CAUSES AND CONSEQUENCES OF THE MERRIESPRUIT AND OTHER TAILINGS-DAM FAILURES

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ABSTRACT

On the night of 22 February 1994, the 31 m high northern wall of the number four tailings dam of the Harmony Gold mine collapsed. The tailings dam is situated 320 m up-slope of Merriespruit, a suburb of Virginia in the Free State Goldfields of South Africa. More than 2.5 million tonnes of liquefied tailings ripped through the sleeping mining village. Eighty houses were largely swept away and 200 others were severely damaged. Seventeen people were killed.

The failure of this tailings dam shocked everybody who followed the unfolding drama of loss of life and destruction of property in the press. At the inquest following the disaster, the judge called this tailings dam a time bomb that was waiting to explode. For the first time in South African history, processed satellite images were allowed as scientific evidence in court. Together with eyewitness reports, all the evidence pointed overwhelmingly to the cause of the failure as being overtopping. The owner, the operator and six of their employees were subsequently found guilty of negligence and heavy fines were imposed.

The Merriespruit disaster provided the State and the mining industry with the impetus to ensure the safe disposal of tailings. It also made the mining industry and all those involved with the design and operation of tailings dams take stock of their management and tailing disposal methods. Copyright © 2005 John Wiley & Sons, Ltd.

KEY WORDS: Merriespruit; tailings; gold; disaster; slimes dam failure

INTRODUCTION

Mine discard and tailings dams are not a revenue-producing aspect of the mining industry. Historically, therefore, many in the minerals industry paid scant attention to tailings deposition with mine operators reluctant to spend money on their tailings deposition. This was especially the case in South Africa during the late 1980s and early 1990s when the gold-mining industry declined due to a very low gold price and severely increasing labour costs. This situation created the perfect scenario for a major disaster to occur. At approximately nine o’clock on the night of 22 February 1994, the 31 m high, number four tailings dam of the Harmony Gold mine collapsed. More than 2.5 million tonnes of liquefied tailings ripped through the sleeping mining village of Merriespruit, killing 17 people and destroying 80 houses. Given the devastation it is remarkable that only 17 people died that night (Celliers et al., 1998).

Despite the knowledge gained from on average two tailings-dam failures every year in South Africa (Wagener et al., 1997) the Merriespruit disaster still occurred. The causes and consequences of tailings-dam disasters elsewhere were also studied in order to establish what factors they had in common with the Merriespruit disaster.

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This paper explores the geological and management causes of tailings-dam disasters and provide guidelines for the future management and monitoring of these facilities.

TAILINGS-DAM DISASTERS

Aberfan (Wales) 1966

On 21 October 1966 a colliery waste tip of the Merthyr Vale Colliery slid down Merthyr Mountain and into the mining village of Aberfan in South Wales (Couto, 1989). It first destroyed a farm cottage in its path, killing all the occupants and then engulfed the Pantglas Junior School and about 20 houses in the village. A total of 144 people died in the Aberfan disaster, including 116 school children and 28 adults (McLean, 2000). A tribunal found that, ‘the Aberfan disaster is a terrifying tale of bungling ineptitude by many men charged with tasks for which they were totally unfit, of failure to heed clear warnings, and of total lack of direction from above’. Right up to the time of the mudflow the tip was continuously being added to in a chaotic and unplanned manner (www.nuf.ox.ac.uk/politics/aberfan/esrc).

The National Coal Board (NCB) attributed the disaster to ‘natural unknown springs’ beneath the tip. Springs, however, were well known by all the local people and are shown on maps of the neighbourhood. In this coal-mining region, coal discard was deposited on hillside above the coal-mining villages. The discard was more than 20 years old and had been deposited on top of the local Brithdir Sandstone, a highly porous rock layer that contains many springs. Two days of heavy rainfall had resulted in increased spring discharge and runoff which partly liquefied and loosened the coal discard resulting in subsidence of about 3–6 m on the upper flank of the tip. This was followed by the liquefaction of more than 150,000 m³ of discard that flowed downhill at high speed ripping through everything in its path (Fritz, 1968).

This tragic accident led to regulations that charge quarry owners in Wales with securing the safety of solid and liquid tips and provide for design, supervision, inspection, notification, records and the making of tipping rules (www.bbc.co.uk/h2g2/guide).

