Mount Polley Tailings Dam Failure – More Lessons to Learn

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Abstract

The Mount Polley Tailings Facility was first constructed in 1996 at a time when three new mines were under development in BC, Canada (Mount Polley, Huckleberry and Kemess South). The design, review and regulatory oversight of these three projects were influenced by tailings facility failures that had occurred at that time (Merriespruit, South Africa (1994), Omai, Guyana (1995)). Qualified geotechnical engineers developed designs, Independent Engineering Reviews were conducted, and enforcement of mining regulations occurred with strong participation by the Provincial Government. The concurrent development of these mines allowed for lessons learned from one project to be applied to the others. For example, foundation instability in glaciolacustrine soils encountered during construction of the starter dam at the Kemess Tailings Facility resulted in review of similar glaciolacustrine soils at the Mount Polley Tailings Facility, and the early embankment designs incorporated suitably flat and/or buttressed slopes to accommodate the potentially weak foundation conditions. The Mount Polley dam failure occurred after the facility design was modified by incorporating steeper overall slopes for the higher embankments. Recent regulatory changes in BC mandate Independent Review Boards along with increased inspections by Regulators for tailings facilities. This will result in more conservative designs with increased oversight during all phases of mine operations, in order to foster a safer mining industry.

Biography

Mr. Ken Brouwer is the President of Knight Piésold Canada. His areas of expertise include geotechnical investigations, construction management, hydrogeological evaluation, tailings management, dam design, rock mechanics, heap leach pads, water management, regulatory liaison, and permitting support. He has provided specialist tailings management services for numerous mining projects throughout North America, Central America, South America, Europe, Asia, and Africa. Mr. Brouwer has made significant contributions to the evolution of the current best practices for tailings management during his 30+ year career and pioneered the development of many drained and dewatered tailings impoundments in North America.

Mr. Greg Smyth is a Project Manager at Knight Piésold's Vancouver office, where he oversees feasibility studies and environmental assessments related to mine waste management for mining projects. He has 20 years of environmental and engineering experience, allowing him to bring value to mining projects from their inception through to closure. His areas of expertise include: mine waste and water management design, baseline studies, environmental impact assessment, First Nation and public consultation, mine permitting, reclamation and closure design, and communication with agencies at all levels of government. Mr. Smyth has applied his unique skillset working for the mining industry as a member of Knight Piésold as well as for mine development companies since 1996.

Preface

When significant events occur, we are naturally curious to understand the nature of the event, why it happened, and how we can prevent future similar events from being repeated. The 2014 dam breach at the Mount Polley Mine in BC, Canada was one of those significant events for the mining industry, local communities and indeed all those that were affected. Numerous investigations were initiated to understand the issues surrounding this incident, including an Independent Expert Engineering Review Panel set up by the Provincial Ministry of Energy and Mines (Morgenstern et al., 2015). Secondly, the Chief Inspector of Mines, supported by in-depth technical analysis developed by Klohn Crippen Berger (KCB), conducted a more extensive investigation highlighting additional relevant and important details (Hoffman, A., 2015). Thirdly, the Office of the Auditor General of BC published results of their investigation into the role of the key Ministries that provide oversight to the mining industry (i.e. the Ministry of Energy and Mines; and the Ministry of Environment) (Bellringer, C., 2016).

A fourth investigation is on-going and is being led by the BC Conservation Officer Service, Major Investigation Group, with support from Fisheries and Oceans Canada and Environment and Climate Change Canada. This investigation is focused on potential contraventions of the Provincial *Environmental Management Act* and the Federal *Fisheries Act*. As was the case from the first three investigations, additional details will be learned, which will assist in a more fulsome understanding of the event, ultimately working towards prevention of any repetition of a similar event.

Regardless of the level of insight gained from any one investigation, let alone the combined knowledge from all investigations, a reflection on historical context can often offer additional lessons that can strengthen the institutional knowledge for all, and perhaps assist to a greater extent the prevention of unplanned events. Such is the case at Mount Polley, which is detailed below.

Common Threads

The mid-1990s was an active time in the mining industry in BC. Three large-scale mines began construction between 1996 and 1998 as illustrated on Figure 1. The Mount Polley Mine, the Kemess Mine and the Huckleberry Mine were being developed by separate mine development companies, with oversight for all three projects on the part of the BC Ministry of Energy and Mines. During the early planning phase for each of these projects, the global mining industry was learning from two unfortunate dam breaches that had occurred immediately prior to this timeframe. The tailings facility near Merriespruit, South Africa breached in 1994, while the tailings facility at the Omai Mine in Guyana breached in 1995. With these events fresh on the minds of all involved in the mining industry, and nearly simultaneous construction of three new mines in BC, the Ministry of Energy and Mines chose to demonstrate strong leadership and required Independent Engineering Reviews of the tailings facilities at some of these new proposed mines.

