

# STEWARDED DAM SAFETY IN ALBERTA: THE DAM INTEGRITY ADVISORY COMMITTEE (DIAC)

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## ABSTRACT

After decades without a major failure in Alberta, the Obed Mountain Mine dyke breach and subsequent overtopping of their main tailings dam near Hinton in 2013, and the Mount Polley tailings dam breach in northern British Columbia in 2014 caused many engineers and dam safety specialists to ask: “Could another major dam failure like these happen again here?”

In response, the Alberta Chamber of Resources (ACR) convened a task group to carry out a high level evaluation of systemic risk. The top technical experts from eight resource companies met for a series of discussions about company practices, external reviews and regulatory oversight of the approximately 70 major dams in Alberta, including both tailings retention and water retention structures. The discussions culminated in a Briefing Note which concluded that the Alberta dam safety ‘system’ was fundamentally robust. Taking advantage of the collective wisdom of the technical experts, a two-day workshop was organized in November 2015 to identify and prioritize potential enhancements to make the dam safety system even more robust.

It became apparent that finding answers to such broad questions about dam safety was complex and could only be achieved through committed stewardship and consistent application of continuous improvement. The Dam Integrity Advisory Committee (DIAC) was formed, comprising senior technical staff from participating ACR Member Companies. The paper explains the components of a healthy dam safety system and highlights the unique role and mandate of DIAC in Alberta. The principal goals, initiatives and deliverables of DIAC in support of dam safety in Alberta are discussed in the context of the overall dam safety system.

## INTRODUCTION

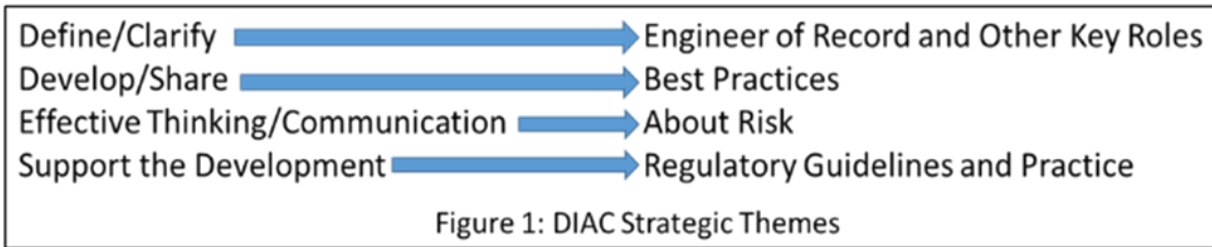
Major engineering failures, such as the Obed Mountain Mine dyke breach and subsequent

overtopping of their main tailings facility in October 2013 (AER, 2017) and the breach of the Mount Polley tailings facility in August 2014 (Morgenstern et al, 2015), invariably cause human anguish, environmental damage and economic loss. Within this dark cloud, a small but important silver lining is that failures sow the seeds of progress through questions like “Could another major failure like these happen again here?” or, “Really, how healthy are our engineering practices and safety systems?”

To provide an initial answer to these questions, the Alberta Chamber of Resources (ACR) pulled together senior technical experts from natural resources companies to prepare a Briefing Note (ACR 2015) on the health of dam safety in Alberta. The main conclusion of the review was that the dam safety ‘system’ – cultivated through the past five decades in Alberta – was among the best in the world. Managing the inescapable risks of major engineered structures means that proactively reducing the probability of dam failure as low as practically, or as reasonably, possible (ALARP; ECL, 1949) presents a multi-faceted challenge which needs sustained stewardship and ongoing improvement.

Around the same time as the Briefing Note, in March 2015 the Alberta Office of Auditor General (OAG) released an assessment report (OAG, 2015) which included recommendations for improvement of the dam safety regulatory framework in Alberta. Following these events and reviews, The ACR dam integrity task group decided to convene a two-day workshop in November 2015 comprising leading engineers and specialists in dam safety, to examine in more detail the components and conditions of the dam safety system in Alberta. The four strategic themes (shown in Figure 1) that emerged from the workshop were subsequently refined into prioritized objectives and supporting actions.