Bafokeng (South Africa) 1974

On 11 November 1974, a major failure of part of the south-eastern wall, of the number four tailings dam of Impala Platinum Mines near Rustenburg, South Africa, (also known as the Bafokeng disaster) took place. The dam, 900 m × 900 m and 20 m high, contained more than 13 million m³ of tailings. More than 3,000,000 tonnes of tailings escaped through the breach and engulfed the number four mineshaft, killing 12 men underground, and flowed on the surface for 25 kilometres down the Elands River. The dense fluid destroyed all surface installations in its path and dragged the shaft equipment to the bottom of the shaft. The Bafokeng tailings dam failure produced a tailings flood that was up to 800 m wide and 10 m deep, four kilometres away from the breached dam wall (www.stava1985.it).

The sequence of events leading to the Bafokeng disaster started with a leak in the form of a jet of water, which appeared approximately seven metres up the slope of the dam wall in the south-eastern face. The hole grew quickly and the water jet became a large stream of water. Two or more cracks developed in the outer face of the wall and extended upwards at steep angles to form a wedge with the apex down to the hole. More and more blocks of material collapsed out of the wedge into the increasing floodwater. The gully widened rapidly to 130 m and a dense viscous fluid flowed out of the breach, carrying along everything before it. It took less than one hour for total cessation, leaving a typical bottle-shaped scar normally associated with flow slides (Fourie et al., 2000).

It was concluded that the main reason for the disaster was piping through the dam wall. Piping is an erosional process that takes place at the interface of course and fine layered material and is consistent with the jet of water observed shooting out of the dam wall during the initial stages of the failure event. Pipes were also exposed during excavations of the tailings dam after the failure. A week before the failure, heavy rainfall was experienced over Rustenburg with more than 75 mm of rain falling in the two hours just before the disaster.
The inquest into the deaths of the 12 miners found that the failure of the platinum tailings dam was an act of God and therefore that no one was to blame for the Bafokeng disaster. The seeming lack of application of the lesson learnt from the Bafokeng event in 1974 to the Merriespruit tailings operation became apparent when the latter failed in a similar fashion, due to static liquefaction. At Bafokeng in 1974, seepage/piping introduced the retrogressive liquefaction flow slide (www.tailings.info). This demonstrates the need to study and learn something from each failure event.

The main issue revealed by the Bafokeng disaster was that the factors contributing to the formation of pipes should be controlled. These are:

- Thin layers (1–20 mm thick) of very fine, saturated tailings should not be sandwiched between thick layers (200–500 mm thick) of coarser, partly saturated tailings.
- Fine tailings should not be deposited in small pools of limited extent.
- Coarser, partially saturated material will always be liable to collapse.

Arcturus (Zimbabwe) 1978

On 31 January 1978 at the Arcturus mine, Zimbabwe, the Corsyn Consolidated Mines gold-tailings dam overflowed. A 55 m wide breach suddenly developed, releasing more than 30 000 tonnes of liquefied gold tailings, that blocked and contaminated a public waterway and adjoining rough pasture through extensive siltation. A local village was damaged, one child was killed, and another injured (www.tailings.info/accidents).

The Arcturus gold tailings dam was wrongly constructed on a ridge. The arched surface under the dam caused the water table to mound (or arch) resulting in poor drainage and seepage at the western side and at the base of the dam, over a prolonged period of time. The perimeter walls of the tailings dam were excessively steep, more than 38 degrees, whereas the maximum safe angle for tailings dams was 35 degrees at the time (Shakesby et al., 1991).

More than 1800 mm of rain fell during the 1977–78 wet season and over one third of this occurred during the four weeks prior to the disaster and particularly in the last four days when 183 mm of rainfall were recorded. Saturation of the internal tailings occurred and because the penstock was not in proper working order, the pool moved away from the penstock to the west wall of the tailings dam. The freeboard capacity of the dam was exceeded and the bunds were overtopped by the surfacewater level. A 55 m breach developed, releasing 30 000 tonnes of liquefied gold tailings (www.antenna.nl/wise/uranium).

The main issues that caused this disaster were:

- The walls of tailings dams should not be steeper than 35°. (Recent regulations in Zimbabwe state that angles should not exceed 26°) (www.meridiangold.com/glossary.cfm).
- Plenty of freeboard should always be available in tailings dams to allow for periods of excessive rainfall.
- The siting of the tailings dam and good drainage are fundamentally important for good tailings-dam construction and management (www.deh.gov.au/industry/industry-performance/minerals).

