NSW GOVERNMENT | Trade & Investment Mine Safety

NSW CODE OF PRACTICE | WHS (MINES) LEGISLATION

Inundation and inrush hazard management

This code of practice has been approved under section 274 of the *Work Health and Safety Act 2011*.

Notice of that approval was published in the NSW Government Gazette referring to this code of practice as inundation and inrush hazard management on 23 January 2015. This code of practice commenced on 1 February 2015.

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NSW code of practice: Inundation and inrush hazard management

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Foreword

The *NSW Code of Practice: Inundation and inrush hazard management* is an approved code of practice under section 274 of the Work Health and Safety Act 2011 (WHS Act).

An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the WHS Act, the *Work Health and Safety Regulation 2011* (WHS Regulations), *Work Health and Safety (Mines) Act 2013* (WHS (Mines) Act) and *Work Health and Safety (Mines) Regulation 2014* (WHS (Mines) Regulations)[1].

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS laws, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks that may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS laws. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

Compliance with WHS laws may be achieved by following another method, such as a technical or an industry standard, if it provides an equivalent or higher standard of work health and safety than the code.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice.

The development of this code of practice

This code of practice has been developed under the ‘Inter-Governmental Agreement for Consistency or Uniformity of Mine Safety Legislation and Regulations in NSW, Queensland and Western Australia’ and forms part of the mining safety legislative framework for these states. Under this agreement, tri-state model legislation was developed, although designed to be structured and customised differently in each of these states.

This code was developed in consultation with the Non-Core (tri-state) Legislative Working Group representing the following stakeholders from the mining industry in the tri-states:

- NSW Minerals Council
- Construction, Forestry, Mining and Energy Union (CFMEU) – NSW and Queensland
- Cement, Concrete and Aggregates Australia
- NSW Trade & Investment (Mine Safety)
- Queensland Resources Council
- Queensland Department of Natural Resources and Mines
- Western Australian Department of Mines and Petroleum
- Western Australia Chamber of Mines and Energy

[1] It will sometimes be convenient to refer generally to ‘WHS laws’ as per clause 5 of the WHS (Mines) Act, which includes:

- WHS Act
- WHS (Mines) Act
- WHS Regulations
- WHS (Mines) Regulations

Accordingly, this code of practice is based on both:

- the Non-Core (tripartite) Legislative Working Group endorsed tri-state model code on 10 December 2013; and
- the National Mine Safety Framework model code version, developed in conjunction with Safe Work Australia.

A draft of this code of practice was released for public consultation on 2 June 2014 and was approved by the Minister for Energy and Resources, the Hon Anthony Roberts MP on 19 January 2015. The code will be reviewed as required or when the legislation is reviewed.

Contents

Scope and application

This code of practice provides practical guidance to assist mine operators in developing and implementing a principal mining hazard management plan (PMHMP) for inundation and inrush in surface and underground mines. Gas/coal outburst hazards, air/wind blast hazards and rock burst hazards are not included in the definition of inundation and inrush hazards for this code and are generally controlled in separate principal mining hazard management plans – namely the gas outbursts principal mining hazard management plan and the strata/ground failure principal mining hazard management plan. The code also addresses specific legislated control measures required to be implemented for inrush hazards at an underground mine, regardless of whether they are a principal mining hazard. These control measures would be included in the safety management system (SMS) for the mine.

This code should be used by persons conducting a business or undertaking (PCBU) to manage the risks associated with inundation and inrush at underground and surface mines. In particular, officers and workers of mine operators, including, mining engineering managers, senior management nominated in the mine management structure, engineers, supervisors and mine workers should use this code to develop, implement and monitor specific risk controls and a principal mining hazard management plan for inrush and inundation, if required. The code can assist in finding a practical way to identify, assess and control the hazards of inundation and inrush. This code can be used by workers and health and safety representatives who need to understand the risks associated with inundation and inrush.

How to use this code

This code includes references to both mandatory and non-mandatory actions. The references to legal requirements contained in the WHS Act, and WHS (Mines) Act, WHS Regulations and WHS (Mines) Regulations are not exhaustive and are included for context only.

This code has been prepared to be consistent with the WHS laws as at the date of publication and should be interpreted, to the extent that there is any ambiguity, in a manner that is consistent with the WHS laws.

To ensure you comply with your legal obligations you must refer to the latest legislation, which is available on the NSW legislation website (www.legislation.nsw.gov.au).

This publication does not represent a comprehensive statement of the law as it applies to particular problems or to individuals or as a substitute for legal advice. You should seek independent legal advice if you need assistance on the application of the law to your situation.

The words ‘must’, ‘requires’ or ‘mandatory’ indicate that legal requirements exist and must be complied with. The word ‘should’ indicates a recommended course of action, while ‘may’ indicates an optional course of action.

Unless otherwise indicated in the text, lists of points in the code should not be read as exhaustive.

Samples provided in Appendix C are based on specific mining environments. For example, the triggers in sample A for a metalliferous mine using a caving method of mining has been designed to monitor the critical factors that, in that environment, indicate a deterioration of inrush controls in a timely manner. The action/responses are similarly specific to the environment.

The samples in Appendix C are included as examples, some drawn from current practices, as to how a process may be undertaken or how a document may be set out. Every process developed or document prepared for a mine should be developed to suit the nature, complexity and location of the particular mining operation and the risks associated with that mining operation.

Some samples or examples are drawn from practices existing prior to the commencement of the WHS (Mines) Act and Regulations in NSW, and/or from other jurisdictions. Therefore some of the content and terminology used in these appended examples/samples are referable to statutory requirements under previous or interstate legislation and do not represent a current statement of the law as it currently applies in NSW.

Key terms

Barrier – a structure between the inundation and inrush hazard (and an area where people may be) designed to prevent the release of the hazard into a working area.

ICZ – Inrush control zone. This is the zone required around an inrush hazard that is a principal mining hazard under cl 46 of the WHS Regulations, in which additional controls are required to be implemented.

Inundation and inrush – when a liquid, gas or other substance that can flow enters a workplace at a rate or volume or concentration that creates an emergency situation and presents a risk to health and safety of mine workers.

Irrespirable atmosphere – an atmosphere that may be unsafe for a person to breathe as a result of either oxygen depletion or the presence of toxic fumes, gases or contaminants.

Flammable gas – a gas that when mixed with air within prescribed limits will propagate a flame away from the source of ignition.

Fluid – a gas or liquid

Fluid material – a material that can flow, including gases, liquids, muds and slurries.

Hydraulic fills – a class of mine fills made from material either naturally occurring or produced from mill tailings, with a size ranging from coarse sand, through medium and fine sand, through coarse, medium and fine silt to clay. The fill is placed underground into a mining void as a slurry/pulp via boreholes and/or pipelines. The content of the particles of clay and size must be rigidly controlled to ensure the fill is sufficiently permeable for excess water to drain from the stope. Hydraulic fills may be either cemented or uncemented depending on whether a binder has been added.

