TSF safety or contravene applicable permit conditions and regulations.

An effective reporting mechanism for employees' safety or environmental concerns on the mine site (whether directly or anonymously) should be established, implemented and monitored.

Personnel educated in risks associated with TSF-related activities can offer ongoing insight into conditions that may compromise the safety of the structure.

1.9.2. RECOMMENDATIONS FOR THE MINING INDUSTRY

RECOMMENDATION 2: TSF DESIGN

Recommendation 2-1: Design Objectives

Tailings storage and water management systems and structures should be designed for worker and public safety and the protection of the environment. TSF design should incorporate a comprehensive feasibility assessment that considers technical, environmental, social, and economic aspects of the mining project in sufficient detail to support the submitted design. An assessment of the applicable best available technologies and best available practices for the project should be incorporated into the design considerations to reduce the risks associated with the TSF for life-of-mine from construction to post-closure.

Design based on a comprehensive feasibility assessment will reduce the likelihood of unexpected conditions developing that could negatively impact the safety of the structure.

Recommendation 2-2: Independent Technical Review Board

Mines with impoundments should each develop independent technical review boards (ITRB) to provide additional perspectives on site investigation, site selection, design, construction, maintenance, operations, surveillance, water management and closure. The ITRB's review should provide additional oversight to include BAP/BAT for tailings storage and water management. The ITRB would include one or more individuals with appropriate engineering expertise with similar structures; and its opinions should be integrated into the mine's TSF management system. The requirement for an ITRB should be determined and incorporated into the Code.

ITRBs will strengthen oversight and risk management by providing review, professional opinion, and feedback to the EoR and the mine regarding the TSF.

1.9.3. RECOMMENDATIONS FOR PROFESSIONAL ORGANIZATIONS

RECOMMENDATION 3: PROFESSIONAL AND ASSOCIATION STANDARDS

Recommendation 3-1: Professional Reliance Standards

The Chief Inspector recognizes the necessity of reliance on professional practice for the design, construction, operation and closure of mines and mine facilities. The Regulator does not design the mine or associated structures, and thus is reliant on the professional practice of the designer.

Reliance on professional practice requires that the organizations overseeing the professionals or developing guidelines and standards for the professional community incorporate best available practices into their oversight. Organizations supporting such standards include:

Association of Professional Engineers and Geoscientists of BC (APEGBC). Responsibilities include professional practice guidelines. APEGBC should develop specific practice guidelines for site investigation, roles and responsibilities of the Engineer of Record (EoR), standards of practice for transfer of EoR, especially when the transfer involves changing engineering companies, and standards for engineering presence on site during construction.

Mining Association of Canada (MAC). Responsibilities include participatory guidelines applicable to tailings and water management, including applicable safety, operations, design, construction, surveillance, and planning; and corporate governance standards of practice. MAC should review existing guidelines to define the roles and responsibilities of the mine dam safety manager, and should develop guidance on what is required to document the tailings management system such that it can be audited by a qualified third party such as the International Standards Organization (ISO).

Canadian Dam Association (CDA). Responsibilities include the ongoing development of design guidelines for water and mining dams. CDA should update safety guidelines to reduce ambiguity, and develop specific guidelines for mining embankments which recognize the continued changes and raises during the life of the TSF and the consequence classification associated with a tailings dam failure.

Strengthening standards of practice will enable better design, construction, and operation of impoundments, improve governance, and establish benchmarks to evaluate these practices.

Recommendation 3-2: Integration of Standards

The Regulator should consider and incorporate as appropriate guidelines from these external associations as applicable and consistent with MEM objectives.

The Regulator will be able to incorporate improved standards and guidelines to better align with appropriate professional and industry practices.

1.9.4. RECOMMENDATIONS FOR THE REGULATOR

RECOMMENDATION 4: REGULATOR FUNCTIONS

Recommendation 4-1: Review of the Code

MEM should undertake a comprehensive review of the Code to ensure that the lessons learned and recommendations from this report are fully considered and appropriately incorporated; and that all relevant standards and guidelines from external bodies (such as MAC, CDA, and APEGBC) are fully considered in the review as appropriate.

Enhancements to the Code will assist the inspectorate in the enforcement of necessary management and engineering standards and guidelines.

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Recommendation 4-2: Life-of-Mine Planning for Permitting

Short-term, incremental *Mines Act* permit amendment applications can obscure life-of-mine conditions and long-term risks. The Regulator should ensure a perspective that spans the life of the mine be considered for *Mines Act* permit applications, while acknowledging that the nature of mining frequently requires changes to the life-of-mine plan.

Requiring life-of-mine planning in TSF design and the permitting process will enhance the robustness of the overall design of proposed structures.

