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Duty of Care Applied to Tailings Operations

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Abstract

The ever increasing costs and risks associated with tailings facilities worldwide have led to the adoption of a Duty of Care in ensuring high standards of tailings operation. The Oil Sands industry stands to benefit from lessons learned elsewhere in the world in regard to the application of a Duty of Care to tailings operations.

Palmiter (2006)1 suggests that in business, "the duty of care addresses the attentiveness and prudence of managers in performing their decision-making and supervisory functions."

Aspects addressed by the authors based on their international and local tailings experience include definition of the Duty of Care; select examples of tailings dam failures for lessons learned; tailings management imperatives of risk, quality and cost; reducing operational costs; universal indicators of quality tailings operations; a checklist of key operational components, and implementation and the human dynamic.

Introduction

The design of tailings facilities worldwide has seen a remarkable improvement over the past 40 years. Very few if any new facilities are commissioned today without careful planning and design. There are literally dozens of excellent conferences annually, such as this one, and hundreds of papers published worldwide every year, which further advance our knowledge and understanding of the behaviour of tailings and the design of tailings facilities.

A somewhat unique engineering feature of tailings facilities as civil engineering structures, however, is that their construction continues through most of their operational life. Much emphasis and reliance is placed on the auditing, monitoring and surveillance of tailings facilities, to ensure that they are constructed and operated in keeping with the principles of good design and sound geotechnical engineering.

It is the authors' contention, in this paper, that insufficient attention is paid to the actual operation of tailings facilities, and that it is overdue that a Duty of Care is implemented for tailings operations, in order to close the quality circle effectively. In other words, more direct attention should be focused on tailings operations, and not just the design and monitoring processes.

There is an informal and casual approach in many mining operations environments, which demands that all tailings designs must be very robust to compensate for operations inadequacies. In addition, it is often incorrectly concluded that if the project develops problems, e.g., failing to provide a geotechnically stable structure or deposit, then the fault must clearly lie with the design. As a result, designs have become increasingly conservative and expensive in order to compensate for an operational approach that has a less than adequate "duty of care" or operational diligence. In addition, we now find ourselves preferring designs and tailings treatment technologies which favour electrical, mechanical, or chemical intervention. Instead, if we harness natural and environmental processes we could accomplish the same result, but with a bit more time and more skill, diligence and attention to detail in the operation.

We could do so much more as a tailings industry. There are examples of excellence in tailings operation, but these tend to be the exception, rather than the rule. Reliable, published papers on tailings operational practice or case studies are very rare. In addition, an unacceptably high cost of tailings disposal is not viewed as a failure. We appear to have accepted the trend that tailings disposal must

necessarily become more and more expensive, and that to dispose of tailings soundly and at reasonable cost, is a pipe dream.

Before we fundamentally redesign the kitchen and throw out all our recipe books, however, let's make sure that the oven is working.

Background

Both authors of this paper have spent substantial portions of their career working very closely with operators and, in the case of Boswell, actually operating tailings facilities. Operating a tailings facility is not for the faint-hearted, and is usually a highly demanding organizational challenge. The litany of tailings failures and environmental and safety incidents worldwide bears witness to this harsh reality.

We have scoured the literature over the years, and found few papers published on the actual operation of tailings facilities. A data search will usually find only passing reference to tailings operation. A few of the more useful references are provided at the end of this paper.

Duty of Care defined

The concept of due care, or operating to a high standard of care in any professional or management activity, is not new, and has been followed by the professions as they have developed for much of the past century. The worldwide chemical industry, for example, following the lead from Canada, developed the so-called "Responsible Care" approach, in the wake of high profile chemical incidents in the 70's and 80's, (International Council of Chemical Associations, 2002).

We could do worse than adopt a similar standard of care and apply it to tailings operations.

The authors have chosen to describe this as a Duty of Care for tailings operations.

A brief search in Wikipaedia (2011) found the following definitions:

"In tort law, a duty of care is a legal obligation imposed on an individual requiring that they adhere to a standard of reasonable care while performing any acts that could foreseeably harm others. It is the first element that must be established to proceed with an action in negligence. The claimant must be able to show a duty of care imposed by law which the defendant has breached. In turn, breaching a duty may subject an individual to liability. The duty of care may be imposed, by operation of law, between individuals with no current direct relationship (familial or contractual or otherwise), but eventually become related in some manner, as defined by common law (meaning case law).