Inundation and inrush hazards – gases, liquids or material that can flow

Magnitude (of a hazard) – includes the size, nature, energy content and potential flow rate

Maximum potential – the worst case considering maximum rate, volume, and concentration

Paste fill – a fill consisting of ultra high-density thickened tailings with a binder or binders added. The essential difference between hydraulic fill and paste fill is that paste fill contains significantly higher quantities of fine particles, which are always cemented, and water is retained in the fill for hydration of the binding agent.

PCBU - person conducting a business or undertaking

Pore water pressure – the pressure within the water within the pores of a porous medium, such as placed hydraulic fill

TARP – trigger action response plan. A plan designed to prevent a risk from escalating by identifying potential indicators to the hazard, assigning a hierarchy of alarms, or trigger levels, to each potential indicator, and specifying responses for each trigger level. (adapted from Galvin 2008).

1 Introduction

1.1 What is inundation and inrush?

An inundation or inrush occurs when a liquid, gas or other substance that can flow, enters a workplace at a rate or volume or concentration that creates an emergency situation and presents a risk to health and safety of mine workers.

An inundation or inrush hazard could include the existence of the following:

- significant quantities of water or other fluid material, including precipitation
- any material that flows when wet
- material that may be fluidized as a result of vibrations such as earthquakes, blasting or other means,
- irrespirable atmospheres or flammable gases
- paste or hydraulic filled stopes
- water storage dams, tailings dams or other man-made water bodies, and
- rivers, lakes, the ocean or other natural water bodies

These hazards may be pressurised and swiftly flow, or be released into or within a mine.

In the Australian mining industry there have been at least nine fatal incidents resulting from inundation or inrush with the loss of 19 lives (appendix A).

They were caused by:

- inrush from ore pass
- fill barricade failure
- extracting adjacent to filled stopes
- creek overflow into decline
- mining into old flooded workings.

Other significant non-fatal inundations or inrushes have occurred where:

- A gold mine had an unravelling of roof (similar to a chimney-type failure) that led to a rapid inflow of water from the surrounding limestone strata cavities. This required the immediate evacuation of the mine and eventually caused the loss of the mine.
- A coal mine had set temporary ventilation seals on the edge of a goaf and the pressure on the seals rose as the gas pressure rose in the goaf (measurements in the mine later showed the potential gas pressure to be above 15 kPa). The seals failed under the gas pressure and the gas release flooded the immediate working areas with an irrespirable atmosphere requiring immediate evacuation.
- A coal mine working towards a faulted zone struck a zone of fractured flowing material that rilled back over 50 metres. All workers safely retreated from the area.
- An open cut mine was working adjacent to several old, flooded mine entries. The entries were blocked with dams made of uncompacted spoil. One dam failed and the water flooded the face area.
- During a major rain event, a sinkhole was created above old, shallow underground workings allowing a creek to flow into the mine. The area was poorly mapped and there was a high probability of interconnection between several old mines and potentially to at least one working mine. An adjacent mine was evacuated.
- A gold mine was installing a raise bore shaft. After a fall of ground or mud within the raise borehole being excavated, the cuttings built up over the collar of the hole and, as a result, water accumulated within the raise bore shaft. During bogging operations a release of water and cuttings rushed down through the workings, banking up to over three metres in places.

- Underground coal mine intercepting an unsealed borehole that brought in saturated very weak strata, resulted in surface subsidence and connection to swampy ground. This resulted in closure of the mine.

For the purpose of this code, the hazards of gas/coal outbursts, air/wind blast and rock burst are not considered as they are generally managed under separate principal mining hazard management plans (gas outbursts PMHMP and strata/ground failure PMHMP).

The principal mining hazard management plan for inundation and inrush forms part of the mines safety management system (SMS). The SMS is the primary means of ensuring the health and safety of workers and that the health and safety of other persons at the mine is not put at risk from the mine or work carried out as part of the mining operations.

1.2 Who has duties relating to inundation and inrush?

The mine operator of any underground mine must identify and control inrush hazards:

WHS (Mines) Regulations

45 Inrush hazards (cl 642 model WHS Regs)

(1) The mine operator of an underground mine must implement a system for the mine that ensures:

(a) the identification of all reasonably forseeable inrush hazards at the mine, and

(b) the determination of the presence and location of an inrush hazard by exploratory bore-holes (including a way of sealing or otherwise controlling a bore-hole to prevent inrush) or other exploratory methods, and

(c) communication of the location of identified inrush hazards, including inrush hazards being approached, to all affected persons, and

(d) the determination of whether or not an identified inrush hazard is a principal mining hazard, and

(e) if an identified inrush hazard is a principal mining hazard—the identification, establishment and maintenance of an inrush control zone for the inrush hazard in accordance with the WHS laws.

(details of penalty omitted)

The mine operator must prepare and implement a principal mining hazard management plan for a mine if it identifies an inrush or inundation principal mining hazard is present:

WHS (Mines) Regulations

24 Preparation of principal mining hazard management plan (cl 628 model WHS Regs)

(1) The mine operator of a mine must prepare a principal mining hazard management plan for each principal mining hazard associated with mining operations at the mine in accordance with this clause and Schedule 1.

(details of penalty omitted)

...

In preparing the plan, the mine operator must specifically consult with workers for the risk assessments:

WHS (Mines) Regulations

120 Safety role for workers in relation to principal mining hazards (cl 675Q model WHS Regs)

The mine operator of a mine must implement a safety role for the workers at the mine that enables them to contribute to:

(a) the identification under clause 23 of principal mining hazards that are relevant to the work that the workers are or will be carrying out, and

(b) the consideration of control measures for risks associated with principal mining hazards at the mine, and

(c) the consideration of control measures for risks to be managed under principal control plans, and

(d) the conduct of a review under clause 25.

(details of penalty omitted)

121 Mine operator must consult with workers (cl 675R model WHS Regs)

For the purposes of section 49 (f) of the WHS Act, the mine operator of a mine must consult with workers at the mine in relation to the following:

(a) the development, implementation and review of the safety management system for the mine,

(b) conducting risk assessments for principal mining hazard management plans,

…

Further guidance on consultation, cooperation and coordination can be found in the NSW *Code of Practice: Work Health and Safety Consultation, Cooperation and Coordination*.

While the mine operator has the duty for the specific underground risk controls and principal mining hazard management plan under the WHS (Mines) Regulations, all PCBUs at a mine have the duty to manage risks to health and safety associated with mining operations at the mine:

WHS (Mines) Regulations

9 Management of risks to health and safety (cl 617 model WHS Regs)

(1) A person conducting a business or undertaking at a mine must manage risks to health and safety associated with mining operations at the mine, in accordance with Part 3.1 of the WHS Regulation.

Note. See sections 19, 20 and 21 of the WHS Act, as applicable (also see clause 4 of this Regulation and clause 9 of the WHS Regulations).

…

To meet the above legislative requirements, all PCBUs at the mine must consult, cooperate and coordinate with each other to carry out their duties in relation to risk management of principal hazards:

WHS Act - Part 5 Consultation, representation and participation

Division 1 Consultation, co-operation and co-ordination between duty holders

46 Duty to consult with other duty holders

If more than one person has a duty in relation to the same matter under this Act, each person with the duty must, so far as is reasonably practicable, consult, co-operate and co-ordinate activities with all other persons who have a duty in relation to the same matter.