Figure 1 – Mid-1990s Mines Under Construction in BC

The implementation of Independent Review Boards is not a new concept today, nor was it novel at that time. It was, of course, a prudent measure to strengthen the technical review capacity of the Ministry of Energy and Mines, thereby providing an additional layer of oversight with the goal of preventing any similar unplanned event such as those that had occurred but a few years earlier in other parts of the world. All three new mines had seasoned geotechnical engineers designing the tailings facilities, in addition to review by the experienced staff working at the Ministry. With the addition of the Ministry-mandated Independent Boards on a case-by-case basis, the tailings facility designs incorporated an addition technical review that brought strengthened oversight and an independent second opinion.

Given that construction of three mines was occurring nearly simultaneously, an opportunity existed whereby the learning from one mine could be applied during the construction of another. Such was the case with the Mount Polley and Kemess mines. The Mount Polley and Kemess tailings facilities began construction at similar times in the mid-1990s. During the construction of the starter dam at the Kemess tailings facility, foundation instability in glaciolacustrine soils was encountered. This experience resulted in review of similar glaciolacustrine soils at the Mount Polley Tailings Facility thereafter, with the early embankment designs incorporating suitably flat and/or buttressed slopes to accommodate the potentially weak foundation conditions.

As the role of the Ministry of Energy and Mines is to provide oversight of the mining industry, they provided a common connectivity between each of the mines that were under concurrent construction. They were aware of the

unique issues for each facility, as well as the common traits that expressed themselves during the early construction activities. Additionally, the existence of the Independent Review Boards, and the fact that several members of each Board were reviewing both mines, there was a common level of oversight between the projects that provided for enhanced opportunities to share lessons learned between projects.

Updates to *Mines Act* – BC Health, Safety and Reclamation Code

Following the recommendation by the Mount Polley Review Panel, the Ministry of Energy and Mines embarked upon updates to the BC Health, Safety and Reclamation Code under the BC *Mines Act* (Ministry of Energy and Mines, 2017). This was updated in a number of areas, not the least of which was to require Independent Review Boards (IRB) for tailings facilities in BC. As such, now that there is a formal requirement for IRBs, the opportunities exist again for lessons learned from a vast array of other projects to be provided by the members of such Boards.

The Ministry of Energy and Mines had mandated IRBs for mining projects on a case-by-case basis some two decades ago. Hence, these Boards did not exist on every mine within the province, nor were they necessarily continuous through the life of the operation. With the formal requirement brought in under the *Mines Act*, IRBs will now exist on most, if not all, projects with a tailings facility in the province of BC. This change will improve the continuity of knowledge for a given tailings facility.

Continuity is a Key Consideration (adapted from Kostaschuk et al., 2000)

The design and construction of tailings facilities often occurs over a long period of time. A starter dam is designed and constructed to manage the tailings from the initial mining period, typically for one to two years of operations. Thereafter, the impoundment is raised in construction stages over the life of the mining development, which can last several decades or more. Constructing the confining embankments in stages reduces initial capital investment, and distributes ongoing capital expenditure over the life of the mine.

Staged construction allows tailings dam designers to adopt an observational approach so the designs can be regularly adjusted and optimized as development proceeds. With this approach, the results of performance monitoring are used to confirm the initial design predictions, and changes to the design can be implemented as appropriate. However, the prolonged construction period can also present additional challenges for continuity of the design and construction quality assurance (QA) when ownership of the mine changes hands, or when different engineers are responsible for the design and QA of the subsequent stages of the dam.

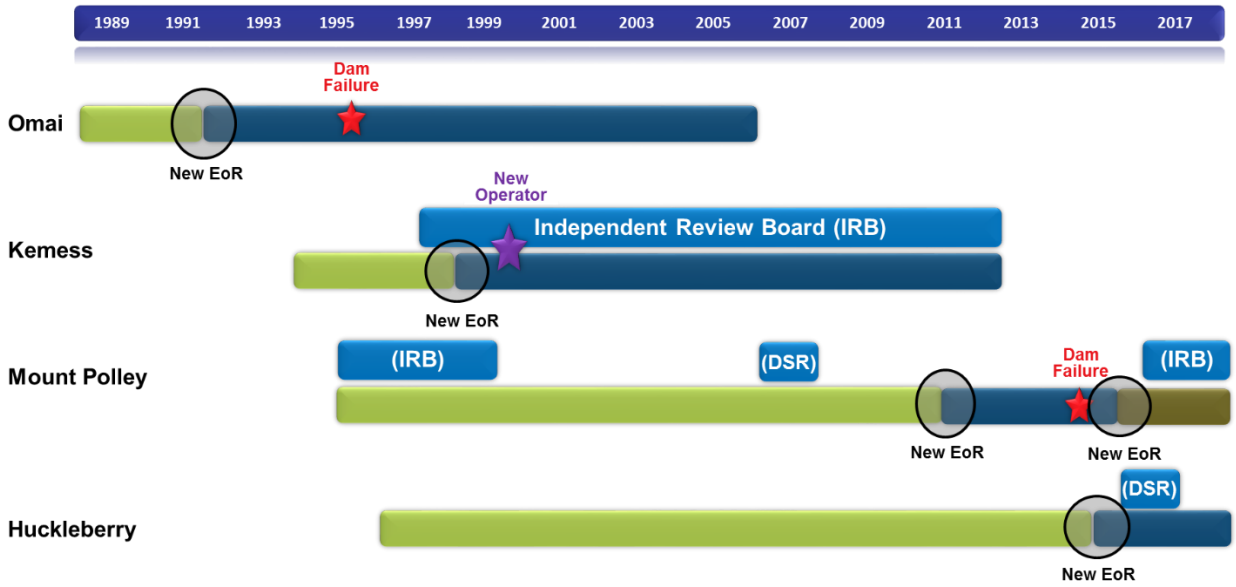
Key documentation for the continuing design and construction of a tailings facility includes a detailed design report and a construction report for each stage of construction, together with an annual review of operating performance. These reports typically include detailed design assumptions and analysis, as-constructed drawings, and summaries of the results of the field and laboratory QA tests completed during construction. In addition, construction reports or annual inspection reports typically also include an interpretation of data from instrumentation systems. The observational approach involves continuous data collection and interpretation to provide essential information for the design of future stages.

