

# COMPLIANCE PRIORITIES OUTCOMES

Constructing, operating and decommissioning tailings storage facilities



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# Overview

The NSW Resources Regulator initiated a compliance priority project in 2018 to establish a consistent approach to regulating tailings storage facilities across both the coal and metalliferous mining sectors. The program aimed to ensure that title holders and mine operators were aware of their obligations, and to promote leading practice tailings storage facility management.

The project involved collaborating with other agencies including Dam Safety NSW, Environment Protection Authority and the Department of Planning, Industry and Environment. Professor David Williams from the University of Queensland, a leading expert in tailings management, was engaged to provide technical advice.

The key outcomes of the project included the following:

- Identifying specific risks and knowledge gaps.
- Improving the knowledge base of regulators and industry by identifying relevant guidelines, standards, best practice, emerging technologies/innovations with tailings treatment/processing and disposal.
- Clarifying the specific roles of the various regulators and associated legislative frameworks, and opportunities for a collaborative whole-of-government regulatory approach in relation to tailings storage facilities.
- Improvement to work health and safety regulation to ensure regulatory oversight of the metalliferous mining sector is consistent with existing arrangements in the coal sector.

The project identified opportunities to improve how the mining industry understands the risks associated with tailings storage facility management and adopting appropriate controls for hazards. In particular, the mining industry should be aware that the risks to tailing storage facilities management need to be considered throughout the life of a mining operation (design, construction, operation and decommissioning) to effectively implement controls to ensure operations are conducted in a safe, sustainable manner and lead to effective rehabilitation outcomes.

The compliance priority project also identified that further research and innovation should focus on dewatered tailings. This would also facilitate combining the material with other waste products, such as waste rock, to allow integrated waste emplacement or co-disposal to move away from conventional slurry tailings storage facilities.

## Contents

Overview .....	3
Background .....	5
Objective .....	6
Regulatory framework .....	6
Guidance material .....	10
Guidance material .....	10
Mining Act 1992 considerations .....	10
WHS (M&P) Act 2013 considerations .....	11
Other regulators .....	11
Other guidelines and standards .....	11
ANCOLD guides on tailings dams .....	11
Tailings management, leading practice sustainable development program for the mining industry .....	12
Global Acid Rock Drainage Guide (GARD) .....	12
Construction engineering standards .....	12
Site assessment program .....	12
Industry engagement .....	15
Regulatory approach .....	16
High risk activity notification .....	16
Mining operations plan .....	16
Risk assessment .....	17
Conclusion .....	20
Recommendations .....	21



## Background

Building, operating and decommissioning tailings storage facilities involves managing multiple issues that have the potential to affect safe and sustainable mining operations and rehabilitation outcomes. There are many cases of tailings storage facilities failures across the world, resulting in escaping tailings materials off site and/or significant landform instability issues. Consequences range from displaced downstream communities to significant injuries and the death of mine workers and members of the public. Environmental impacts have included polluted downstream rivers and land, contaminated groundwater and poisoned native wildlife through exposure of adverse tailings, as well as dust from exposed tailings materials.

Regulatory activities, specifically through the review of mining operations plans (MOPs) and rehabilitation cost estimates developed for mining operations across the state, have identified uncertainties and knowledge gaps in managing tailings storage facilities. In regard to decommissioning, the processes for treating, capping and rehabilitating tailings storage facilities to ensure that they are safe, stable and non-polluting needs to be a key focus for mine operators.

*Figure 1 Metalliferous mine tailings storage facility, southern NSW*



## Objective

The overarching objective for the project was identified as:

*Safer tailings storage facilities with sustainable final land uses are attained by adequately addressing safety and closure risks. This ensures that tailings storage facilities across NSW are safe, stable and non-polluting.*

To work towards achieving this, we coordinated a multi-phase review of tailings storage facility management, which began in 2018. This project involved the following:

- Review the NSW regulatory framework to ensure roles and responsibilities for NSW regulators are well understood.
- Review reference material, including industry-accepted guidelines applicable to tailings storage facility management.
- Conduct site assessments of selected tailings facilities to gain insights on how well the industry is addressing identified key knowledge gaps associated with rehabilitation/mine closure, as well as safe operation through the full life cycle of the facilities. These inspections were also attended by other NSW regulators to promote cross agency awareness and collaboration.
- Conduct a workshop in Dubbo in April 2019 (attended by more than 130 people from industry and regulators) focussing on tailings management leading practice and key risks.
- Assess our regulatory approach, with the aim of continual improvement to regulating tailings facilities.

