ABSTRACT

The majority of currently available dam safety guidelines do not account well for the specifics of tailings dams. In the guidelines commonly used in Canada, tailings dams are addressed alongside water retention (conventional) dams. This results in a user-unfriendly, and potentially unsafe and/or inappropriate, treatment of safety aspects specific to tailings dams. A number of guidelines developed for tailings dams have been published by the International Commission on Large Dams (ICOLD). Except for one of those guidelines (ICOLD 1989), a focus on the tailings dam safety is not provided. In particular, there seem to be very few and largely incomplete guidelines that speak to dam safety aspects specific to the tailings dam closure phase. Unlike for a conventional dam that would typically be breached upon the end of its useful life, the closure phase will be by far the longest state of being for a tailings dam, regardless of how long the dam was in operational use. This paper identifies and examines a number of tailings dam design criteria and safety requirements applicable to the closure phase, and concludes that many of such requirements must currently be selected on a case-by-case basis without support of sufficiently comprehensive guidelines.

INTRODUCTION

While tailings dams may be viewed as structures similar to conventional water retention dams in the sense that similar design and safety evaluation principles apply, this view carries too many restrictions to be well suited for practical purposes. As related to the dam ‘production’ phase when a dam structure is operated with the purpose of metal recovery, power generation, flood control, etc., the critical differences between tailings and conventional dams are rather conspicuous. These encompass dam function (e.g., contaminated water management in tailings ponds), specific dam design criteria (e.g., width of tailings beach rather than freeboard) or the dynamics of dam operation (e.g., episodic raising of tailings dam and the essentially continual raising of the impounded solids and fluid phase during mine production phase). Albeit some of these differences may falter with respect to the tailings dam closure phase (e.g., contaminated water management and/or raising of tailings dam may no longer be required), a set of design criteria and safety evaluation requirements specific to this phase needs be defined and accounted for. With this being done, one discovers that such requirements for tailings dams may be substantially different from those applicable to conventional dams.

A number of guidelines that address the design and safety of tailings dams are available, including frequently quoted publications such as Canadian Dam Association (CDA) Guidelines (CDA 1999), the draft Ontario Dam Safety Guidelines (ODSGs) (OMNR 1999), or some ICOLD bulletins. Several
ICOLD (including ANCOLD) bulletins quoted in References were specifically intended for tailings dams. The CDA Guidelines, on the other hand, were originally developed for conventional dams and tailings dams were only later incorporated into a framework that had not been originally intended to account for the specifics of tailings dams. The draft ODSGs are based on the CDA Guidelines as are some other regulatory requirements in Canada, for instance the B.C. ‘Guidelines for Annual Reports – Dam Safety Inspections’ or Ontario Regulation 240/00 ‘Mine Development and Closure under Part VII of the Mining Act’. The ODSGs are of special interest here as these refer to some aspects of the tailings dam closure phase.

Of special importance to the topic of this paper is the fact that there seems to be no technical guideline used in the Canadian mining industry that would provide a focus on the tailings dam closure phase. This is particularly lacking as the closure phase may be considered to last 1000 years or more, as compared with a typical mine production phase lasting some 20 years or a water retention dam service life typically assumed at 100 years. The long closure phase also means that the number of tailings dams will increase with time as new mines are put into production and tailings dams are constructed while none are removed/breached.

Some problems with using currently available dam safety guidelines for tailings dams were pointed out by the authors previously (Szymanski 1999a,b; Szymanski, Martin and Davies 2000). This paper identifies and examines selected design criteria and safety requirements relevant to the tailings dams closure phase that are not well addressed in currently available dam safety guidelines.

As the CDA Guidelines are currently under review and the draft ODSGs await finalization, it is hoped that this paper may stimulate greater interest in more detailed treatment of the tailings dam closure phase in the upcoming editions of those and similar guidelines. The safety of tailings dams has long been a concern to the authors who stated this concern on a number of occasions previously (e.g., Davies and Martin 2000; Davies and Lighthall 2001; Szymanski 1999a).

**TAILINGS DAM CLOSURE PHASE**

There are basically four tailings dam ‘operating’ phases that may apply to most mine sites:

1. Production (tailings disposal)
2. Transition (preparation for the closure phase, may include flushing out contamination)
3. Long-term treatment (dam operation continues in the sense of regulated water levels)
4. Closure (dam is no longer operated in the sense of regulated water levels)

In this paper, the focus is on the long-term treatment phase and the closure phase.
**ECONOMICS**

Whatever the actual closure design criteria and safety requirements are, these will not result in excessive implementation costs in the majority of cases if properly accounted for during the tailings dam design phase or, for facilities in operation, well in advance of mine closure.