General guidance on the risk management process is available in the NSW *Code of Practice: How to manage work health and safety risks.*

Finally, officers, workers and other people must satisfy their general duties under sections 27 to 29 of the WHS Act in relation to the principal mining hazard management plan and when consulted by the mine operator. Workers must comply with all reasonable instructions and cooperate with any reasonable health and safety policy or procedure, for example procedures in relation to their safety role at a mine.

2 Risk management

The risk-management requirements from the WHS laws apply at mines.

2.1 General requirements

The WHS Regulations require Persons Conducting a Business or Undertaking (PCBU) to identify hazards and control them according to the hierarchy of controls applies to mines. The WHS (Mines) Regulations have additional requirements for PCBUs generally assessing risks at mines.

WHS (Mines) Regulations

9 (1) A person conducting a business or undertaking at a mine must manage risks to health and safety associated with mining operations at the mine in accordance with Part 3.1 of the WHS Regulations.

Note. See sections 19, 20 and 21 of the WHS Act as applicable (also see clause 4 of this Regulation and clause 9 of the WHS Regulations).

(2) A person conducting a business or undertaking at a mine must ensure that a risk assessment is conducted in accordance with this clause by a person who is competent to conduct the particular risk assessment having regard to the nature of the hazard.

(details of penalty omitted)

(3) In conducting a risk assessment, the person must have regard to:

(a) the nature of the hazard, and

(b) the likelihood of the hazard affecting the health or safety of a person, and

(c) the severity of the potential health and safety consequences.

(4) Nothing in subclause (3) limits the operation of any other requirement to conduct a risk assessment under this Regulation.

Note. A number of specific risk control duties are linked to this clause, see clauses 28–32, 38, 43, 44, 50, 52 and 65–70.

(5) A person conducting a business or undertaking at a mine (who is the mine operator of the mine or who is a contractor) must keep a record of the following:

(a) each risk assessment conducted under this clause and the name and competency of the person who conducted the risk assessment,

(b) the control measures implemented to eliminate or minimise any risk that was identified through any such risk assessment.

(6) A person conducting a business or undertaking at a mine is not required to keep a record of a risk assessment if:

(a) the risk assessment is one that an individual worker is required to carry out before commencing a particular task, and

(b) the person keeps a record of risk assessments that addresses the overall activity being undertaken (of which the task forms a part) such as risk assessments carried out in relation to the development of the safety management system for the mine or for a principal mining hazard management plan.

(7) The record kept under subclause (5):

(a) if kept by a mine operator—forms part of the safety management system of the mine and the records of the mine, or

(b) if kept by a contractor who has prepared a contractor health and safety management plan—forms part of the plan.

...

A PCBU at a mine has the additional duty to ensure workers are trained and competent in basic risk-management techniques:

WHS (Mines) Regulations

104 Duty to provide information, training and instruction (cl 675B model WHS Regs)

(1)This clause applies in addition to clause 39 of the WHS Regulations.

…

(3) A person conducting a business or undertaking at a mine must ensure that each worker engaged by the person is trained, and is competent, in basic risk management techniques used at the mine having regard to the nature of the work carried out by the worker.

(details of penalty omitted)

The risk assessments must be documented by the mine operator or contractor at the mine.

WHS (Mines) Regulations

9 Management of risks to health and safety

...

(5) A person conducting a business or undertaking at a mine (who is the mine operator of the mine or who is a contractor) must keep a record of the following:

(a) each risk assessment conducted under this clause and the name and competency of the person who conducted the risk assessment,

(b) the control measures implemented to eliminate or minimise any risk that was identified though any such risk assessment.

(6) A person conducting a business or undertaking at a mine is not required

to keep a record of a risk assessment if:

(a) the risk assessment is one that an individual worker is required to carry out before commencing a particular task, and

(b) the person keeps a record of risk assessments that addresses the overall activity being undertaken (of which the task forms a part) such as risk assessments carried out in relation to the development of the safety management system for the mine or for a principal mining hazard management plan.

(7) The record kept under subclause (5):

(a) if kept by a mine operator, forms part of the safety management system of the mine and the records of the mine, or

(b) if kept by a contractor who has prepared a contractor health and safety management plan, forms part of the plan.

If the mine operator forms an opinion as to whether or not it is reasonably practicable to eliminate or minimise each identified potential source of inundation or inrush, the documentation should state the reasons for that opinion. If it involves a principal mining hazard, then the management plan must document the reasons.

Further advice on risk management, can be obtained from the NSW Code of Practice: How to manage work health and safety risks and the NSW Code of Practice: Safety management systems in mines.

2.2 Principal mining hazard management plan (PMHMP)

The risk-management process for preparing a principal mining hazard management plan is set out in WHS (Mines) Regulations clause 24:

WHS (Mines) Regulations

24 Preparation of principal mining hazard management plan (cl 628 model WHS Regs)

(3) A principal mining hazard management plan must:

(a) describe the nature of the principal mining hazard to which the plan relates, and

(b) describe how the principal mining hazard relates to other hazards associated with mining operations at the mine, and

(c) describe the analysis methods used in identifying the principal mining hazard to which the plan relates, and

(d) include a record of the risk assessment conducted in relation to the principal mining hazard, and

(e) describe the investigation and analysis methods used in determining the control measures to be implemented, and

(f) describe all control measures to be implemented to manage risks to health and safety associated with the principal mining hazard, and

(g) describe the arrangements in place for providing the information, training and instruction required by clause 39 of the WHS Regulations in relation to the principal mining hazard, and

(h) refer to any design principles, engineering standards and technical standards relied on for control measures for the principal mining hazard, and

(i) set out the reasons for adopting or rejecting each control measure considered....

The risk assessment forms the basis for developing an effective mine inundation and inrush management plan.

These factors should be included (as a minimum) in the assessment:

- identification of all possible significant inrush and inundation hazards
- identification of the mechanism and magnitude of the identified inrush or inundation hazard (if not clear, the exercise should define assumed hazard, rationale and basis for assumption, including methods/information used to investigate the hazard)
- identification of specific loss scenarios for all inrush/inundation hazards considering planned or expected mining operations that will be affected, or that will affect, the hazard
- the number and location of people who may be affected by inrush and inundation, including people off the mine site that could be affected by an inundation or inrush.
- the path of the inundation or inrush, including off the mine site if that is a possible outcome
- assessment of risks considering conservative probabilities and reasoned worst-case position, including single or multi-fatality consequences
- prevention - controls to prevent an inrush or inundation event
- monitoring - controls to monitor status of inrush/inundation hazard to identify changes
- first response - controls to respond to an inrush or inundation event in the early stages
- emergency response - controls to respond to a principal inrush or inundation event.

Clause 45 of the WHS (Mines) Regulations also requires that an ICZ be established and maintained where an inrush hazard is a principal mining hazard. The location of the inrush hazard, and whether it is a principal mining hazard, should be identified through the risk assessment. If the exact location of an inrush hazard is unknown, the risk assessment must determine the size of the inrush control zone (more than 50 metres). The risk assessment should address any special systems of work developed for mining and working in inrush control zones, and any assumptions made in the development of any such system.