Since the stability of the dam walls depends on them being very well dried out, heavy rainfall and continued spigoting of tailings onto the dump will reduce the strength of these walls. A further research question that should be considered is what meteorological data should be used to guard against tailings-dam disasters.

Stava (Italy) 1985

At 12:22 on 19 July 1985, a fluorite tailings dam of the Prealpi Mineraia mine in Stava, Trento, Italy, failed. The tailings dam was built on a hill-slope and consisted of two basins. The failure occurred when the up-slope basin collapsed and released more than 200 000 m³ of liquefied tailings into the lower basin. The inflow of this material caused overtopping of the lower basin and a subsequent collapse of the lower basin as well. The resulting slurry wave flowed 4-2 km downstream at a speed of up to 90 km h⁻¹ until it reached the river Avisio. It killed 268 people and completely destroyed three hotels, eight bridges, fifty-three homes, and six industrial buildings. Nine more buildings were seriously damaged. A layer of dense mud, measuring
between 200 and 400 mm in thickness, covered an overall area of 43.5 ha over 4.2 km downstream (Time, 1985).
At the inquest that followed the disaster, it became apparent that the tailings dams underwent no serious stability checks over a period lasting more than 20 years.
The causes of instability included the following:

- Tailings could not settle because the dams were built over partly waterlogged alluvial ground.
- Drainage of the dams became very difficult because the upper basin had steep, unstable sides and was built too close to the lower basin so that the two started to coalesce.
- The dams were too high (34 m) and the inclination of the sides too steep (40 degrees). The tailings dams were built on a slope where the average inclination was already approximately 12.5 degrees.
- The drainage pipes below the dams were incorrectly installed, causing them to become blocked easily (www.zpok.hu/~jfeiler/baiamare/docs).

It is unfortunate that the lessons learnt from the above well-documented and publicized tailings-dam disasters could not have prevented the Merriespruit disaster.

Merriespruit
Merriespruit, a suburb of Virginia, is located south west of the town centre and 28 km south west of the city of Welkom (Figure 1). Virginia is part of the Free State Goldfields, the most southerly of the goldfields of the Witwatersrand Basin. It is located approximately 290 km southwest of Johannesburg (Coetzee, 1960).
Conglomerate layers within the Witwatersrand Sedimentary Basin host the world’s largest accumulation of gold with about 50 000 tons of gold having been mined from seven major goldfields. The Witwatersrand sediments of the Free State Goldfields are immediately overlain by Ventersdorp lava, which in turn is covered by younger Karoo-age sediments. Gold mining is carried out at depths of 1.5 to 2 km below surface (South African Committee for Stratigraphy (SACS), 1980).

![Figure 1. The Witwatersrand basin of alluvial gold deposits.](image-url)
Gold occurs in minute quantities associated with the mineral pyrite ($\text{FeS}_2$), in conglomerates, and has to be extracted by sophisticated technology using complex metallurgical processes (Fuggle and Rabie, 1992). Once the gold has been extracted, the rest of the material is a waste product, which is deposited on large residue or tailings dumps on the surface (Chevrel and Coetzee, 2003). In South Africa the mining sector is the single largest generator and accumulator of solid wastes. The total mass of mineral ore removed by the six major operating goldfields (the Central Rand Goldfield ceased operations in the mid-1970s) is estimated to be 294 million tonnes per annum (Best, 1987). Solid waste is typically stored as either rock dumps or tailings dams. The main features of a Witwatersrand tailings or slimes dam are schematically portrayed in Figure 2.

**Figure 2. Diagrammatic representation of a typical gold-tailings dam (not to scale).**

Historical Background to the Merriespruit Gold-Tailings Dam Disaster

The town of Virginia had its origin with the discovery of the Free State Goldfields in 1936. The 250-house suburb, Merriespruit, was built near the Harmony Gold mine in 1956. When the number four tailings dam was started in 1978, as a 154 ha rectangular dam, Merriespruit township was already in existence. After sixteen years more than $260 \times 10^6$ m$^3$ of gold-mine tailings containing largely fine silica (quartz) and phyllosilicates but also containing significant amounts (up to 5 per cent) of pyrite as well as residual cyanide had been deposited. The north wall of the dam was placed only 320 m away from the nearest houses of Merriespruit village (www.icme.com).

The Merriespruit number four tailings dam consists of a northern compartment (4A), a southern compartment (4B) and a small emergency compartment (4C) (Wagener et al., 1997).