The dam integrity task group was transformed to the Dam Integrity Advisory Committee (DIAC), through a terms of reference and mandate (ACR, 2016a), under the auspices of the ACR, to steward the follow-up actions in proactive pursuit of the



desired goals. DIAC was founded on the established principles that eventual success could only be achieved through intentional stewardship of dam safety and continuous improvement of the dam safety system in Alberta.

### THE DAM SAFETY SYSTEM IN ALBERTA

In order to understand DIAC's vision and role in dam safety, it was important to outline the purposes and interrelationships between the key components of the system. Figure 2 illustrates the model (ACR, 2016b) developed by DIAC for the Alberta context.

This model demonstrates the importance of having a strong safety and integrity culture, top management support, resources, and technical expertise available for and working in harmony with

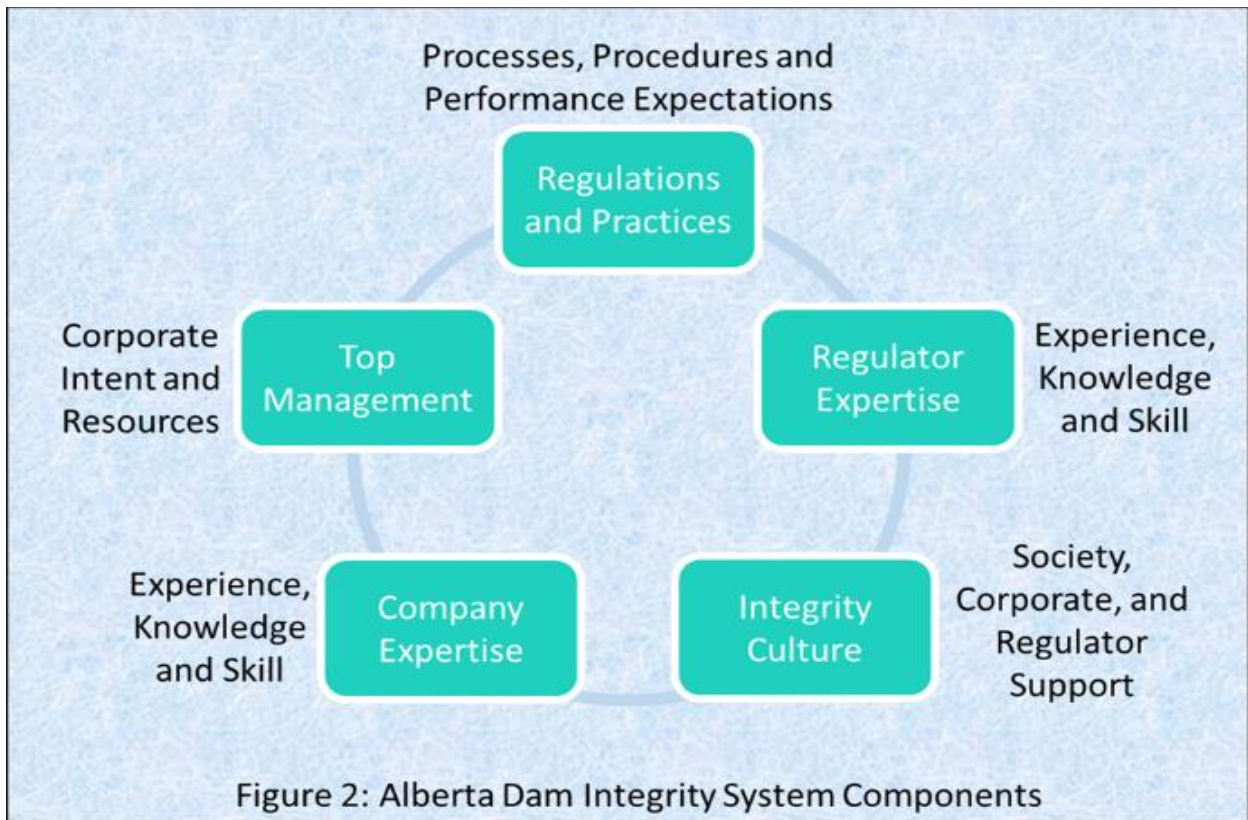
regulators in the development of appropriate policies and regulations to establish and maintain the system. Some of the main components and supporting features include the following:

#### Top Management and Integrity Culture

- Active corporate risk management, review and assessment of dam safety
- Appropriate allocation of dedicated resources for dam safety management
- Aligning societal, regulatory and corporate dam safety principles and values

#### Company and Regulator Expertise

- Active research and refinement of technical inputs and requirements



- Continuous training of personnel in new and improved methods of design, construction, operation and closure
- Succession plans for personnel engaged in dam safety management

### **Regulations and Procedures**

- Incorporation of risk-informed methods in dam safety regulations and procedures
- Clear definition of roles, accountabilities and responsibilities for individuals
- Understanding how the state of practice compares with best practice

Consistent and reliable dam safety is achieved when each node is strong, incorporates robust processes, and all nodes are interacting and performing synergistically; should one node weaken temporarily, other strong nodes can compensate. However, the system would not be considered resilient or sustainable if there are acute or chronic weaknesses in one or more of the nodes or in the interactions between the nodes. Complacency with such a status quo could threaten the health of the overall system.

### **THE ROLES AND ACTIVITIES OF DIAC**

DIAC was established to support the existing dam safety system across the natural resource sectors in Alberta and includes representation from the electricity generation, and coal and oil extraction and processing industries, where water and tailings containment dams are necessary infrastructure for successful operations. Considering the components and requirements of a healthy dam safety system, and in the light of recent events and observed trends, DIAC has taken on the following general objectives:

- Timely sharing of non-proprietary operating experiences and learnings
- Maintaining a global watching brief on dam safety issues, incidents and trends
- Identifying new technologies and facilitating their assessment and implementation
- Integrating implementation of Canadian Dam Association (CDA, 2013) and Mining Association of Canada (MAC, 2017a) guidelines for resource sector dams
- Facilitating discussions of mutual interest with regulators
- Developing recruitment strategies for the next generation of dam safety engineers, following

the model of the ACR Mining Industry Advisory Committee (MIAC)

With respect to the individual components and/or their interactions, key DIAC activities focus on maintaining, strengthening, giving greater visibility to, or establishing broader understanding of the current components, policies, practices and procedures. These activities are aimed at stewarding and supporting the current dam safety system and culture by establishing broad-based understanding and effective implementation of existing standards and practices.

Additional activities focus on future trends and developments and are intended to identify and assess opportunities for positive change within the Alberta dam safety system. The main objective is to promote and facilitate implementation of innovations and continuous improvement.

Notable milestones, products, ongoing activities, and tasks of DIAC include the following:

#### **Currently Completed Activities:**

- Articulated a conceptual model for dam safety in Alberta (Figure 2)
- Encouraged the University of Alberta to expeditiously organize the inaugural five-day course on tailings management, December 2015
- Catalogued an indexed reference list of 90 leading practice papers in dam safety (ACR, 2017a)
- Prepared a white paper on roles and accountabilities for key positions responsible for management of dam safety in Alberta, with an initial focus on the Engineer of Record (ACR, 2017b)
- Promoted the development of leading versus lagging indicators for assessing performance of dam safety and dam safety systems (Boswell and Sobkowicz, 2018)

#### **Ongoing Activities:**

- Prepare a white paper on thinking clearly and communicating effectively about dam safety and risk management
- Engage with Alberta Environment and Parks (AEP) and the Alberta Energy Regulator (AER) to provide industry feedback on the revision and updating of dam safety legislation
- Liaise with national and international dam safety organizations with similar interests