In this regard, when a design criterion or safety requirement is considered with respect to the closure phase, it needs be asked what this criterion or requirement really means in terms of implementation cost and dam safety. The classic example is the size of spillway. As tailings dam watersheds are usually small, providing a spillway-freeboard system capable of passing a probable maximum flood (PMF) for the closure phase will often be economically feasible, regardless of a less stringent criterion that could be derived from a dam safety guideline. Although there may be some, the authors have not seen a tailings site yet where a spillway capable of passing PMF could not be economically provided for the closure phase if that commitment had been made from the outset of operations. This is contrary to the production phase where providing a large spillway for each raise of tailings dam could be very expensive in some cases, for instance, at high dams constructed across steep-sloped valleys.

Whenever a dam design criterion or a dam safety requirement is discussed in the remainder of this paper, the authors used the following mindset:

> What does it really mean in terms of both economics and dam safety margin?

This mindset meets the two main objectives of tailings dam owners of keeping costs of their tailings management system to a minimum, yet not incurring issues with potential long-term liability upon mine closure. Optimization of these objectives does not have to be as difficult as it may appear. The trick is in the ability to design and operate with the closure condition in mind and having that closure condition appropriately envisioned (e.g., permittable).

**FLOOD AND EARTHQUAKE DESIGN CRITERIA**

The authors have previously pointed out some specific concerns with the selection of flood and earthquake design criteria for tailings dams (Szymanski, Martin and Davies 2000). With respect to the tailings dam closure phase, two of the most essential aspects that are not well addressed in typical dam safety guidelines include:

1. the very long time that defines the closure phase
2. potential environmental impacts.

Neither of these aspects is addressed in the CDA Guidelines, although potential environmental impacts are now addressed in the draft ODSGs.

A certain probabilistic flood or earthquake design criterion as applied to a tailings dam production phase lasting, say, 15 years needs not be appropriate for the closure phase that is assumed to last 1000 years or more. In engineering, designing for 1000 years is essentially designing for perpetuity. Tailings dams are,
in that regard, very unique in the engineering world. Very few facilities are designed to last for much
longer than a few generations save, for example, spent nuclear fuel disposal sites. In general, it needs be
recognized that a flood or earthquake design criterion will have to be at least equal or more stringent for
the closure phase than for the production phase, even if the consequences of hypothetical dam failure
remain about the same (note that long-term land use changes can occur). This simply is a result of much
longer exposure period (design interval) applicable to the closure phase. The need to account for the
lengths of exposure periods for tailings dams has been recognized, for instance, in the New Zealand Dam
Safety Guidelines (NZSOLD 2000). This design aspect with an emphasis on the tailings dam closure
phase is discussed in detail and relating recommendations provided elsewhere (Szymanski 1999a). There
seems to be no dam safety guidelines commonly used in Canada that address this critical while unique
tailings dam design aspect. As this aspect of tailings dams is so fundamental to their very nature, this
omission alone challenges the use of commonly available guidelines for appropriate assessment of
tailings dams at closure.

The issue of potential loss of life requires a special emphasis in relation to the tailings dam closure phase.
In the authors’ opinion, the most stringent flood and earthquake criteria should be selected, being PMF
and Maximum Credible Earthquake (MCE), respectively, wherever the loss of one life or more is
probable. The selection of a less stringent criterion cannot reasonably be justified, particularly for a dam
that is to last for some 1000 years or more. This view was summarized by the authors previously
(Szymanski 1999a; Szymanski, Martin, Davies 2000) as:

<table>
<thead>
<tr>
<th>POTENTIAL LIVES LOST</th>
<th>RECOMMENDED FLOOD AND EARTHQUAKE DESIGN CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 or more*</td>
<td>PMF and MCE</td>
</tr>
<tr>
<td>0</td>
<td>Prevailing criteria resulting from consideration of economic losses, environmental impacts as well as social and cultural losses</td>
</tr>
</tbody>
</table>

* Downstream residents and occupants of regularly attended workplaces with significant exposure periods. Exposure periods and the number of persons exposed should be considered in other cases (e.g., mine personnel maintaining seepage collection facility, occasional fisherman or passer-by need not be included).