At common law, duties were formerly limited to those with whom one was in privity[1] *one way or another, as exemplified by cases like Winterbottom v. Wright (1842). In the early 20th century, judges began to recognize that the cold realities of the Second Industrial Revolution (in which end users were frequently several parties removed from the original manufacturer) implied that enforcing the privity requirement against hapless consumers had harsh results in many product liability cases. The idea of a general duty of care that runs to all who could be foreseeably affected by one's conduct (accompanied by the demolishing of the privity barrier) first appeared in the landmark U.S. case of MacPherson v. Buick Motor Co. (1916) and was imported into UK law by another landmark case, Donoghue v Stevenson [1932]. Both MacPherson and Donoghue were product liability cases."*

[1] Privity is the relationship between people who are participating directly in, or having a derivative interest in, a legal transaction.

After defining Duty of Care for professional (typically medical) practice and product liability in manufacturing, Palmiter (2006) also suggests that in business, "the duty of care addresses the attentiveness and prudence of managers in performing their decision-making and supervisory functions."

While it is a relatively simple manner to grasp the concept of “duty of care”, and particularly the consequences if such is not in place, it is more difficult to appreciate all of the organizational, management and technical components that might contribute to an acceptable duty of care in a tailings operation. This paper attempts to address some of these components by discussing:

- Select examples of tailings dam failures where one might argue there was an insufficient duty of care, and shows how inadequacies may develop in a number of different areas.
- The relationship that should exist between the risks associated with a tailings operation and the quality of those operations.
- Indicators of quality tailings operations and key operational components.
- Management of the human component of tailings operations.

Select examples of tailings dam failures for lessons learned

Operations and management failure

Blight (2010) records that for two examples of catastrophic failure involving loss of life, which led to a subsequent judicial inquest, the root cause of both was: “poor management, resulting from ignorance of the principles of soil mechanics, poor training of staff, negligence...”

The underlying message from the above statement is the critical reliance placed on tailings operators, and the imperative to focus on avoiding these critical weaknesses if future failures are to be avoided.

Wagener et al (1997) draw attention to a number of specific management failures that led to the deaths of 17 people in the second of these examples.

In dissecting this failure further, Caldwell & Charlebois (2010) note that “the mining company had cut to the bone to reduce costs and as a result the dam was neglected, competent people were not involved, and the contractor’s staff were overly confident”.

Upstream construction demands technical and management quality

Strachan & Caldwell (2010) note among the conclusions from the tailings failures reported by USCOLD, UNEP and ICOLD that the majority of incidents were associated with tailings facilities constructed using the upstream method. The upstream method places greater reliance on the quality of engineering, operating and management expertise.

Resource boom and bust market cycles lead to skills shortages and cost cutting

The upstream method and tailings operations in general, are also particularly vulnerable to commodity price variation (shortage of skills in boom times and cost cutting in bad times). The close correlation between market conditions and failure frequency is reported by Davies & Martin (2009). Van Zyl (2009) demonstrates the widespread lack of adequate provision for the closure of tailings facilities and he presents a case for a different approach to life cycle costing of tailings facilities in order to avoid long term financial and environmental liabilities.

Davies & Martin expand in a practical way by describing a number of operational incidents and failures and show a strong correlation between failure on the one hand, and operation and management shortcomings on the other. They list among their reasons for incidents and failures: “Rapid turnover of

key mine *management* and *operating* personnel as new opportunities abound during the boom times" (use of italics by authors).

Lack of engineering and management quality can lead to failures

Standard practice in oil sands tailings engineering is to use the "observational approach" to manage structure performance risks while allowing design optimization. This approach has both technical and management components. These are discussed at length in Morgenstern (2010), who provided a "score card" for practice in the oil sands industry. Inadequate attention to the requirements of this design philosophy can lead to failures, which Morgenstern argues to date have been avoided in the oil sands industry by high technical and management quality.

However, the observational approach is not universally applicable to tailings structures. McRoberts (2008) lists static liquefaction as an important risk to be considered in oil sands tailings containment, and adds that the use of the observational method is not suitable for the control of certain aspects of static liquefaction. In those cases, it is important to "do it right" the first time, both in design and construction, as there may not be a remediation option later. Blight (2010) notes that one of the most important factors in preventing failure is to deposit tailings in such a way that they will not liquefy.

Tailings Management Imperatives: Risk, Quality and Cost

The examples cited above show what can go wrong in a tailings operation. The challenge for management is more than just knowing the key factors to watch out for: it also requires a Duty of Care to be applied in the management process. In other words, there is more to it than having all the pieces of the puzzle in one box; one has to know how they all fit together.