## Regulatory framework

The project set out to map the regulatory framework to understand the relationship between legislation applicable to tailings storage facilities management in NSW, and the role of each agency enforcing legislation. This applies to the full life cycle of tailings management (approval, construction, operation and decommissioning).

The roles and responsibilities of NSW Government agencies in relation to tailings management are presented in Table 1. A summary of each regulators' involvement in each stage of the tailing's lifecycle is summarised in Table 2.

Table 1 Comparison of legislation that applies to tailings management in NSW

Legislation	Agency	Comment
<i>Mining Act 1992</i>	NSW Resources Regulator: Mining Act Inspectorate	NSW Resources Regulator’s Mining Act Inspectorate ensures the rehabilitation of tailings storage facilities to achieve a safe, stable and sustainable pre-determined final land use at mine closure. Rehabilitation and final closure is required to be considered through the full life cycle of the tailings storage facility.
<i>Work Health and Safety Act and Work Health and Safety (Mines and Petroleum Sites) Act 2013 (MPS)</i>	NSW Resources Regulator: Mine Safety Inspectorate	NSW Resources Regulator’s Mine Safety Inspectorate considers workers’ safety regarding the design, construction and operation of tailings storage facilities.
<i>Dam Safety Act 2015</i>	Dam Safety NSW	<p>Dam Safety NSW is responsible for dam safety in relation to the community and environment.</p> <p>Dam Safety NSW does not provide regulatory oversight for all tailings storage facilities, only those that are declared in accordance with the <i>Dam Safety Act 2015</i> (i.e. dams which have a higher consequence to the community, including workers on site, or the environment in the event of catastrophic failure).</p>
<i>Environmental Planning and Assessment Act 1979 (EP&amp;A)</i>	NSW Department of Planning, Industry and Environment (DPIE) for state significant development (SSD)  Local council for non-SSD	<p>Before commencing mining operations, development consent is required under the <i>Environmental Planning and Assessment Act 1979</i>. The proposal to construct and operate a tailings storage facility is assessed and approved as part of the development consent. The requirements of the development consent are regulated by the consent authority such as the local council (for non SSD) or the Minister for Planning and Public Spaces (or delegate) for SSD.</p> <p>The relevant consent authority also has a compliance role and must ensure compliance with conditions of the development consent. In most cases, this involves enforcing the tailings management commitments outlined in the environmental</p>



## COMPLIANCE PRIORITIES OUTCOMES

Constructing, operating and decommissioning tailings storage facilities

		assessment documentation that formed part of the development application.
<i>Protection of the Environment Operations Act 1997 (PoEO)</i>	NSW EPA	The Environmental Protection Authority (EPA) is the primary environmental regulator in NSW for pollution prevention. For tailings storage facilities, this typically relates to seepage (impacts to both surface water or groundwater) and managing dust. The EPA regulates through their Environment Protection Licencing (EPL) system. The EPL issued by the EPA sets monitoring requirements and pollution limits, including permitted discharges from tailings facilities.

Figure 2 Lined tailings storage facility under construction in southern NSW





## COMPLIANCE PRIORITIES OUTCOMES

Constructing, operating and decommissioning tailings storage facilities

Table 2 Summary of each regulators' involvement in each stage of the tailing's lifecycle

Regulator	Legislation	TSF Approval	TSF construction	TSF operation	TSF decommissioning
Dam Safety NSW	<i>Dam Safety Act 2015</i>	✓ (submits advice) Declared dams	✓ Declared dams	✓ Declared dams	✓ Declared dams
DPIE Resource Assessment	<i>EP&amp;A Act 1979</i>	✓ (SSD*)			
DPIE Compliance	<i>EP&amp;A Act 1979</i>		✓ (SSD*)	✓ (SSD*)	✓ (SSD*)
Local Government Council	<i>EP&amp;A Act 1979</i>	✓ (non SSD*)	✓ (non SSD*)	✓ (non SSD*)	✓ (non SSD*)
NSW Resources Regulator -Mine Safety Inspectorate	<i>WHS &amp; WHS (MPS) Act 2013</i>	✓ (submits advice)	✓	✓	✓
NSW Resources Regulator - Mining Act Inspectorate	<i>Mining Act 1992</i>	✓ (submits advice)	✓	✓	✓
Environmental Protection Authority	<i>PoEO Act 1997</i>	✓ (submits advice)	✓	✓	✓