The above recommendations are consistent with the current views of many dam safety organizations (e.g.,
ICOLD 1987, U.S. Army Corps of Engineers 1995, or FEMA 1998). The CDA’s view, which permits
using less stringent criteria even if “some fatalities” are expected to occur, reflects somewhat historic dam
engineering practice where “few” probable casualties would not necessarily require adopting the most
stringent design criteria. It is highly unlikely that this view will prevail, particularly for a tailings dam
that is to last for some 1000 years during the closure phase. Neither is it likely that a new dam where
“some fatalities” are probable will ever be permitted in Canada. In the authors’ view, this issue requires a
regulatory clarification with respect to tailings (and other) dams.

The selection of flood or earthquake design criterion with respect to potential environmental impacts
within the framework of the consequence classification (or hazard rating) method presents a significant
challenge. It is commonly supported by some ‘gut-feeling’ arguments that are hoped to be acceptable to
the regulators, often with reference to the CDA or another guideline. The fact is, however, that the CDA Guidelines specifically exclude accounting for potential environmental impacts (CDA 1999, p. 1-1):

“This document does not cover the environmental aspects or environmental performance of dams or consequences related to environmental, social and cultural impacts, as these issues are site-specific and are subject to applicable regulatory approval process.”

This is a “catch-22” situation since one of the primary objectives of the CDA Guidelines is: “To provide a basis for dam safety legislation and regulation” (CDA 1999, p. 1-1), which also applies to “tailings … dams” (CDA 1999, p 1-2). In other words, both the regulator and the owner/engineer are left without any guideline as to the selection of flood and earthquake criteria from the consideration of potential environmental impact. This is particularly disappointing from the perspective of tailings dams where potential environmental impacts represent, in the majority of cases, the prevailing hazard and the liability of most concern to the owner and, for public companies, their shareholders. And, in many cases, this hazard will persist for hundreds of years, if not “forever”, during the tailings dam closure phase.

The majority of other dam safety guidelines provide a perfunctory treatment of the environmental impacts, if these are addressed at all. As pointed out previously however, environmental impacts, referred to as ‘environmental losses’, are explicitly accounted for in the draft ODSGs (OMNR 1999). In the authors’ opinion, the provisions of the ODSGs are well suited for classifying a tailings dam in terms of hazard potential, although selecting a flood or earthquake design criterion for a tailings dam based the ODSGs would still require applying special considerations and significant judgment. Much discussion on potential environmental impacts in relation to the selection of flood and earthquake design criteria is provided elsewhere (Szymanski 1999a). Regardless, significant work is required to develop appropriate guidelines for selecting these criteria that could be used throughout Canada and elsewhere. For the time being, these have to be selected on a case-by-case basis.

ENVIRONMENTAL DESIGN FLOOD

The concept of environmental design flood (EDF) is not relevant to the conventional dam engineering and thus not addressed in the CDA and similar guidelines. Yet, it presents one of the most formidable aspects of tailings dam design at many mine sites, with respect to either the production or the long-term treatment phase, or both.

The EDF is considered with respect to the containment of contaminated tailings pond water under all hydrologic events less severe than a design event. It is the smallest flood, in terms of volume, during which a controlled discharge of contaminated tailings pond water is permitted. In practice, the EDF is assumed to be the largest flood, in terms of inflow volume, that must be stored with another, somewhat larger flood(s) analyzed to construct a tailings pond discharge hydrograph necessary to estimate the impact on downstream environment.

In Canada, the EDF is explicitly addressed in the British Columbia guideline (Price and Errington 1998). It stipulates that ARD contaminated waters must not be released under a 1 in 200 years flood (minimum
design criterion). In the authors’ opinion this is a useful and technically sound guideline that can be applied to many situations. Nonetheless, in some cases this design criterion may be challenged from the engineering perspective as being non-conservative or overly conservative, depending on the site-specific conditions. For instance, on a project in northern Ontario it was found from routing a contaminated tailings pond water discharge through a river, that the impact resulting from a 1 in 100 years flood would be minor and thus acceptable.