A shallow, roughly north–south trending natural drainage valley underlies the centre of the 4A and 4B tailings dams and exists from below the dam at the point where the breach occurred on the northern side of the wall. Following inspections of the dams in March 1993, seepage was noted on the north wall above the drainage exit point and a patch in the form of cladding was constructed and, after discussions with the operator, it was agreed that all deposition on compartment 4A should be stopped. Either the order to stop deposition on compartment 4A was not properly communicated to all levels of staff at the mine, including the operator, or some simply ignored the order and rogue deposition of tailings took place without anyone realizing the danger of these actions. The division wall between compartments 4A and 4B had breached some time before the disaster, resulting in drainage from compartment 4B flowing into compartment 4A where it collected in the pond of compartment 4A. This additional drainage increased the size of the pool, and affected the freeboard at the northern wall which was lowered to a mere 300 mm. The standard for the freeboard is 1 metre (Wagener et al., 1997). After the disaster the total freeboard measured from the tailings level at the penstock inlet was about 500 mm and at some places it was a mere 150 mm. The result of all this was that the pool on compartment 4A was progressively pushed away from the penstock/decant pipe towards the northern wall, a feature that developed months before the disaster and led to the seepage noted above (Figure 4).
Legislation (Act 54 of 1956: Water Act, as amended, and the Act 50 of 1991: Minerals Act) requires that the dam have sufficient capacity to contain a 1:100 year, 24-hour storm with a 0.5 m freeboard. This, however, was not done at Merriespruit. The pond was partially filled with metallurgical plant water, which should not have been deposited on the dam, and was clearly in a completely unacceptable condition prior to failure of the northern wall (Wagener et al., 1997).

The Free State Goldfields are situated in a semi-arid region with a mean annual rainfall of between 400 and 600 mm. Local thunderstorms and showers are responsible for most of the precipitation during the summer months from October to March, peaking in January (Duvenhage, 1998). The summer of 1993–1994 in the Free State had been particularly wet and on the night of Tuesday 22 February 1994 there were violent thunderstorms over Virginia. More than 50 mm of rain fell in 30 minutes over the tailings dams, which was not unusual for this area.
During the early evening between 19:00 and 21:00, eyewitnesses saw water flowing over the crest of the northern wall of the dam. At approximately 21:00 there was a sudden collapse and a 150 m-wide breach formed in the dam wall (www.icme.com) (Figure 5).

**Causes of the Failure**

It is statutory procedure in South Africa that an inquest and an inquiry are held following a disaster when there is a loss of life. In this instance the Minister of Justice set up a joint inquest/inquiry in view of the magnitude of the Merriespruit disaster, and due to the lack of clarity relating to the personnel responsible and the complicated technical issues involved. There were many complications in resolving the issues, with the operator, the owner and the state each having different approaches in their investigations to ascertain the causes of the tailings-dam failure (Wagener et al., 1997).
It was not surprising that there were different perceptions on some aspects of the investigations, yet the overall crucial facts were established and the different investigators were in general agreement about the technical conclusions, with only a few minor controversies.

Information about the state of the tailings dam before the disaster occurred was needed and Landsat satellite images from the Satellite Application Centre of the CSIR at Hartebeeshoek were made available. These satellites have repetitive, 16-day cycles in a near polar orbit at an altitude of 700 km above the Equator. Changes in moisture conditions on the tailings dam between any two dates, are portrayed by changes in the reflectance characteristics of
satellite images. Using the infrared bands, a wetness classification was compiled. In an image of 28 October 1993, four months before the disaster, it was already clear that the pool in compartment 4A had moved away from the penstock to the northern wall.

From this satellite image study, the following could be demonstrated:

- There was a considerable quantity of free water on the dam over a long period of time prior to the failure.
- The pool in compartment 4A was not located around the penstock outlet, but was lying against the northern wall (Figure 4) and it had been located there for a considerable period of time. The staff of the operator repeatedly denied this important fact, until the satellite images proved otherwise.
- The water level was estimated at 0.45 m below the crest of the dam on 1 February 1994.

Together with eyewitness reports, all this pointed overwhelmingly to the cause of the failure being moisture build up in the tailings along the northern wall and eventual overtopping (Wagener et al., 1997).