\*Note SSD is state significant development

Our role covers both safe operation (including engineering) of the tailings facilities, as well as environmental management to achieve sustainable final land use.

There are clear opportunities for further collaboration between each of the regulators for ensure a whole-of-government approach to the regulation of tailings facilities.

*Figure 3 Government inspectors assessing tailings dam seepage*



## Guidance material

### Mining Act 1992 considerations

The [ESG3 Mining operations plan \(MOP\) guideline](#) (September 2013) provides requirements for operators to consider specific risks relating to rehabilitation (refer to Section 3.1 and 3.2). Risk assessments are required to be undertaken in accordance with AZ/NZS ISO 31000:2009 Risk Management – Principles and Guidelines.

## WHS (M&P) Act 2013 considerations

The [Principal hazard management plan guideline](#) (July 2019) provides information for how operators are required to consider risk to workers associated with tailings management. Although tailings storage facilities management is not listed as a 'specified hazard' in accordance with WHS (Mines and Petroleum Sites) Regulation, it requires consideration due to the reasonable potential for multiple deaths in the event of a single incident or a series of recurring incidents.

Tailings storage facilities are listed as a high risk activity under Schedule 3 of the WHS (MPS) Regulation. Information on [notifying the regulator of a high-risk activity](#) can be found on our website. It provides notification requirements for operators undertaking listed high risk activities in accordance with WHS (MPS) Regulation.

## Other regulators

Dam Safety NSW has published several guidelines specific to tailings storage facilities management, referred to as [DSC3F Tailings Dams](#) (June 2012). Dam Safety NSW guidelines are generally consistent with ANCOLD guidelines.

With the commencement of the *Dams Safety Act 2015*, guidance material will be developed as part of the new regulatory framework and made available at [www.damsafety.nsw.gov.au](http://www.damsafety.nsw.gov.au).

## Other guidelines and standards

The following guides are recognised by the Regulator as providing acceptable practice. There are legislative requirements for tailings facilities operators to exercise due diligence by acquiring and keeping up-to-date knowledge of work health and safety matters. This includes knowledge of appropriate guides that apply to tailings management.

### ANCOLD guides on tailings dams

The Australian National Committee on Large Dams (ANCOLD) is recognised as the primary industry advisory body for dams in Australia and provides a series of guidance on what is considered acceptable practice, including engineering performance criteria.

An addendum to these guides was released by ANCOLD in July 2019. The addendum provides important updates in response to recent tailings storage facilities failures. These updates reinforce the need for robust management practices, as well as updates on earthquake considerations for static liquefaction.

Further information on these guidelines can be found at [www.ancold.org.au](http://www.ancold.org.au).

## Tailings management, leading practice sustainable development program for the mining industry

These guides provide an overview of tailings management strategies and leading practice (including case studies). The guidelines facilitate general understanding of tailings management and are useful for consideration of alternate tailings management options and innovations.

Further information on these guidelines can be found [here](#).

## Global Acid Rock Drainage Guide (GARD)

The GARD guide addresses mine waste covers to manage Acid Metalliferous Drainage (AMD) issues. It is published by INAP (International Network for Acid Prevention), an industry-sponsored advisory body for issues relating to AMD.

Further information on these guidelines can be found [here](#).

## Construction engineering standards

Although an Australian Standard specific to tailings storage facilities construction has not been drafted, the following Australian Standards are relevant to the construction and quality control for tailings storage facilities wall foundation investigation and construction:

- **AS 1726-2017** Geotechnical Site Investigations
- **AS 3798-2007** Guidelines on Earthworks for Commercial and Residential Developments
- **AS 1289-2014** Methods of testing for engineering purposes
- **AS 2758.6-2008** Aggregates and Rock for engineering purposes, guidelines for the specification of armour stone.
- **AS 1170.4-2007** Structural Design Actions, Part 4 Earthquake actions in Australia.