High risk of tailings operation calls for high quality management

In Figure 1 below it may be seen that the quality of management should match the risk of the operation. Problems involving low risk are usually easier to manage. While the penalty for failing to recognise that an operation is too expensive is not catastrophic, it may lead to other problems later (complacency, inappropriate cost cutting, premature cessation of operations on account of unaffordability).

On the other hand, tailings management is usually called upon in a potential high-risk environment. The first step in managing high risk is to recognize it. A number of failure incidents, some of which were referenced earlier in this paper, have occurred because the operators became complacent or failed to recognise that the risk profile of the operation was changing, even albeit quite slowly, over time.

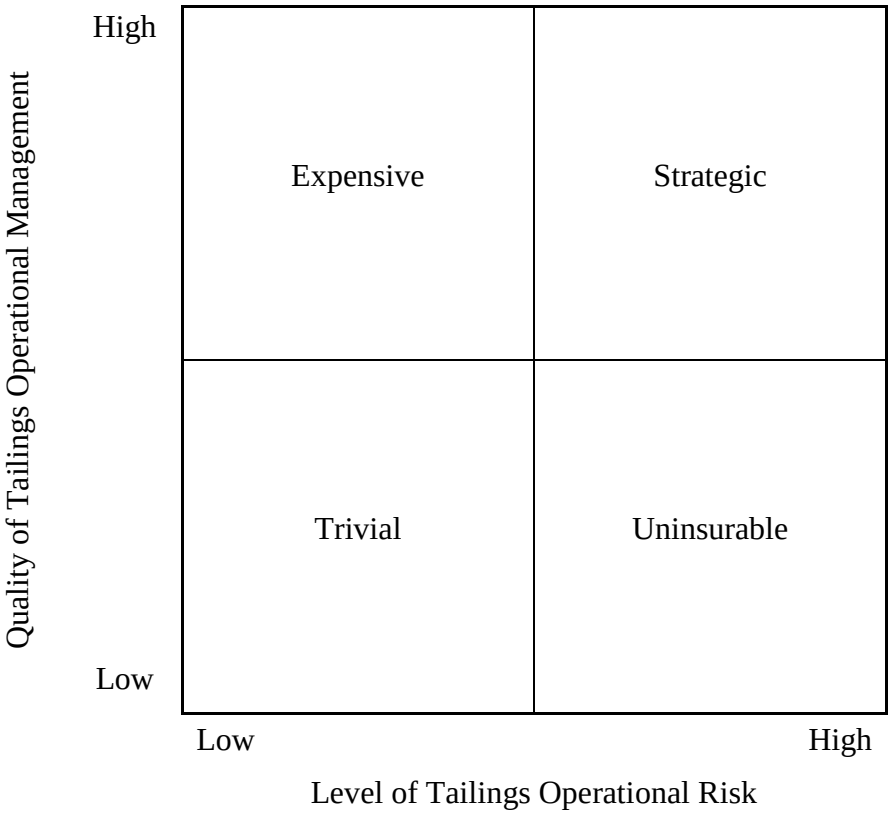

Figure 1: The Application of Appropriate Quality Management to the Level of Risk of Tailings Operation

Reducing operational costs

In the life cycle costing model shown in Fig 2 below, Boswell (1997) shows the significant contribution that operational costs make to the overall cost of a waste management facility.

Even seemingly small daily operational costs when accumulated over 30 to 50 years amount to a huge cost. In facing high costs, and the need to reduce them, the operational items in a life cycle are usually most vulnerable. In a high risk tailings management environment, those cost cutting decisions could prove to be disastrous.

The wise operator may find the following pointers useful regarding tailings costs:

1. Know how much your facility costs. Keep tabs on individual costs. Track changes and trends in costs.
2. Know which items are risky. Track changes in risk profile for key components of the facility.
3. Know which operational actions are essential. Prioritize. Revisit the list on a quarterly basis.
4. Accept that certain items may be satisfactorily postponed, and that timing of expenditure can be varied (in other words, every tailings facility has a cash flow that can be pro-actively managed).

Remember that the bitter aftertaste of poor quality lasts long after the sweet cost of low price is forgotten.

Van Zyl (2009) makes some valuable observations regarding the correct use of life cycle costing in allocating sufficient funding for closure of tailings facilities.