Seismic action, piping, slope instability, static liquefaction and overtopping were investigated as possible causes and modes of failure. Wagener (1997, p. 28) describes the most likely chain of events leading to the failure:

Rain falling in the impoundments of compartments 4A and 4B flowed towards the pool, which had moved away from the penstock towards the north wall. The pool already contained at least 40 000 to 50 000 m³ of water from the plant. The impoundment had insufficient capacity to contain the additional inflow of approximately 50 000 m³ that had resulted from the rainstorm but then started overtopping at the lowest point of the north wall. The spilling water, together with what had accumulated on the northern section of the dam, eroded the loose tailings that had been pushed into earlier sloughs on the lower slope. This led to small slip failures occurring, with the sloughing tailings being removed by overtopping water, and preventing the buttressing effect of any material that would otherwise have accumulated at the toe of the unstable slopes. This resulted in a series of slip failures retrogressively moving up the slope in domino fashion, ultimately leading to a massive overall failure that released the flow slide.

**Consequences of the Disaster**

**Culpable homicide**

The failure of this tailings dam shocked everybody in South Africa. At the inquest that followed the disaster, the judge called this tailings dam a time bomb that was waiting to explode. The owner, the operator and six of their employees were subsequently found guilty of negligence and heavy fines were imposed (Mail & Guardian, 1996). It emerged that due to economic pressure at the time there had been a reduction in personnel numbers and direct management input of the tailings dams was reduced because the metallurgical manager had fewer available management hours. Personnel were also promoted to positions where they had the responsibility for the tailings dams, but did not receive appropriate training or had not gained appropriate experience in respect of tailings-dam operations.

**Safe disposal of tailings**

The Merriespruit disaster gave the South African Government and the mining industry a very good reason to make the disposal of tailings safer. A fundamental reassessment of the philosophies for the design, management and operation of tailings in South Africa was initiated by the state and the mining industry. The mining industry now views tailing dams and their associated problems far more seriously than in the past and is now required to carry out regular, independent self-audits (McPhail et al., 1997).

The Council for Scientific and Industrial Research (CSIR) was appointed by the South African Government to investigate the matter and largely confirmed the conclusions reached. These investigations highlighted the inherent deficiencies in the operation of this facility and others of its kind. This resulted in a 1995 Draft Code of Practice for the ‘Design, Operation and Closure of Tailings Dams’ in South Africa being introduced (www.africon.com).

As in the past, the mining industry showed a willingness to participate in measures to enhance the safety of the industry. In terms of this 1995 Code, every tailings dam will be classified according to its hazard potential and (as a result of this classification) certain mandatory procedures will be required. Also, all tailings dams will be audited regularly by experienced, professional engineers.
The code is intended to provide South African companies involved in mine residue disposal with objectives, principles and, where necessary, minimum requirements for good practices in the various stages of the management of the lifecycle of such residues. The development of the code was initiated primarily in order to overcome safety concerns related to structural failure and the environmental impact of these failures. Emphasis is given in the code to ensuring that the owner of a tailings dam appoints appropriately experienced and trained operators (Martin Creamer’s Mining Weekly, 1997).

Mining personnel and the law
Mining personnel are also now more aware of their legal responsibilities when they make appointments. They will make absolutely sure that staff have the necessary skills and appropriate experience to perform their functions. Unions are more active in assisting mining personnel to become trained in different skills. The South African Government promulgated several new laws to ensure that companies train staff sufficiently and incorporate environmental issues in tailings-dam management (Martin Creamer’s Mining Weekly, 1997).

Public awareness
One important outcome of the Merriespruit disaster is that the general public’s awareness of the threats posed by tailings dams was enhanced. This was evident in 1997 when the Fleurhof community protested the redevelopment of a tailings dam adjacent to the Florida, West Rand suburb. RMP Properties had applied to the Department of Mineral and Energy Affairs for approval of the reopening and enlarging of a tailings-dam complex in the region adjacent to Fleurhof (www.anc.org.za). The application was turned down because of pressure from the community who were acutely aware that the site was situated within 1 km of houses in Fleurhof and Soweto, as well as close to a school and a hospital (The Star, 1997).

Merriespruit tailings dam operator
The operator of the Merriespruit tailings dam who is also responsible for the majority of tailings dams in South Africa undertook a detailed self-examination of the company’s strengths and weaknesses and, in line with the Code of Practice, appointed appropriately qualified staff to provide a professional service to the mining industry. The operator also implemented a hazard-management system for every single tailings dam (Wagener et al., 1997).