WATER COVER

Considering the ‘collect and treat’ (long-term treatment phase) vs. the ‘water cover’ (closure phase) option for decommissioning of a tailings impoundment may present a serious dilemma. In general, while ‘no long-term treatment’ objective is preferred, the fact is that in general a tailings dam supporting water cover will be more hazardous in the very long-term as compared with a dam where the tailings pond is partially or fully drained. This is particularly evident when comparing a semi-pervious (e.g., ‘upstream’) or highly pervious (e.g., rockfill) tailings dam with allowance for long-term treatment, and a low permeability dam designed to support a water cover throughout the closure phase.

Some confusion in this regard appeared in the late 1980s and 1990s in conjunction with considerations given to the ‘collect and treat’ vs. ‘water cover’ closure options for sites where tailings had the potential to impact runoff geochemistry, for instance, the potential to generate ARD. Some mine owners and regulators were under the impression that providing a permanent water cover supported by one or more dams, which would relieve the owner and, potentially, the public from the obligation to treat the tailings impoundment runoff in the long-term. It is understandable how the water cover gained appeal as at first glance it was clearly a highly desirable closure option. Besides significant technical and economic problems with flooding of some tailings deposits, this judgment was flawed since an implicit assumption was made that a flooded tailings impoundment would essentially be ‘care and maintenance’ free as long as an adequate spillway is provided. This certainly is not the case. While a water cover can indeed create a low oxygen diffusive environment, from a geotechnical perspective a flooded impoundment is certainly of higher risk with regard to essentially every nature of possible physical failure mode and needs to be considered as such for impoundments with a flooding plan for the closure condition. An allowance for long-term inspections, monitoring and maintenance must be made wherever a dam is left to support a water cover. In general, such an allowance will be less for dams where the tailings pond is partially or fully drained (and the residual risk of dam failure will be less as well).

On the other hand, should the expected length of the treatment phase be comparable to the length of the closure phase (±1000 years), the water cover option would present a more desirable solution, particularly for smaller tailings dams located in areas of low seismicity, gentle topography and moderate floods.

LONG-TERM STABILITY OF TAILINGS DAM

Should any special consideration be given to the designing of tailings dam because the dam is to function for 1000 years (which, in engineering, is essentially perpetuity)? The necessity to allow for appropriate
levels of long-term inspection, monitoring and maintenance of the dam structure in the long-term is obvious and requires no comments.

The question of the degree of long-term structural integrity, or stability margin, of a tailings dam is more complex. To the authors’ knowledge there are virtually no specific guidelines as to evaluating the physical stability of tailings dam for the closure phase.

In a number of cases, the engineer may derive some comfort from the fact that, as examples, the water level will be permanently lowered, or the consolidation of a clay stratum in the dam foundation will increase in strength. In the case of upstream tailings dams, some engineers even believe that the tailings will ‘age’ thus resulting in an increased strength and resistance to liquefaction. This latter issue presents some curiosity as while some alteration to material fabric and even density can occur over time, there is no “magical” improvement in the in-situ state of a tailings facility just because it has been there a long time. For any engineer to judge a dam stable for the long-term simply because it has been apparently stable for a long period of time is, without any other substantiation, a potentially catastrophic error in judgment.

On the other hand, chemical reactions in a tailings deposit may result in a long-term rise of the phreatic surface and/or perched water table as a result of ‘hardpan’ formation (the authors conducted a dam safety review in 2003 at a mine site where such a rise was already observed during the production phase). Chemical reactions may also result in dissolution of minerals contained in dam or dam foundations materials. There was, for instance, much discussion on possible weakening of the marl foundation due to acidic seepage in the case of the 1998 Los Frailes tailings dam failure. Besides the chemical reaction aspects, the potential for piping, filter clogging or creep deformations over hundreds of years cannot really be appreciated by the available dam safety evaluation methods.

It seems therefore that, for the time being, that ‘old fashioned’ engineering judgment as to the appropriate degree of design conservatism has to be used in tailings dam stability evaluations with respect to the closure phase. One of the authors suggested that the minimum design safety factor (shear failure under static conditions) be increased to 1.6-1.8 from the conventional 1.5 (e.g., CDA 1999, ODSGs 1999) specifically with respect to the tailings dam closure phase (Szymanski 1999a). While derived from actual project experience, this suggestion was arbitrary, driven by judgment and the feeling of uncertainty with regard to the various long-term processes affecting the dam structures.