Recommendation 4-3: Investigation, Compliance and Enforcement Review

The Regulator must enhance its investigative capacity, as well as its ability to exercise its existing compliance and enforcement authority under the *Mines Act* and Code. A supported director-equivalent position specific to investigation, compliance and enforcement should be established to evaluate and oversee these roles. This oversight should extend to applying recommended standards to the Regulator's compliance and enforcement function. A full range of regulatory tools, such as incentives, administrative penalties, outside agency collaboration and other best practices should be considered.

Improved investigative and enforcement capacity will enhance the ability of the Chief Inspector to increase compliance and achieve greater safety at mines, improve industry practices, and lead investigations in the future.

Recommendation 4-4: Geotechnical Oversight

The Regulator has a responsibility to oversee the decisions of the EoR. The Regulator must maintain sufficient technical capacity to conduct appropriate oversight of the professional opinions on which it relies. A Regulatory Dam Safety Manager dedicated to the coordinated regulatory oversight of tailings dams in the Province could be responsible for ongoing policy development, technical review, and inspection capacity as it relates to tailings impoundments.

Effective oversight of professional reliance in the design, maintenance, and operation of tailings impoundments will increase compliance with engineering and operational standards, reducing risk in tailings storage facilities across mines in the Province.

Recommendation 4-5: Organizational Review of Inspectorate

There exists an ongoing need to adequately support the increased tempo of review, monitoring and inspection that would be placed on MEM's inspectorate. It is recommended that a comprehensive internal review of operational and business practices be conducted.

An organizational review of the Inspectorate is warranted by the scope and urgency of the recommendations of this report, and will strengthen MEM's ability to fulfill the Chief Inspector's obligations to the citizens of BC.

RECOMMENDATION 5: STRENGTHENING RECORDS MANAGEMENT

Recommendation 5-1: Internal Records Management

A formal MEM management system of documentation for all mines from development to post-closure should be established. The system will assist the Chief Inspector in integrating regulatory oversight capabilities; assist with investigation, project tasking, formal documentation and indexing; and enhance the ability of MEM to meet the expectations for transparency and appropriate disclosure within the limits of privacy considerations.

An effective records management system will support long-term, integrated decision making by the Regulator, the permittee and consulting professionals.

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RECOMMENDATION 6: REGULATORY INTEGRATION

Recommendation 6-1: Alignment of Regulatory Objectives

Agency objectives (environmental protection, worker health and safety, facilities integrity) overlap but are not always integrated. MOE and MEM interests, disciplines and standards should be reviewed for alignment opportunities to support timely and effective program outcomes while optimally fulfilling the mandates of both agencies.

Recommendation 6-2: Permitting Process Alignment

Separate permitting processes for MEM and MOE should be reviewed for opportunities to integrate and align these processes as appropriate to avoid duplication and increase efficiencies. There should be a mechanism to flag each agency's participation in the process to ensure that risks, such as those related to the discharge permitting process, are adequately characterized and prioritized.

RECOMMENDATION 7: FOSTERING INNOVATION

Recommendation 7-1: Collaborative Education

MEM, the industry, professional organizations, and educational institutions should continue to seek new collaborative opportunities to foster education (including formal academic, onsite or online employee-focused, public-facing, and professional continuing education). This initiative could include the availability of standards for education to better define the knowledge, skills, and abilities for various accountabilities within mining; and to increase the knowledge base, information sharing, and innovation. MEM could ensure that resources are allocated to enable the implementation of this objective.

Recommendation 7-2: Research and Development

Current technologies in tailings processing, dewatering, and discharge water treatment have not achieved a sufficient level of technical and economic feasibility in many projects. Both government and industry should support research and development efforts to improve these technologies for practical application.

1.10. NEXT STEPS: TOWARD A SAFER MINING INDUSTRY IN BC

As government, industry and others prepare to respond to the Chief Inspector's recommendations, action in response to the Mount Polley TSF breach is already under way. For example, the Province has accepted all the recommendations of the Independent Expert Engineering Panel and has begun working with the mining industry, unions and First Nations to conduct a major review of the Code. The review is focused on a number of areas, including:

- Application of best available technologies (BAT) and best available practices (BAP) in mining
- Enhancing validation of safety and regulation of all phases of a TSF
- Improving dam safety and TSF management requirements

The BC Environmental Assessment Office has established additional requirements for evaluating tailings management options for proposed major mines in BC. It has also taken steps to ensure that best available technologies will be part of the environmental assessment process.

All mines in the Province were ordered to conduct accelerated Dam Safety Inspections and assess the safety of their impoundments. APEGBC, which represents professional engineers and geoscientists, is developing professional practice guidelines for dam site characterization assessments, to help ensure that future dams are built to consistent safety standards. CDA and MAC are likewise moving forward with revisions to their guidelines.

These steps suggest that all affected parties are willing and able to work together to act on the lessons learned from the Mount Polley dam breach, helping to improve the safety of workers, communities, First Nations, and the environment.

The recommendations of the Chief Inspector will continue to focus the attention and commitment of Government and the mining community to build a safer, more sustainable industry in BC.