The inrush and inundation risk assessment must be documented to satisfy the requirements in the WHS (Mines) Regulations clauses 9 (see section 2.1 above) and 24 (above). The risk assessment does not constitute the inundation and inrush management plan for the mine. However, it must be included in the plan.

Details and assumptions made in developing special systems of working for inrush control zones must be documented:

WHS (Mines) Regulations

Schedule 1 Principal mining hazard management plans—additional matters to be Considered

2. Inundation and inrush

...

(2) A principal mining hazard management plan that addresses inundation and inrush of any substance is to include details of any special systems of working developed for inrush control zones established under clause 45 of this Regulation and the assumptions underpinning the development of any such system.

See Chapter 8 for advice on how to prepare the content for a principal mining hazard management plan for inundation and inrush.

3 Identifying hazards and assessing risks

All PCBUs working at the mine must identify hazards as required in clause 9 above in Chapter 1.

For inrush hazards, there are specific requirements under clause 45 for the mine operator to identify inrush hazards, and to determine whether they are principal mining hazards , as set out above in Chapter 1 under 'Who has duties relating to inundation and inrush':

There are specific considerations for identifying inundation and inrush principal mining hazards and subsequently developing controls for them (see Chapters 4 and 7 for controls) that are required under clauses 23 and 24, and Schedule 1 of the WHS (Mines) Regulations:

WHS (Mines) Regulations

Schedule 1 Principal mining hazard management plans—additional matters to be considered

2. Inundation and inrush

(1) The following matters must be considered in developing the control measures to manage the risks of inundation and inrush of any substance:

(a) the potential sources of inundation, including extreme weather, overflow or failure of levies and dam structures, failure or blocking of flow channels (including regular, overflow or emergency flow channels),

(b) the location, design and construction of dams, lagoons, tailings dams, emplacement areas and any other bodies of water or material that could enter the mine, including any such entry because of extreme weather conditions such as a cyclone,

(c) the potential sources of inrush including current, disused or abandoned mine workings, surface water bodies, backfill operations, highly permeable aquifers, bore-holes, faults or other geological weaknesses,

(d) the location of other workings and the strength of the ground (including the geotechnical characteristics of the rock) between those workings,

(e) the potential for the accumulation of water, gas or other substances or materials that could liquefy or flow into other workings or locations,

(f) the magnitude of all potential sources and maximum flow rates,

(g) the worst possible health and safety consequences of each potential source, including the accuracy of plans of other workings, variation in rock properties and geological weaknesses,

(h) survey plans of the mine including any historical survey plans.

(2) A principal mining hazard management plan that addresses inundation and inrush of any substance is to include details of any special systems of working developed for inrush control zones established under clause 45 of this Regulation and the assumptions underpinning the development of any such system.

3.1 Identifying hazards

Inundation and inrush hazard identification should take place at all stages of the mining process from resource evaluation, exploration, mining studies through the operational phases, and continuing to closure and rehabilitation of the operation.

The identification of inundation and inrush hazards should be carried out by a cross section of the workforce with the appropriate competencies. The process should also include the consideration of relevant plans, files or other materials retained by adjoining mines or the Regulator. The WHS (Mines) Regulations require underground mine operators to provide certain information to operators of adjoining mines. This provision can be used to obtain information relating to inundation and inrush from other operators.

WHS (Mines) Regulations

18 Duty to provide information to mine operator of adjoining mine (cl 626 model WHS Regs)

(1) The mine operator of a mine must, as soon as is reasonably practicable and on request, provide to the mine operator of any adjoining mine any information that the mine operator has about conditions at the mine or any activities or proposed activities at the mine that could create a risk to the health and safety of persons at the adjoining mine.

(details of penalty omitted)

(2) For the avoidance of doubt, subclause (1) applies to survey plans and mine plans to the extent that they are relevant to the health and safety of persons at the adjoining mine.

3.2 Sources of hazards and failure mechanisms

3.2.1 Identification of inundation and inrush hazards

When inundation and inrush hazards are being identified, the following factors should be considered:

- natural surface features – rivers, creeks, lakes, swamps and floodplains. Additional information can be sourced from the relevant local and state authorities.
- man-made surface features – dams, tailings facilities, water storage areas, levee banks. Information should be gathered on age, construction methods, design criteria and maintenance. Considerations should include any structures which are intended to be built during the course of mining
- natural underground features – potential for voids containing fluids, strata/ground that will freely release fluids
- other mining operations including those above or below the mining horizon, highwall mining and open cut voids – this will often require a search of historical mining records for the area
- the proposed mining systems and the potential to create inundation and inrush hazards in the mine – this could include water storage underground, paste and hydraulic fill operations or sealing of waste areas that may contain irrespirable atmospheres or flammable gases
- tidal waters, oceans and connections to the ocean
- man-made or natural unconsolidated material that could flow when wet, including emplacement areas, tailings dams and mine water dams
- aquifers, buried channels and other natural sources of ground water, old workings or excavations
- raisebore shafts or holes
- ore passes and dump holes
- connection to the surface (e.g. portal / adits / escape-ways)
- other non-mining, man-made structures
- the mine being extended into any new areas the survey plan or mine plan prepared for the mine, as required in WHS (Mines) Regulations clauses 122(4) and 123(3), which will show the location of some inundation and inrush hazards including water and tailings dams and disused workings:

WHS (Mines) Regulations

122 Survey plan of mine must be prepared (cl 675S model WHS Regs)

…

(6) The plan must show the following (if present at the mine):

(a) the workings of the mine, including disused workings and bore holes,

(b) any other disused workings that are attached, or in close proximity, to the mine,

(c) the location of high voltage electrical installations,

(d) the location of telephones and other fixed plant associated with the radio and telecommunications systems,

(e) water dams and tailings dams,

(f) natural features surrounding the mine,

(g) places for the storage of hydrocarbons or explosives,

(h) in the case of an underground mine, points of entry and exit, including emergency exits,

(i) refuge chambers (in an underground mine),

(j) caches, refill stations and change-over stations (in an underground coal mine).

(7) In complying with subclause (6), the mine operator of a mine must take all reasonable steps to obtain historical mine surveys of the mine to ensure the accuracy of the mine survey plan.

123 Plans of mines (other than mine survey plans)

…

(3) The plan must show the following (if present at the mine):

(a) proposed workings of the mine,

(b) the existing workings of the mine, including disused workings,

(c) any other disused workings that are attached, or in close proximity, to the mine,

(d) the location or estimated location of the boundary of any adjacent mine workings or geological structures.

In taking all reasonable steps under clause 122(7) above to obtain historical mine surveys, the mine operator should always verify historical material through separate inquiries before making any important decisions or taking any action on the basis of that information.

Mine survey plans and mine plans are key sources of information for many inundation and inrush hazards. However, there are typical errors in these plans that should be considered. These errors may include:

- your own workings information
- information about other old or current workings
- orientation of workings
- unrecorded mine workings.