Given that the one constant for any given tailings facility is that there will be a change in personnel over the life of a facility, providing for the necessary continuity is a key consideration to successful design, operation and closure of any particular site. Since tailings facilities can be constructed and operated over many decades, it is reasonable to assume that personnel on the part of the mine operator will change for a variety of reasons, including switching careers, moving, retiring and death. The mine operating company may change as well, in the always-dynamic mining industry where market forces create new owners regularly. The engineering company responsible for the facility design may change over the life of a tailings facility, as too will the specific engineers with a given design company. Regulators and IRBs are not an exception to this ‘constant’ either, since the length of time for the life of a facility can

outlast careers for government employees and/or Board members in the same manner as the mine owner and engineering designer.

The level of continuity at the Omai, Kemess, Huckleberry and Mount Polley mines is illustrated on Figure 2. Each case history presents changes over the life of the particular facility.

Figure 2 – Transitions and Independent Review Board Involvement



In the case of Omai, there was a transition to a new EoR several years before the dam failed (Kostaschuk et al., 2000). The Kemess Mine also had a transition to a new EoR, followed shortly after a transition to a new mine operator. Throughout most of the life of this particular mine, including during the initial construction phase, an IRB provided a technical review function (Martin, 2011).

The Mount Polley Mine had several EoR transitions, one that occurred several years prior to the dam failure, another EoR transition that was in progress at the time of the failure and one that occurred upon reconstruction of the facility that exists today. Like Kemess, there was an IRB for the initial construction and early years of operations, however unlike Kemess, it did not remain in effect throughout the life of the operation. A Third Party Dam Safety Review (DSR) was conducted approximately mid-way through the life of the facility, which provided an independent review role at this particular point in time (Morgenstern et al., 2015). Finally, as the facility began to be reconstructed, an IRB was set up and presently continues to function in a review capacity.

The Huckleberry Mine had one transition to a new EoR, along with a Third-Party DSR (Golder, 2016).

At each point of transition, continuity is potentially affected. While this potential effect can be minimized through transitionary meetings and document hand-off, the role of the IRB, as well as the regulator can act to assist in the transition process.

Regardless of these expected changes, as part of the transition, it is imperative for the new responsible party to obtain documentation so that institutional knowledge and lessons from the past are not lost. The formal requirement for an

IRB is a good step to assist in this continuity. This can assist when engineering designers are changing, as well as when there are changing personnel on the part of the mine owner. However, good systems to create consistent continuity between on-site operators is perhaps the basis upon which all other systems of continuity should be developed. Specifically, since the company hires the design firm as well as the Board members, they would establish continuity systems for those that are working for the mine operator. The guidance that has been developed by leading mining industry groups such as the Mining Association of Canada (MAC) provide recommendations for best practices with respect to construction, operation and closure of tailings facilities. Such guidance assists greatly in creating continuity by mine operators and others involved in the success of a tailings facility.

Summary

There have already been a number of lessons learned from the unfortunate dam breach at the Mount Polley Mine from 2014. Three investigations are complete and begin to draw a picture of the circumstances and provide insight into how a similar incident can be prevented. A fourth investigation is pending and will no doubt provide additional insight.

Reflecting on the history of the Mount Polley Mine, and the context of when it was constructed, simultaneously with two other large mines in the Province, and recognizing the Independent Review Boards that functioned in the early years at both Mount Polley and Kemess Mines, indicates that continuity is one of the key considerations in preventing similar incidences from occurring. As a tailings facility will generally outlive the careers of most individuals involved in the design, construction, operation and closure, a robust system of creating and maintaining continuity is vital.

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