**Note:** The ANCOLD guide makes direct reference to the use of AS 3798-2007 and AS1170.4-2007.

Australian Standards can be purchased at [www.standards.org.au](http://www.standards.org.au).

## Site assessment program

The purpose of our assessment program, of selected mine sites across NSW, was to undertake a focussed assessment on how industry was identifying and managing risks associated with tailings facilities. The assessments focussed on safe operations and rehabilitation/mine closure through the full life cycle of the facilities.



To promote cross agency awareness, inspections were undertaken with Department of Planning – Compliance, Environmental Protection Authority, Dam Safety NSW, Water NSW, and local councils that are responsibly for authorising non-SSD development on the nominated mine sites.

The assessment findings are set out in Table 3.

*Table 3 Key assessment findings*

#### Key findings

Some mine risk assessments were deficient in addressing risks/application of controls for tailings capping construction and final landform requirements.

Some mines were uncertain whether final landform designs (generally) complied with long term stability requirements recommended by the Australian National Committee on Large Dams (ANCOLD) guidelines for post-closure life. This includes ANCOLD's recommendation for these facilities to be designed for a 1000-year notional post-closure life. This has implications for incorporating spillways in the final landform design.

Capping issues – lack of design and performance information, particularly for unconventional type capping design. In some cases, sources for obtaining required quantities of capping material were undefined. In addition, there was uncertainty about how the future of vegetative growth (e.g. deep-rooted trees) might impact on the integrity of capping layers and lead to the exposure of adverse tailings material in the future.

Consolidation/settlement of tailings – deficient information predicting total tailings settlement following closure. If total settlement is not considered within the final landform design, surface drainage pathways could be affected. In extreme cases, settlement could create depressions/pooling in landforms that were designed to be free draining at closure. This also has implications for water being inadvertently collected and directed back through tailings, creating seepage/contaminant mobilisation issues. Differential settlement was also identified as problematic and requiring further consideration, especially when locally deeper voids are located with the tailing's facilities.

Uncertain desiccation timeframes effecting the rehabilitation schedule. This could result in significant delays in progressing mine closure, especially if desiccation rates were impeded by surface crusting.

Seepage – lack of water balance modelling to predict long-term seepage rates. Implications for managing chemically unstable tailings long term. In some cases, this was indicative of poor-quality assurance and quality control processes during construction.

Evidence of poor application of quality assurance and quality control processes and expert oversight of tailings facilities construction.

Cases in which vehicle access edge protection was deficient may lead to potential safety risks to workers.

Unsatisfactory consideration of risks (in particular geotechnical stability) when excavating tailings for reprocessing.

Connection lacking to principal hazard management plans for tailings facilities in accordance with the WHS(MPS) Regulation 2014.

Reduced powerline clearances following tailings facilities raising. Associated vicinity permits and corridor permits.

Industry is unaware of compliance obligations, especially to specific conditions in development consent and other requirements under WHS and DS Act requirements.

*Figure 4 – Erosion at base of tailings dam wall - western NSW*





## Industry engagement

A tailings management workshop was held on 10 April 2019. Invitations were extended to all mines in NSW that operated tailings storage facilities, as well as relevant NSW regulators including Dam Safety NSW, EPA, DPIE Resource Assessment and Compliance and councils.

The workshop had 130 attendees, 43 of whom represented NSW Government agencies.

Professor Williams, a leading expert in tailings management, provided presentations on leading practice tailings management and key life cycle tailings management risks.

Professor Williams highlighted that there was a move away from conventional slurry tailings to dewatered tailings technologies and other innovative tailings treatment methods that don't necessarily rely upon a tailings facility structure to contain material. He highlighted that further research and innovation should focus on dewatered tailings to combine the material with other waste products, such as waste rock for integrated waste emplacement or co-disposal, to shift away from conventional slurry tailings storage facilities.

The workshop promoted leading practice tailings management and dialogue between industry and regulators. All workshop presentations and videos are available on our [website](#).