3.2.2 Mechanisms of failures

The potential mechanisms of failure (that is an initiating event that could cause an inrush or inundation) should be understood so that appropriate controls can be designed and implemented. Some considerations that may be taken into account when considering potential failure mechanisms:

- sinkholes
- open boreholes
- rising water tables
- subsidence zones
- raisebored holes and shafts
- ore passes
- failure of barrier such as dam wall
- flooding
- high water head
- atmospheric pressure changes
- conduits such as geological formations
- connecting workings (refer to clause below).

Mine operators of underground mines must check for hazards before connecting workings.

WHS (Mines) Regulations

45 Inrush hazards (cl 642 model WHS Regs)

(6) The mine operator of an underground mine, before connecting any underground mine workings at the mine to any other workings (including disused workings), must:

(a) ensure that the other workings are inspected for water, gas and any other circumstance that may be an inrush hazard, and

(b) if it is not possible to safely gain access to the workings to be connected—ensure that exploratory bore-holes or other exploratory methods are used to determine the location of the other workings.

(details of penalty omitted)

3.3 Assessing the risks from inundation and inrush

Inundation and inrush hazards can be affected by factors such as, but not limited to:

- faults and other geological structures affecting barriers or acting as conduits
- active drainage holes acting as conduits
- rainfall
- permeability
- barriers
- seismicity / blasting
- gradient, head, etc.

For hazards from the surface or other inrush and inundation hazards affected by weather, identify the appropriate flood event/rainfall levels. Specialist advice should be sought where structures are present (such as tailings dams) which, if they fail, may pose an off-site threat and may affect communities. This may include advice from the NSW Dam Safety Committee to ensure that the design criteria are suitable for the environment.

3.4 Assessing the magnitude of inundation and inrush hazards (risks)

Once identified, the magnitude of an inundation or inrush hazard should be assessed for the risks. The magnitude of a hazard is determined by the size, nature, energy content and the mechanism by which it might come about. Assessments to establish the magnitude of the hazard should err on the conservative side. The risk assessment should consider the maximum potential if the area is not accessible or there is reasonable uncertainty of the magnitude. Maximum potential means the worst case considering maximum rate, volume, and concentration.

The magnitude of all potential sources and maximum flow rates must be considered by the mine operator for inundation and rush principal mining hazards:

> **WHS (Mines) Regulations**
>
> **Schedule 1 Principal mining hazard management plans—additional matters to be Considered**
>
> **2. Inundation and inrush**
>
> (1) The following matters must be considered in developing the control measures to manage the risks of inundation and inrush:
>
> …
>
> (f) the magnitude of all potential sources and maximum flow rates,
>
> …

The assessment of the magnitude of inundation and inrush hazards should be carried out by a person or people (possibly in a team) who have the appropriate competencies. Consideration should be given to include workers and people with suitable technical expertise and experience.

Each inundation and inrush hazard identified should be risk assessed to identify the:

- nature of the hazard (water, gas and/or materials)
- volume and relative level in relation to the mine operations
- pressure, and
- potential flow rate
- location of persons that may be affected by an inundation or inrush
- path of an inundation or inrush.

3.5 Flowcharts for identifying and assessing inundation and inrush hazards

Appendix D provides three flowcharts that outline processes that may help identify and assess hazards associated with inundation and inrush from the following sources:

- Flow chart 1 – Identifying an inrush hazard from your mine
- Flow chart 2 – Identifying an inrush hazard from an abandoned mine
- Flow chart 3 – Identifying an inrush hazard from another current mine

4 Controlling the risks

Control measures or prevention controls are intended to avoid an inrush or inundation event by reducing its risk level or its likelihood and severity of outcome/consequence.

If there is inadequate information to implement effective controls, then mining operations should not be carried out until sufficient information can be obtained. If the information cannot be obtained, or if the mine operator determines that it is not reasonably practicable to eliminate or minimise the risk, then mining operations are not to take place where the principal mining hazard exists.

4.1 Consideration of control measures

Consideration of controls should include, but not be limited to, reviewing the following issues. These examples of controls will assist in choosing an appropriate control measure for the specific situation.

4.1.1 Elimination

Draining or otherwise removing the inundation or inrush hazard is the most effective way to prevent inrush. This may include:

- removing redundant water storage structures,
- draining areas of the mine that have an inundation and inrush hazard
- ensuring water storage is at the lowest part of the mine so the hazard is eliminated
- keeping old workings ventilated to prevent the build-up of irrespirable atmospheres or flammable gas.

Areas that have been drained should be closely monitored and checked that they are not being recharged, including with gas. This option is strongly recommended. If areas are not drained, the mine operator who decides that it is not practical to drain or otherwise remove an inundation or inrush hazard must document the reasons for forming that opinion, in compliance with WHS (Mines) Regulations clause 24(3)(i). This information must be included in the PMHMP.

4.1.2 Diversions

The development of diversions to direct potential flows away from working areas can mitigate any unexpected flows. The design process for the mine should consider the following as a minimum:

- overflow channels that will take fluid materials to a safe release point
- designing the location of water storage so that any failure will result in the flows moving to areas where people will not be present
- for underground mines, the appropriate design of ventilation around areas of irrespirable atmospheres or flammable gases so that any release of the gases will be diluted to safe levels or carried out through a path that will not have people present
- isolating surface openings, including subsidence cracks and other types of fissures, from potential water inrush or inundation, including a consideration of estimated maximum flood/rainfall events and monitoring procedures during flooding periods
- the design dimensions, and materials and construction methods used.

If a diversion system is implemented, it must be maintained so it remains an effective control for inundation and inrush, as per clause 37 of the WHS Regulations for all controls.

4.1.3 Barriers

Barriers are standard tools used to reduce the risk of inundation and inrush. They are any structure that separates working areas from an inundation or inrush hazard. Barriers can consist of:

- levee banks
- dam structures
- septum between seams (coal) or crown pillar between stopes (metalliferous)
- solid strata or ground between mines
- solid strata or ground between workings and the inundation and inrush hazard
- ventilation seals erected against areas that contain irrespirable atmospheres or flammable gases
- sealing or otherwise isolating potential man-made conduits such as boreholes.

Barrier design should, as a minimum, take into account:

- pressure, quantity and nature of the hazard

- long-term stability of the barrier under worst-case natural and induced stress regimes
- suitability of the construction material
- the rock mass quality
- presence of geological weaknesses likely to affect the barrier
- nature of the roof and floor contacts (coal), sidewalls, backs and floor (metalliferous)
- foundations
- strata/ground permeability
- strata/ground grade or dip.

The barrier should be designed in accordance with the degree of certainty associated with each of the points listed above and also to be able to withstand the worst case scenario consequence for each potential source of inundation and inrush. If a barrier is used, it must be maintained to its design criteria and monitored to ensure this remains intact, as required by clause 37 of the WHS Regulations for all controls. The barrier should not be mined, modified, or lessened in any way without a full assessment of the change and its impact on the potential performance of the barrier.

4.1.4 Inrush control zones (ICZ)

The aim of the ICZ is to heighten awareness and put in place procedures that ensure the designed barrier is not compromised. Specific requirements for ICZs, where inrush is identified as a principal mining hazard at the mine are:

WHS (Mines) Regulations

45 Inrush hazards (cl 642 model WHS Regs)

(1) The mine operator of an underground mine must implement a system for the mine that ensures:

...