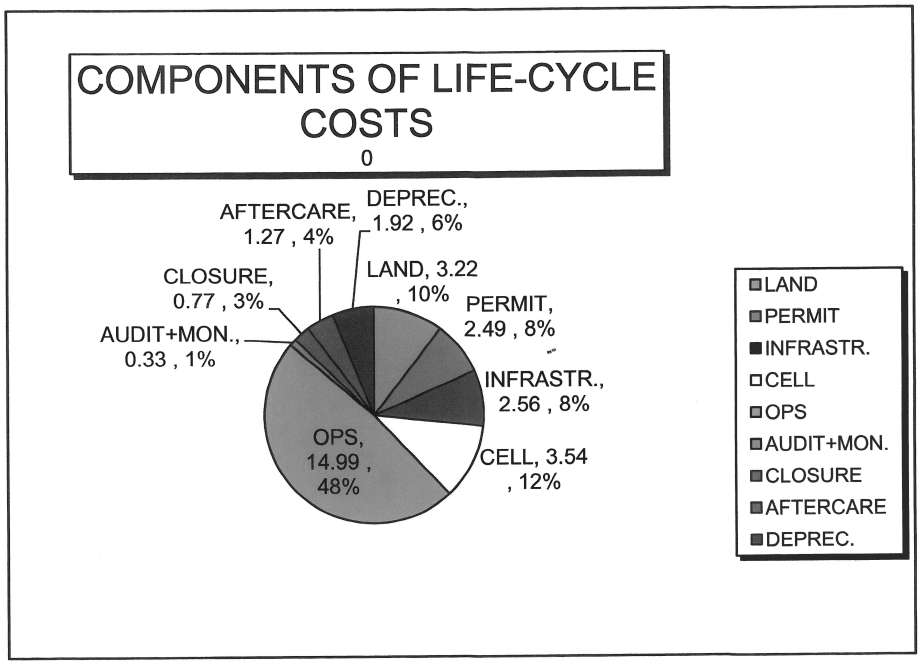

Figure 2: Components of Cost in the Life Cycle Costing of Waste Management Facilities (Boswell 1997)

Universal Indicators of Quality Tailings Operations

In travelling around the world and visiting mines in many countries, successful tailings operations have been characterised by the following key indicators of high quality:

1. Tight Control of Slurry Relative Density and Feed Characteristics
    a. Limited variation in tailings delivery feed characteristics / properties.
    b. Agreed operating boundaries for tailings slurries.
    c. Minimised hourly variation in characteristics, especially solids content.
    d. Avoidance of flushing of pipelines.
    e. Recognition of the critical role that tailings chemistry plays in tailings behaviour, environmental performance and the impact of recycle water on extraction plant performance.
    f. Decoupling of processes where possible (such as decanting of supernatant and retreatment of fines).
2. Controlled Tailings Discharge and Deposition
    a. Controlling exit velocities from tailings delivery discharge points.
    b. Homogeneity of material; avoidance of excessive layering and material variability.
    c. Use smaller diameter spigots rather than single open ends, but not so small that the discharge plugs with feed variations.
    d. Control beaching deposition velocities.

   e. Conduct cell filling by use of header/mixing/blending devices, and/or use of a weir at the head of the beach.
3. Painstaking care of, and attention to Beaching
   a. Carefully establishing and maintaining the optimum beach profile.
   b. Minimal mechanical intervention and reduced cost of beach preparation.
   c. Ensuring all material is deposited onto the beach, and minimizing flow off the beach of any material other than clear supernatant.
   d. Management of beaching deposition to minimise lift thickness.
   e. Avoidance of prolonged channel or gulley flow.
   f. Avoidance of erosion of beaches (by for example, preventing discharge of off spec product and preventing the creation of deep plunge pools below deliveries).
   g. Development of beach surfaces that are as free draining as possible.
   h. Enhancement of long term downward drainage through all seasons.
   i. Commencement of deposition only on “beaching ready” surfaces.
   j. Tailings deposition that never covers a layer that is not dewatered.
   k. Preparation of sufficient cells in advance of deposition to handle all anticipated operational conditions / variations.
   l. Conditioning of receiving surfaces prior to beaching (ensure beaches are graded to the correct slope and are free of contamination, salt crusting (where possible) and standing water).
   m. Extension of deposition cycle times during inclement weather and shoulder seasons.
   n. Avoidance of deposition methods that limit drying or cause incomplete dewatering through the lift (such as a permanent central discharge which does not include a drying cycle).
4. Rate of Rise and Maximum Height Limitations.
   a. Calculation of allowable rates of rise for each deposit and each material.
   b. Establishment of allowable limits for rate of rise, and maximum height, based on the dewatering and consolidation characteristics of the tailings material.
   c. Measurement of incremental and average rates of rise.
   d. Strict compliance with seasonal, annual and overall rate of rise limitations.
   e. Adjustment of trigger levels and limits to cater for unseasonal or extreme precipitation.
5. Adoption of safe cycle times between deposition periods
   a. Filling of cells in a prompt routine, avoiding stop-start operations.
   b. Decanting (removal) of supernatant immediately (avoiding deliberate containment of free water on beaches).
   c. Prevention of ponding of standing water on beaches if at all possible (avoiding the inadvertent accumulation of free standing water on beaches).
   d. Avoidance of subaqueous deposition wherever possible, unless the design specifically provides for this practice.
6. Dealing quickly and effectively with Off Spec Tailings Material
   a. Designated “Go to” areas for off spec product, NOT back into the recycle water pond.
   b. Prescribed Shut Off options to cater for off spec events (such as tailings slurry too dilute, flooding, etc).