Figure 5 Tailings management workshop April 2019



## Regulatory approach

### High risk activity notification

High risk activity notification requirements apply to coal emplacements. This requirement replaced the previous section 100 approvals requirement under the *Coal Mine Health and Safety Act 2002*. In December 2019, the Work, Health and Safety (Mines and Petroleum Sites) Regulation 2014 was amended to include high risk activity notification for tailings storage facilities on metalliferous sites. Details of the commencement of the amendment on 1 February 2020 is available on our [website](#)

The notification allows the Regulator to be made aware of the risks assessed and the controls to be implemented before the planned activity (establishment, operation or decommissioning of emplacement area) occurring. This provides visibility of these controls and assessment information before the activity occurs and allows us to request additional information if required. Other compliance action can also be applied at this time, including extensions in notification periods and improvement or prohibition notices.

### Mining operations plan

Site assessment activities generally found risk assessment information in Mining Operations Plans (MOPs) to be deficient. In most cases, when risks were identified, it was unclear how controls were implemented to address the specific risk. It was also unclear how the implementation of the control (if identified) was tested to determine the effectiveness of the control.

A review of the MOP guidance material found limited specific guidance for industry on tailings facility management.

Tailings management was not identified as a 'specific risk relating to rehabilitation' in section 3.2.1 of the MOP guide. However, other specific risks identified in this section do cover some aspects of tailings management risks, namely 'material prone to generating acid mine drainage' and 'erosion and sediment control'. The guidance note for 'erosion and sediment control' specifically mentions 'stability issues that relate to tailings dams'.

A rehabilitation risk assessment guide is being developed as part of the operation rehabilitation reform project, with an increased emphasis on risk management for tailings. This guide will clarify the need for proponents to identify risks and controls associated with tailings rehabilitation and closure. The implementation of these controls will then be detailed in the rehabilitation management plan.



*Figure 6 In-pit tailings disposal typical of coal mines - Hunter Valley NSW*



## Risk assessment

We held risk assessment workshops to help our understanding of critical controls to address risks associated with events that affect both worker safety and environment and mine closure.

For each critical control, we identified the performance requirement, supporting activities and verification method to determine successful implementation of the control.

Risk assessment using a bow tie methodology was developed for three events:

- catastrophic dam failure
- release to the environment
- post closure failure.

It was determined that the 'catastrophic dam failure' event had implications for both worker safety and the environment. The remaining events being 'release to the environment' and 'post closure failure' were primarily relevant to environmental considerations (sustainable rehabilitation) under the *Mining Act 1992*.