(e) if an identified inrush hazard is a principal mining hazard—the identification, establishment and maintenance of an inrush control zone for the inrush hazard in accordance with the WHS laws.

(detail of penalty omitted)

(2) An inrush control zone must be located in the vicinity of the inrush hazard and:

(a) if the exact location of the inrush hazard is known—extend at least 50 metres from the location of the inrush hazard, or

(b) if the exact location of the location of the inrush hazard is not known—extend any greater distance from the suspected location of the inrush hazard determined by a risk assessment conducted under clause 23.

(3) The mine operator must ensure, in relation to each inrush control zone, that control measures and procedures are implemented to control the risk of inrush.

(4) The mine operator must ensure that an inrush control zone is not mined before:

(a) control measures and procedures have been implemented under subclause (3), and

(b) the persons who are to work in the zone have been trained in relation to the implementation of those controls and procedures.

(5) If an identified inrush hazard is not at an accessible place at the mine, it is sufficient to control the risk from inrush by:

(a) providing adequate separation of solid rock between the mine workings and the assessed worst case position of the potential source of inrush, and

(b) complying with the requirements of any applicable principal mining hazard management plan prepared for inrush hazards.

...

Schedule 1 Principal mining hazard management plans—additional matters to be considered

2. Inundation and inrush

...

(2) A principal mining hazard management plan that addresses inundation and inrush of any substance is to include details of any special systems of working developed for inrush control zones established under clause 45 of this Regulation and the assumptions underpinning the development of any such system.

...

The extent of the ICZ (subject to the minimum distance set out in clause 45(2)(a), where applicable), is to be determined by a risk assessment. Such risk assessments and the controls to be implemented in the ICZ may include the following considerations:

- the nature of the hazard (e.g. water, gas etc)
- the magnitude of the hazard (e.g. volume, pressure, purity, concentration – see Key Terms for meaning of magnitude for a hazard)
- the confidence level on the location of the hazard
- the confidence level on the magnitude of the hazard
- the assessed risk of the hazard
- the designed size of the barrier to be maintained between the workings and the hazard
- the ability to inspect the hazard.

Once a decision has been made to implement an ICZ, then the zone should be shown on the mines working plans. Procedures should be put into place to ensure that no mining takes place in an ICZ unless the controls developed specifically for the ICZ are implemented and monitored.

The specific controls put in place in an ICZ may include but are not limited to:

- frequency of survey checks of the area
- maximum mining advance distances
- exploratory drilling program
- monitoring criteria/parameters (e.g. water balance)
- inspection regimes
- emergency response equipment and protocols
- training and communication
- Trigger action response plans (TARPs).

Special systems of work for working in ICZs must be detailed in the PMHMP (refer to Schedule 1 extract above), and mining operations in general should also be documented.

Further guidance for ICZs is contained in Appendix B.

4.2 Specific risk-control measures

4.2.1 Raiseboring

The risk presented by an accumulation of water above raisebore cuttings or material that has slumped from the sides of a raise bore shaft should be prevented by draining water and maintaining the base of the raise bore shaft to be clear of material such that liquid cannot accumulate and present a potential risk to workers. This may be achieved by:

- implementing procedures that ensure that the base of the raise is regularly monitored and kept clear of material from reaching the brow of the raisebore hole
- drilling drain holes into the lower sections of the raise bore shafts, so that if the cuttings build up to above the brow or mud or materials fall from the sides of the raise bore shaft, then water can still drain away, and
- implementing tele-remote bogging capability.

4.2.2 Drainage systems

Where appropriate, the design of effective drainage systems should take into account, as a minimum, the following factors:

- volume to be drained
- time for drainage with respect to mining scheduling and meeting environmental standards
- in case of draining water, the potential hazard arising from the release of dissolved gases particularly carbon dioxide (CO_2), and the dropping of atmospheric oxygen concentrations to unsafe levels
- the risk of residual water or other fluid after the drainage
- the need for an adequate standpipe design for underground de-watering, and
- the need for adequate and appropriately placed sump or water storage or underground de-watering and gas monitoring.

4.2.3 Scheme of protective drilling

The drilling scheme should be designed to achieve the desired outcome. On some occasions, this will be to intercept the expected area containing the inundation or inrush hazard to confirm location and possibly for drainage purposes. On other occasions, it may be used to confirm the minimum barrier size by ensuring that workings in the same horizon are far enough away from the current workings by drilling probe holes, flanking holes (coal) and cover holes (metalliferous) out to the distance of the minimum barrier size.

Current practice utilises:

- for underground coal mines; survey controlled in-seam or targeted drilling of long holes or advance drilling of development headings (often 1km or longer)
- for underground metalliferous mines; from the working place through the ore body and into surrounding host rock.

The holes are generally drilled through standpipes set in off-face drives. These holes can be used to identify suspected workings by direct holing out or proving the ground to be free of unrecorded workings.

Note: Due to the risks to workers near the face, it is no longer considered acceptable practice to use small diameter, limited length boreholes drilled directly from the working face by hand-held drills when approaching potential inrush and inundation sources that may be pressurised or may have uncontrolled flows through such a hole.

The protective drilling strategy should:

- take into account the actual or possible pressure, volume, toxicity or explosive potential of the fluid material being drilled towards
- take into account the drilling method and quality of ground/strata being drilled
- include protection against the uncontrolled release of water or gas and employ methods to permanently fill and seal drill holes if the need arises, and
- provide appropriate training for persons involved in giving effect to the scheme.

The scheme may also have the engineering controls reviewed and certified by qualified engineering personnel.

4.2.4 Hydraulic and paste fill operations

Summary of significant issues that should be considered as a minimum to prevent an inrush or inundation from underground filling operations:

- Once hydraulic fill is deposited in a stope its excess water, which was used for transporting the hydraulic fill underground, should be drained as soon as possible to prevent potentially dangerous saturated zones from developing within the fill mass or even more dangerous ponding on top of fill in underground stopes. Otherwise it could be a source of hydraulic pressure that could rupture fill barricades. It could also act as both a fluidising medium and a source of energy for an inrush or inundation if a barricade fails for any reason. If the deposited fill in a stope is well drained but then its containment fails, it is unlikely to create a fill inrush or inundation as insufficient water will be available to mobilise the exposed fill.
- Control of the fines and clay content in underground hydraulic fill is critical. It can reduce permeability and/or reduce the effectiveness of the binder that is used with the cement preventing it "setting" or it could reduce the strength of the fill. Therefore, high clay content in underground fill may be a contributing factor to an inrush or inundation occurring.
- Undrained, uncemented hydraulic fill will mobilise and create an inrush or inundation if there is a barricade failure. Cemented hydraulic fill has less mobility after 24 hours of emplacement and therefore has less potential for a serious inrush or inundation to occur. However, cemented fill has less permeability and does not drain as readily. Both types have intrinsic weaknesses and effective management procedures should be in place to address the critical issues raised by these weaknesses.
- Fill placement plans should consider:
    - placement rates
    - water content
    - placement schedule
    - quality control system to ensure placement as designed and
    - stope and barricade dimensions and geometry.
- An inrush or inundation could also be caused by a stope pillar failure between draw points or even a rock fall adjacent to the fill wall within a stope. As a result, geotechnical support should ensure their design is adequate to maintain the integrity of the ground and ground support.
- A fill barricade failure could result in a serious inrush or inundation. To prevent these failures, barricades should be sufficiently permeable to ensure the pore water pressure within the stope remains below design tolerances.
- Other retaining structures, such as bulkheads, are designed to not promote free drainage. Therefore, these should be designed to withstand the maximum hydrostatic head when the stope is full of saturated fill.
- Barricades should be designed to engineering standards so they are able to withstand the forces from the fill emplacement.
- Barricade designs should consider:
    - construction material, thickness, bonding to walls and back and floor, permeability and curing time,
    - competence of the ground
    - maximum applicable hydraulic (water) pressure, including due to the possibility of the presence of 'worm holes' that can result in excessive localised pressure (refer to appendix A for details of the Bronzewing Mine Incident)
    - size and position of barricade, ie. height, width and set back from brow of stope,