(such as CDA, MAC, USSD, ICOLD, GBA and ASDSO)

- Encourage initiatives regarding engineering courses and career development seminars on dam integrity in the province (e.g. dam safety seminars; annual five-day course on tailings management at University of Alberta and the development of Masters level programs in tailings engineering)

Some of the significant insights, achievements and conclusions, to date, are:

- The dam owner is ultimately accountable for the safety of the dam and responsible for dam safety assurance, which is consistent with Alberta dam regulations.
- For owners that are unaware of these requirements, the engineer of record has a duty to apprise the owner of their accountabilities and responsibilities
- Within the context of owner accountability, effective dam safety is a team responsibility that requires role clarity and coordination of implementation and execution by numerous responsible groups and individuals
- The comprehensive reference list of preferred practices developed by DIAC is being used or

cited by other organizations and agencies across North America

- Opportunities to update legislation and policy do not occur frequently; it is important to adopt a long-term view of change and continuous improvement
- There is a necessity for the conscious appreciation and application of the differences between engineering risk quantification and communication of the implications of those risks to stakeholders

It is also recognized that significant regulatory advances (Eaton et al, 2016) toward ensuring dam safety in Alberta have been implemented since 2014. Some of these advances include:

- Incorporation of risk-based approaches
- Emphasis on management practices
- Annual inspection and audit plans
- Holistic consideration of reviews, inspections and audits (now called safety assessments)
- Increased transparency and public reporting
- Better data management systems

The issues, goals and activities being addressed at DIAC are periodically prioritized and reviewed for progress. An example of the DIAC activity tracking tool is presented in Figure 3. It is clear from the

Goals and Actions	Status	Priority		Comments/Status
		Urgent	Important	
<b>Define EOR and other Key Roles</b>				
Define EOR, DOR, DSE, etc. – clarity of roles and responsibilities...	Complete	High	High	White paper
Owner commitment (e.g. at design application stage) to designating qualified engineer....	Underway	Med.	High	Communicate white paper
Update dam safety guidelines document...	Complete	Med.	High	See above
Roles and responsibilities in regulations ...	Complete	High	High	See above
<b>Develop and Share Best Practices</b>				
Develop (non-prescriptive) best practice document....	Underway	Low	High	Assembled references papers
Annual workshop for dam integrity engineers – share best practices & learnings...	Underway	Low	High	Supported workshop in 2017
Advocacy of education opportunities and mentoring...	Underway	Med.	Med.	Letter support M.Eng. co-op
State of Practice manual for oil sands dam design ....	Upcoming	Low	High	
Update dam safety guidelines document	Upcoming	Low	High	
Explore the need to expand site characterization at design phase....	Upcoming	Med.	Med.	
DIAC follow up with others...	Underway	Low	High	Ongoing liaison
<b>Think Clearly and Communicate Effectively About Risk</b>				
Guidance for company to regulator communication (leading indicators)....	Underway	Med.	Med.	Assembled references
Standardize risk communication	Underway	Med.	Med.	Paper started above
Encourage regulators to establish formal process for communication...	Underway	High	High	Discussed with regulators
<b>Support Regulators to Develop Guidelines and Processes</b>				
Open discussion about principles underpinning water release criteria	Upcoming	Low	High	
Improve regulations with QPOs, DSRs, site investigation requirements, auditing....	Underway	High	High	Working with regulators
Process for auditing designs that rely on the observational approach...	Upcoming	Med.	High	
Encourage coordination between departments to facilitate implementation...	Underway	Med.	Med.	Reviews of regs and directives
Work with dam regulators to open discussion about principles for “de-licensing” of dams...	Underway	Low	Med.	

Figure 3: DIAC Activity Tracking Tool (Aug 2018)

recent scorecard that some important activities were started and completed but that additional work is necessary and ongoing.