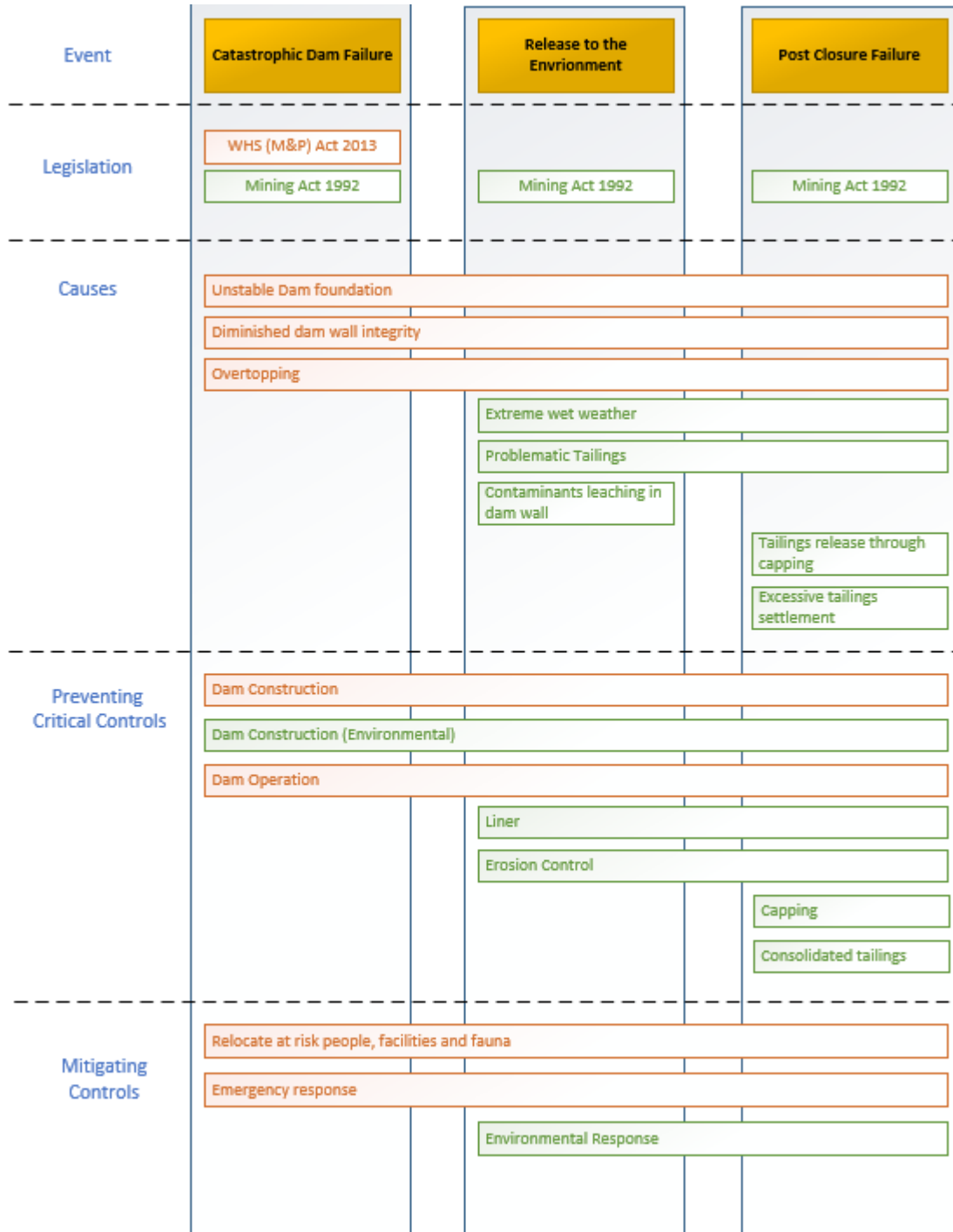
Eight consolidated causes were identified, some of which were considered in multiple events. Following this, seven critical preventing controls were identified and three mitigating controls. A schematic showing the critical controls that relate to each event and how some of these overlap events is shown in Figure 7.

The verification of each critical control developed in this part of the project was of primary importance for us to ensure industry was appropriately addressing risks associated with tailings management. We drew upon the insights gained from this project and the internal risk assessments to develop a targeted assessment program around how mine operators define and implement risk controls for the closure of a tailings storage facility. Further information on the consideration of risks and tailings management targeted assessment programs are available on our [website](#).

# COMPLIANCE PRIORITIES OUTCOMES

Constructing, operating and decommissioning tailings storage facilities

Figure 7 Relationship of events, legislation, causes, preventing and mitigating controls for risk assessment conducted specific to the regulators' oversight.





## Conclusion

Mines must be aware of requirements under the *Work Health and Safety (Mine & Petroleum Sites) Act 2013* and the *Mining Act 1992* that relate to tailings storage facilities management.

The project has successfully promoted leading practice tailings management and dialogue between industry and regulators.

We will use the insights gained from the project to identify and address knowledge gaps and key risks regarding tailings storage facilities management. Targeted assessments will be undertaken at mines that use tailings processing and storage (both coal and metalliferous mines) to ensure operators are effectively identifying and managing risks associated with tailings management and fulfilling their statutory compliance obligations.

*Figure 8 Placement of an engineered cap on legacy tailings facility - northern NSW*





## Recommendations

It is recommended that mine operators and title holders:

- undertake comprehensive risk assessments in relation to tailing facilities during the design, construction, operation and decommissioning phases
- evaluate and consider the use of alternative tailings management practices, where reasonably practical, to eliminate or minimise risks associated with tailings facilities
- implement effective controls to address safety and rehabilitation risks
- monitor and evaluate control measures to determine effectiveness
- define closure risks and develop control measures well in advance of cessation of mining
- design and implement emergency preparedness and response plans.