- number of barricades, location, and
- a barricade design that is not considered independently of the overall system. For example:
    - fill placement rates, water content and permeability should not exceed barricade design specifications,
    - estimation of stresses on the barricade walls should consider all sources of load and to include the pore water pressures within the fill mass during filling.
- The conditions on which the barricade design is based are fully specified and communicated to operating personnel. It is also important that the fill system should be constructed and operated within specification and any variations are properly evaluated and risk assessed.
- Fill design and associated management systems are reviewed and/or designed by engineers experienced in underground fill applications.

Investigation of barricade failures in Australian mines rarely brings new causes to light. In general, the causes are well known and often result from a failure to operate a system within its design specifications. These are often risk-management failures caused by:

- a failure to have a robust system to ensure the filling process is reliable
- use of designs that were developed for different mines and/or conditions
- a failure to appreciate the risks from poor filling practices
- insufficient management attention to the process.

Therefore, it is suggested that the mine operator should consider the following staged risk-management process:

- risk analysis and assessment
- design
- construction
- operation
- monitoring
- review.

4.2.5 Mining under the sea and other large water bodies

Mining under the sea and other large water bodies - including lakes, waters impounded by dams, estuaries and large rivers - represents a special risk since:

- the potential inundation/inrush source is, for all practical terms, inexhaustible, and
- in the event that connection between the mine and the sea or water body is made, the control of the inflow of water into the workings is likely to prove impossible and the entire mine could be permanently lost.

The critical issue to be addressed in mining beneath water bodies is to establish the minimum barrier (usually expressed as the thickness of solid strata/ground that should exist between the seam roof and the floor of the water body to ensure no connection can develop).

The minimum barrier necessary to prevent connection between the mine and the water body will vary from mine to mine and should be determined in every instance. The following factors should be assessed as a minimum:

- mining method, production rate/scheduling, and extraction ratio
- geological anomalies
- permeability
- mining height
- roof lithology
- hydraulic head, and

- magnitude of the inundation and inrush hazard

Mining method

Any underground excavation may influence the permeability of strata/ground overlying that excavation. In general, the wider the excavation the greater the height of deformation or softening that will occur in the roof rock. Deformation (which results from the overlying ground/strata's tendency to deflect or sag into the excavation), will increase the roof's permeability.

In development workings, if roadways are adequately supported, the height of deformation may be measured in metres. However, should a fall occur, particularly at an intersection, then the height of deformation is substantially increased.

In secondary extraction or stoping, for instance where goaf or back caving may or will occur, the height of roof deformation is extended even further. In this instance, it is important to note that the height of deformation extends well beyond caving height. For this reason, considerably greater solid strata should be required above second workings, when compared to first workings.

Additionally in secondary extraction or stoping, the impact of surface and sub-surface subsidence should be considered. Extensive cracking in surface and near surface rocks can be associated with mining induced subsidence. The minimum barrier should be designed to ensure that areas of surface/near surface cracking and the zone of deformation above the seam roof never intersect.

To achieve this result in practice, an appropriate safety margin should be included within the designed minimum barrier. Generally a substantial zone of impermeable material should exist between the workings and the water body floor.

Geological anomalies

Any assessment of the height of deformation above the workings and the depth of cracking below the rock head can be adversely affected by geological anomalies.

Features can link the zone of deformation above the goaf or stope and zone of surface cracking, thus negating the zone of impermeable strata/ground created by the design process. For example, faults, dykes, shear zones and igneous plugs. If this link occurs, water from the sea or other surface water body may enter the mine.

A diligent search for geological features capable of linking the base of the water body and the workings should be carried out and, if found, a conservative estimate of their influence should be made. Where such geological features exist, mining design within the zone of influence of the anomaly may have to be revisited or possibly abandoned.

Mining height

In secondary extraction or stoping, the height of extraction will influence both the height of deformation above the workings and the level of surface subsidence. In general, the greater the extracted height, the greater the level of surface subsidence and height of roof deformation. Minimum solid strata/ground or level thickness should be adjusted accordingly. It should be noted that both pillar strength and stiffness (for a given pillar area) will decrease as the height of the pillar increases. Thick seam pillars are more likely to compress than those in thinner seams. This greater level of compression may adversely influence strata/ground deformation and permeability above thick pillars.

Roof rock type

Typically, laminated strata/ground is more likely to extend the height of deformation than is more massive ground. "Chimney" type falls are generally associated with laminated strata/ground, and instances of such falls extending at least 40 metres above the workings have been documented.

Notes of caution

Once a minimum barrier has been selected, the exact reduced levels of the barrier between the water body and the workings should be determined to ensure that the minimum design thickness of the barrier does exist. The order of accuracy of any method used to determine the reduced levels should be established and applied conservatively to the value of barrier measured.

The erosive capacity of water driven by a permanent and substantial pressure head is strong and constant. The capacity of water to scour joints, cracks, etc., has been long established in dam engineering. Any contemplation that a minor inflow of water directly from the sea or other like water body is acceptable should be dismissed immediately and action taken to secure the area affected or abandon and seal it safely.

Overseas standards (for example the United Kingdom Code of Practice regarding inrush/inundation and mining under the sea – see References), are based upon the nature of strata and ground conditions in those countries and may not be appropriate for conditions in Australia. However, these codes may be a good starting point to investigate the potential risks and controls, as they have been developed in areas where working under major water bodies is common.

4.2.6 Inrush hazard is not in an accessible place at the mine

There may be situations where an inrush hazard is not in an accessible place at the mine, such as adjacent abandoned mines. In these situations, specific risk controls may apply:

WHS (Mines) Regulation

45 Inrush hazards (cl 642 model WHS Regs)

…

(5) If an identified inrush hazard is not at an accessible place at the mine, it is sufficient to control the risk from inrush by:

(a) providing adequate separation of solid rock between the mine workings and the assessed worst case position of the potential source of inrush, and

(b) complying with the requirements of any applicable principal mining hazard management plan prepared for inrush hazards.

...