## ON THE SHOULDERS OF GIANTS

As the era of major Alberta water dams and tailings dams dawned in the latter half of the twentieth century, engineering leaders in the government and in industry demonstrated remarkable foresight in establishing high standards and embracing improved processes. For instance, the near-universal adoption of Independent Geotechnical Review Boards is the best known – but not the only – innovation which has provided confidence that the inherent risks of these large engineered structures are appropriately managed.

The Civil Engineering Department at the University of Alberta has played a unique role, firstly by recognizing the importance of geotechnical engineering generally, and dam engineering specifically, and attracting international leaders as faculty members such as Dr. Norbert Morgenstern, P. Eng. and others. They acted as expert advisors to industry and to governments; their research efforts addressed problems of both immediate and strategic significance, and they have shaped the minds of literally hundreds of students who now occupy positions of professional responsibility and executive leadership in companies and regulators. Their common foundation leading-edge learning and shared frame of reference have enabled the ready sharing of learnings and advancements across the industry.

Finally, comment is warranted on the degree to which the Alberta engineering community is connected to their national and international counterparts. Alberta practitioners are known not only as contributors and leaders in the Canadian Dam Association publications (CDA, 2013) and the initiatives of the Mining Association of Canada (MAC; 2017a, 2017b), but also as ready adopters of improved processes. Leading practices from Alberta are welcomed with interest from the Association of State Dam Safety Officials, the US Society on Dams and the Geoprofessional Business Association, and the reverse is also true.

Engineering professors and engineering consultants from Alberta are regularly called upon to serve on expert panels investigating major dam failures around the world. This is recognition of Alberta expertise; equally importantly, it provides direct connectivity of the Alberta dam engineering

community to the *post mortem* learnings and the sense of engineering humility which arise from major failures.

## DISCUSSION AND CONCLUSIONS

The initial outcome of the high-level review of dam safety in Alberta was a renewed sense of confidence that current engineering practices, corporate commitment and regulatory oversight are appropriately managing the risks inherent in operating major water and tailings dams. The second outcome was the realization that engineering practices, corporate commitment and regulatory oversight interact in a unique synergy in Alberta – a ‘system’ which is more robust than the sum of the component parts. The third outcome was the establishment of an honest broker, the Dam Integrity Advisory Committee, DIAC, through which this industry-wide system can be nurtured and improved.

DIAC sees its primary roles as providing stewardship, support, perspective, and facilitation of dam safety on behalf of owners and operators of major dams in Alberta. Forward-looking and future initiatives could include the definition, development and support for applying ALARP and performance-based, risk-informed principles and practices (Morgenstern, 2018) to produce clear design, construction, operation, closure, decommissioning and de-licensing expectations and requirements.

While taking some pride in the robustness of the Alberta dam safety system and the unique role which DIAC plays, committee members are acutely aware of the imperative of avoiding professional hubris by embracing “generative unease” with the status quo. We are reminded of this imperative by the Obed Mountain and Mount Polley failures and more recently by the Fundão tailings dam failure in 2015 in Brazil (Morgenstern et al., 2016), which had devastating consequences. This sentiment was eloquently articulated in the report by the Independent Forensic Team (IFT, 2018) while investigating the February 2017 failure of the spillway of the Oroville Dam in California:

”Although the practice of dam safety has certainly improved since the 1970s, the fact that this incident happened to the owner of the tallest dam in the United States, under regulation by a federal agency, with repeated evaluations by reputable outside consultants, in a state with a leading dam safety program, is a

wake-up call for everyone involved in dam safety.”

DIAC is uniquely positioned to help advance dam safety in Alberta by working proactively with stakeholders, regulators, technical and engineering practitioners, educational institutions and the public. With its unique mandate, DIAC aims to perpetuate the conclusion from the ACR briefing note: the dam safety system in Alberta is one of the best in the world.

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