It is believed, nevertheless, that a rational guideline in this regard can be worked out. Since it is unlikely that some precise engineering principles could be used to formulate such a guideline, common sense, past observations and hands-on experience of dam operators and engineers could become a base for such a guideline. Until such a guideline is developed, a case-by-case evaluation is deemed the only way to proceed. This is appropriate as depending upon the failure modes of potential concern, different factors of safety to limit-equilibrium analyses can be justified. It is noted that some projects are better served by deformation criteria than use of limit-equilibrium methods but these are, for the most part, of the highest challenge to the engineer and require the use of advanced techniques and well-focused reviews.
Lacking any other rationale supported guideline, and to provide a starting point based upon experience from many mine closure projects, limit-equilibrium safety factors of between 1.5 and 1.8 are suggested by the authors, which must be appropriately supported by site-specific information and an acceptable evaluation of all potential failure modes.

**DAM SAFETY SURVEILLANCE, INSPECTIONS AND REVIEWS**

Consider a conventional (e.g., hydroelectric) dam during its production phase and a tailings dam located in a remote area during the closure phase, both classified in the same hazard potential category. Few dam safety guidelines, if any, differentiate in a meaningful way between such dams when stating dam safety program requirements. And yet, these requirements would most likely be significantly different. For instance, the conventional dam could be seen every day with surveillance walk-overs by site personnel carried out on a weekly basis, while the tailings dam may be seen once a year only. Or, the conventional dam would be operated for some economic advantage (e.g. flood control or power generation) while the tailings dam would not. Or, an emergency preparedness and response plans as well as a warning system could exist and be readily implemented for the conventional dam, while for the tailings dam such plans would not exist or, as a minimum, have different meaning and certainly different response protocols. Monitoring of contaminated groundwater plume would not be relevant to safety evaluations of the conventional dam. The list of such differences can be extended well beyond these sample examples.

The frequency and the extent of dam inspections and safety reviews must account for the practicality of the implementation of dam safety program. In many cases the extent and, possibly, the frequency of dam safety inspections would have to be more intensive in the case of a tailings dam during closure phase, ‘compensated’ by a lower frequency of dam safety reviews.

The frequencies of dam safety surveillance (by site personnel), inspections and reviews recommended in dam safety guidelines often seem rather arbitrary, or customary at best. Yet, having a rationale for such frequencies may be highly desirable where the associated costs are high; like in the case of a remotely located closed tailings facility. At least in some respects such a rationale can be developed.

As an example, one of the factors that might support specifying the frequency of dam safety reviews is the anticipated (possible) change in meteorologic or seismic database. For instance, on a project in Canadian Arctic it was shown in 1995 that there was a definite cooling trend while, after extending the database by 7 years, it was concluded in about 2000 that a clear warming trend has been occurring at the site (Ungava Peninsula). As another example, on a project in B.C. hydrologic designs had to be revised in 1998 after the original database was expanded by additional 7-year precipitation records (Topley Landing). Alongside some other factors, such time periods may guide the frequency and, possibly, the extent of safety reviews for tailings dam during the closure phase. Obviously, the importance of climate warming or precipitation data will vary from site to site. In terms of seismicity, there has been a continual upward revision to NBCC seismic ratings every five to ten years with rumoured changes for 2005-2006 showing remarkable increases in peak ground acceleration for infrequent seismic events in almost all regions of Canada. While an operating conventional dam may see one or two such major revisions, a
closed tailings dam will be subject to changes in meteorologic and seismic databases for any concept of the foreseeable future.

The above examples are provided to indicate that rationalizing a tailings dam safety program will often be possible and advantageous. Having a focused guideline would be most useful to set up a framework for deriving a site-specific safety program for each tailings dam.

OTHER TAILINGS DAM CLOSURE ASPECTS

There are many other design and safety evaluation aspects specific to tailings dams. The classic example, not addressed in typical dam safety guidelines, is the minimum freeboard. Even today when there is more than sufficient guidance literature and case histories to demonstrate potential catastrophic consequence, it often happens that a minimum freeboard rather than a minimum width of tailings beach is specified for upstream tailings dams. A review of the commonly used dam safety guidelines in Canada will not even have mention of the concept of a tailings beach let alone the importance of the concept relative to an absolute measure of freeboard.

Another example strongly relevant to tailings dams during the closure phase is the ‘dry’ spillway concept (a dry spillway means here a spillway that will remain dry even under the design maximum flood; it would only be activated in the case of an event that cannot reasonably be predicted or allowed for at the design stage). A tailings dam could be very significantly safer during the closure phase if a dry spillway is provided and the author’s suggest this should be considered standard practice, particularly for remotely located tailings dams.