Key operational components: a checklist

The operation of a high quality tailings facility is required to pay careful attention to the following components (note that this list is not exhaustive and is somewhat generic in nature):

1. Dyke Construction Schedule
2. Embankment Stability
3. Tailings Planning
4. Off Specification Discharge from Tailings Delivery Lines
5. Tailings Line Sanding-Out or Failure
6. Role of chemicals and additives
7. Beach Deposition
8. Pond Location
9. Fines Capture
10. Accumulation of fluid fine tailings
11. Dewatering
12. Development of Trafficable Surfaces
13. Compliance with local and international laws
14. Tailings Reclamation
15. Water Inventory
16. Debris Management
17. Recycle Water
18. Land use

Implementation and the human dynamic

All of the above guidance is focused on measurement of the parameters of tailings operation. However, it is the tailings operator who is responsible for the standards, and often poor operating standards may be traced to a shoddy treatment of tailings operators or the practice of a poor work environment.

Here are some guiding principles which contribute towards a high quality tailings operational environment:

Leadership from the top

A successful tailings operation will depend first and foremost on having a well established and run management structure, which includes company policies and high level management commitment and leadership. This is especially important in establishing an acceptable duty of care.

This topic is well covered in the "Guide to the Management of Tailings Facilities" (MAC, 1998).

Recruiting and training of skilled operational staff

As noted earlier, there is often a high mobility and/or loss of trained staff in "boom" times, when the demand for their services are high and recruiters abound. Mining companies are forced to develop creative solutions to staff recruitment, training and retention to ensure the integrity of their operations work force. These have included:

- A high level of attention to recruiting from "conventional" sources (such as universities) and an expansion into international markets (which of course creates a world-wide demand and only expands the problem).
- Very attractive compensation packages which address not only salary issues, but "fly-in/fly-out" to remote sites and flexible work schedules that support personal and family values.

- Partnering arrangements with qualified companies that allow resource sharing and training.

Career path planning and human resources strategies for tailings managers

Tailings management and operations in particular is sometimes viewed as the refuge of the incompetent. In other words: "Charlie, we have nowhere else for you to work in the plant so it might be better if you work in tailings!" This unfortunate approach may simply transfer a problem from one area of the operation to another.

Instead, leading operators pay careful attention to managing the human resources available to them by:

- Recruiting skilled and qualified tailings staff.
- Providing ongoing on-the-job training, mentoring and supervision in a wide variety of necessary skills, including, but not limited to environmental, geotechnical, organizational, communication, supervisory, managerial, attitudinal, technical and human resource management skills.
- Resisting the temptation to poach workers from other operations, but to concentrate on developing the tailings operations team and by promoting from within.
- Developing incentive based salary packages for tailings team members which identify, recognise and reward performance against Key Performance Areas appropriate for each category of employee and targeted to important tailings management and reclamation objectives.
- Instilling a sense of company pride in the tailings workforce.
- Ensuring retention of key skills by offering long term career opportunities and bonus and profit-sharing.
- Encouraging key staff to travel locally and internationally in order to benchmark other high quality operations.

Conclusions

There is no substitute for paying attention to what you do. If something is not worth being done properly, it may as well not be done at all. It was once said that a society which pays greater attention to their philosophers than to their plumbers will find that neither their ethics nor their pipes will hold water.

This holds true for tailings operations, and we would do well to exercise a Duty of Care in ensuring a high quality approach to tailings management. Through this paper the authors have sought to draw attention to an often overlooked but essential link in the tailings management value chain.

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