Duvenhage of Vista University in Welkom compiled an ‘environmental management programme’ for the entire area affected by the disaster including the whole area around Virginia where mining activities are taking place. This study aided the clean-up operations in the destroyed bird sanctuary and supplied valuable environmental information, which was used to comply with the new environmental legislation (Act 107 of 1998: National Environmental Management Act) promulgated by the South African Government (Duvenhage, 1998).

Monitoring of tailings dams
Digital satellite image processing is increasingly used to monitor and manage tailings dams. It has proved to be a cheap, easy and effective management tool (Wagener et al., 1997). Monitoring of tailings dams on the ground now includes inspection by a competent person with observations recorded in terms of:

- Toe seepage
- Drying off of vegetation planted on the dam walls
- Slope erosion
- Tailings build up in the erosion paddocks at the base of the tailings dam
- Any signs of wall bulging
- Cracking on top of the walls
- The amount of freeboard available
- Sinkhole occurrences
- Condition of the penstock
Inquest Results

In view of the magnitude of the disaster, the South African Minister of Justice set up a joint inquest/inquiry. The tailings-dam operator and the mining company that owned the tailings dam each employed a team of engineers to gather technical facts and legal advisers to present them in the inquest. Insurance companies and the Mine Workers Union were also represented at the inquest. The state appointed the Council for Scientific and Industrial Research (CSIR) to investigate the matter independently. The Merriespruit disaster should not have happened. These investigations highlighted the inherent deficiencies in the operation of this facility and others of its kind. The owner of the tailings dam, the operator and six of their employees were found guilty of negligence and heavy fines were imposed.

The facts presented by the CSIR prompted the South African Chamber of Mines to draft a Code of Practice for the ‘Design, Operation and Closure of Tailings Dams’ in South Africa (www.africon.com).

The enquiry concluded that several Regulations in terms of the Water Act (Act 54 of 1956 as amended) and the Minerals Act (Act 50 of 1991) were contravened. Suitably qualified and conscientious people did not properly apply the Acts, and therefore these Acts proved ineffectual. New legislation was promulgated by the South African Government, but will only ensure safe tailings disposal if it is properly applied.

CONCLUSIONS AND GUIDELINES TO PREVENT FUTURE DISASTERS

The lessons from earlier disasters were not learnt and therefore did not prevent the series of mistakes and bad management practices that caused the Merriespruit tailings dam to fail. The guidelines to prevent future disasters include:

- The topography of the area where the tailings dam is built should be carefully considered. Depositional sites should be relatively flat without undulating topography and preferably not on the sites of drainage channels.
- Weak foundations will negatively influence slope stability of dam walls.
- Ground conditions and drainage facilities around dams should be sufficient to handle flood episodes.
- Dam walls should not exceed an inclination of 36 degrees and should ideally be less than 26 degrees.
- Excessive rainfall on the tailings dam will cause a sudden rise in the water levels of the pond, which could lead to overtopping, and, therefore, facilities should be created to handle excessive rainfall on top of the dams, including an adequate and properly functioning penstock and sufficient freeboard around the dam perimeter.
- The movement of the pond away from the penstock to a wall should be prevented at all cost because such an event will weaken the wall and could lead to liquefaction.
- Coarse and fine layering of tailings should be avoided to ensure prevention of the formation of piping.
- Tailings dams should be monitored regularly in terms of their characteristics and behaviour.

Numerous environmental studies were conducted to assess the environmental damage caused by the Merriespruit tailings-dam failure and to aid the clean up operations. As the tailings dam had to be repaired and made safer, several engineering studies were also launched and implemented. These studies have been used internationally by other mining companies and tailings-dam operators to assess the safety of their own tailings dams (McPhail et al., 1997).

Every tailings dam is unique. The design and construction of tailings dams depends on a variety of factors including the nature both of the land and the tailings themselves. The appropriate construction and safe operation of tailings dams is now seen as an important management responsibility by the mining industry. Careful planning in selecting the site and in designing the dam, is only the beginning. One of the most pertinent dangers in the management of tailings dams is that the designed plan and the execution of that plan are not always the same. Management overview and continual recording of any changes to tailings dams are crucial. It cannot simply be left to the contractors.

It is to be hoped that the South African Government and mining industry, both locally and internationally, now know enough to prevent further serious disasters. It is imperative, though, that tailings dams be monitored and managed according to the lessons learnt from previous disasters.
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