With respect to the potential for water contamination, tailings pond water quality during the transition, long-term treatment and/or closure phase can be considered as an example of closure design aspects not addressed in dam safety guidelines. The common perception is that tailings pond water quality will improve or, as a minimum, be the same following the cessation of milling operation. In some fortunate cases this will indeed be the case. However, it may also happen that the quality of tailings pond water will deteriorate as a result of, for example, discontinuing the discharge of process water (typically, alkaline) or the onset of net acidity generation. This in turn could also affect the tailings dam/impoundment seepage quality. The potential for deterioration of tailings pond and/or dam seepage quality has to be addressed at the closure design stage as a dam safety issue (at the mine design stage in the case of a new mine). This represents a design requirement and should be an essentially component of any guideline that is considered applicable to tailings dam closure.

One might argue that these types of considerations specific to tailings dams are obvious to regulators and tailings dam engineers. The authors’ experience is that this is, unfortunately, not always the case. Having a widely available, comprehensive tailings dam safety guideline defining current practice would certainly be useful to account for the specifics of tailings dams, while incorporating the relevant provisions of conventional dam guidelines.
RISK ANALYSIS

The foremost conclusion of this paper is that a dam safety guideline that specifically addresses tailings dams is lacking, with respect to the closure phase and otherwise. While the ODSGs cover some tailings dam design and safety aspects applicable to the closure phase, these still are not complete and the focus on tailings dams is not provided as these guidelines attempt to cover all types of dams and, in this effort, still are not specific enough to the unique character of tailings dams.

An alternative to having a guideline specifically focused on the many unique aspects of tailings dams would be to conduct a risk analysis in each case using an acceptable approach that would be fully endorsed by industry and its regulators. An acceptable approach includes:

- use of a risk assessment tool that is sufficiently transparent (not a black box) to all participants and users of the results yet rigorous enough not to over simplify the requisite assessment. Methods such as FMEA or PPA are typically acceptable tools;
- input from a sufficient number of qualified people who can cover all of the key technical areas. Overlap in skill sets is important to avoid biased results;
- a commitment to review the risk assessment results at least as frequently as the specified interval for dam safety reviews.

This would be the most site-specific and thus advantageous approach, while, if not carried out properly, could end up being relatively complex, expensive and potentially unsuccessful. As always there is a catch here: few engineers have the training and experience to carry out an appropriate risk analysis and a guideline for conducting risk analyses specific to tailings dams safety would be required. In this regard, it was noted by one of the authors elsewhere:

"It would be best if a consistent approach to tailings dam safety evaluations is followed throughout the mining community (always subject to site-specific considerations). Otherwise, chances are that different tailings dams will be subject to different dam safety evaluation standards, which necessarily means that some tailings dams will be less safe than others."

CONCLUDING REMARKS

The closure phase of essentially all tailings dams will be substantially longer than the production phase. This unique characteristic alone makes the often-attempted application of conventional dam safety criteria to address the tailings dam closure condition largely inappropriate and potentially unsafe. The closure period for a tailings dam brings about the challenge of assessing a wide array of potential physical and geochemical failure modes for what will be an ever-changing future in terms of environmental conditions and loads to the dam. The authors have suggested some guidance to address the main areas of design and stewardship concern based upon their combined experience from dozens of relevant projects. However, these suggestions are not industry endorsed guidelines and the need for such remains unless it is deemed acceptable to use variable standards of long-term dam safety in terms of both physical integrity and geochemical stability. As it is highly unlikely that either the mining industry or its regulators, the latter
who represent the public at large, would find variable standards acceptable, pressure from interested parties to see such guidelines developed will likely increase. The guidelines should not be a tweak of conventional dam safety guidelines for the sake of expediency or similar well-intentioned but perhaps naïve reasons. Useful guidelines that correctly balance economics and dam safety from the specific perspective of the mining industry are what is required and all stakeholders should not settle for anything less. Above and beyond all, any such guidelines need to allow site-specific considerations dictate the selected dam safety program for the closed dam as the cookie-cutter approach to conventional dam safety guidelines of “one size fits all” simply will not adequately, or appropriately, apply to tailings dams.

REFERENCES


Ontario Mining Act, Regulation 240/00. ‘Mine Development and Closure under Part VII of the Mining Act’