In these situations, it is sufficient to determine the position of the inrush hazard and the barrier requirement using an appropriate factor of safety, so all work does not fall within an area of risk of inrush. The barrier should be equal to or larger than any inrush control zone that would be established for the hazard under clause 45 above.

5 Response and mitigation

First response controls are intended to reduce the consequences of an inundation or inrush event by controlling the event in its early stages when the immediate impact is minor. This section provides advice in this area of the inundation and inrush hazard management prior to the situation falling under the mines emergency management plan.

5.1 Early stage indications

Indications of an early stage of inundation or inrush might include the following:

- obvious changes in water in the mine workings or at fill barricades in metal mines
- unusual strata/ground behaviour
- changes in ground water flow
- change in water quality, i.e. colour, suspended solids, chemical analysis
- release of irrespirable atmospheres or flammable gases into the mine ventilation circuit
- loss of, or damage to, inrush or inundation barriers or leaking fill barricades and ground conditions around those barricades, and
- significant unexpected decrease in surface or other water.

Note: changes in stress levels during the mining process can alter the water flows when mining adjacent to stored water bodies capable of causing an inrush. These changes could be subtle and could even result in cessation of the water flowing if stress levels become high, such as will occur just before holing from one roadway into another. Monitoring should consider this circumstance and trigger levels should be carefully set.

5.2 Trigger levels

First response controls can be 'trigger' levels built into the monitoring and inspection systems as outlined in section 5.1. The following are examples of that style of monitoring system:

- pre-set alarm levels for volume/concentration monitors
- pre-set flow rate triggers for evacuation of the area until the event has been investigated and the area deemed safe
- pre-determined conditions or sets of conditions, including barrier problems, for physical inspection and monitoring that require immediate evacuation of the area
- fail-safe engineered systems of monitoring should be considered where the consequences could be considered extreme, involving loss of life (Fail-safe systems will indicate that they have failed, such as a typical 4 to 20mA transducer which gives a lower than zero result when the monitor fails.)

5.3 Response

For every trigger there should be a well-documented and rehearsed action plan. These should have defined minimum response times and some may involve immediate evacuation and/or implementation of the emergency plan. All relevant people should understand the responses for every trigger so that response times are minimised.

It is important to clearly define the circumstances in which persons should be removed from an area that might be affected by inrush or inundation.

A conservative approach is best, especially if the nature and the magnitude of the hazard is not clear or readily discernible.

An example of responses to potential inrush or inundation warnings may include:

- implementation of the emergency plan
- discontinue production or extension of workings in the affected area until such time as the hazard has been precisely determined and eliminated or otherwise controlled
- inform personnel and prepare to apply the emergency plan
- consider the locations of personnel and the possible inrush or inundation event; if necessary move personnel to a safe location
- assess the nature of the inrush or inundation warning symptoms, position(s) and direction(s) of any inflow(s), for example, seepage through the coal seam or strata/ground above or below the working section; water/gas issuing from conduits, for example, boreholes, fissures, and faults
- seal, as far as practicable, potential conduits; for example, boreholes, joint sets and shear zones, in the affected zone
- notify the regulator, industry and mine safety and health representatives, health and safety representative, site mine rescue team and/or the mines rescue station (where available) if the situation warrants this notification or according to agreed arrangements

Consider further activities to address the situation, for example:

- acquire additional expertise to assist with determination and control of the situation
- determine flow rates of water / gas influx and undertaking chemical analysis where indicated
- determine or otherwise estimating the worst case scenario regarding source, location, pressure and physical magnitude of the hazard

- check mine plans against the known, suspected or potential hazard
- determine practicality of draining the hazard or otherwise rendering it harmless
- prepare, where appropriate drainage infrastructure to help control the hazard, for instance sumps, pumps, drainage paths
- determine the location for and preparation of (where appropriate) foundations for bulkheads and dam walls for further control.

5.4 Emergency plan information

Every mine with a potential inundation or inrush hazard should include in their emergency plan information covering the changing circumstances that could follow an inundation or inrush.

The plan must address all aspects of emergency response that are relevant to the inundation and/or inrush hazards. The following factors, among others, may be considered:

- communication requirements
- assembly points underground
- exit routes
- refuge locations should exits be blocked
- use of transport considering inrush and inundation conditions
- special equipment to assist in exit or rescue etc.

All plans and procedures for managing the risks of inundation and inrush, including a PMHMP, must form part of a comprehensive and integrated safety management system for the mine. This means that any such arrangements for managing inundation and inrush risks must be consistent with the Emergency Plan. See the NSW *Code of Practice: Emergency Planning for Mines.*

6 Monitoring

Monitoring of the inundation and inrush hazard is important to determine if there are any changes such as increased pressure, refilling of previously drained areas or changes to the atmosphere that may render it harmful.

Monitoring is intended to avoid an inundation or inrush event by identifying any indication of potential problems, including changes to the hazard, hazard-related conditions or the effectiveness of controls.

There are different ways of monitoring principal hazards including:

- monitoring the status of the hazard (pressure, quantity, etc)
- monitoring the mechanisms by which the unwanted event may occur (failure of seals or dams etc)
- monitoring status of key controls (inspections, pressure gauges etc).

Examples of monitoring for the various types of inrush and inundation hazards, whether underground, surface or non-mining man-made hazards, include:

- monitoring (if accessible) the volume of fluid material for unexpected changes
- monitoring the volume, on both an absolute and relative basis, and quality of air or water entering the mine in relevant areas
- checking for unrecorded or incorrectly recorded inrush or inundation sources with a scheme of protective drilling
- inspections for relevant underground conditions that may indicate possible proximity to an inrush or inundation hazard or a potential inrush or inundation event. This will include reporting and analysis of the information

- monitoring status and condition of barriers and other key controls to ensure that their integrity is not compromised and they remain effective
- Chemical and bacterial fingerprinting of water for comparison purposes, which may help to monitor risk status, as well as identify the nature of a problem.

6.1 Trigger action response plan (TARP)

A TARP may be effective approach to use for monitoring. It is widely used in the Australian mining industry. This risk management plan summarises the overall monitoring arrangements but also adds the actions to be taken when certain triggers are reached. If used, it should be developed after deciding on the control measures and monitoring requirements, including indicators relevant to the hazards.

The important factors to be considered in TARP development are:

- simplicity – easily understood triggers designed for the workers who are expected to identify them
- clear linkage – the actions required to be taken are linked to, and appropriate to, the trigger that initiates the action
- clear accountability – the actions are assigned to a position that has the authority to take the appropriate actions and that is available in an appropriate timeframe to take that action
- communication – there is a clear line of communication between relevant mining workers (such as operators, engineers etc) and also between shifts
- monitoring frequency – risks may change during the mining cycle and this should be reflected in monitoring frequencies and triggers for each phase of the cycle
- escalation – there are escalating actions linked to deteriorating conditions (generally including ceasing mining and evacuation at the higher trigger levels)
- focus on significant items – most hazards are influenced by a number of variables and TARPs may try to cover too many parameters, leading to confusion. The TARP should focus on the most significant items, rather than trying to cover all eventualities.

The overall advantage of developing a TARP is that it provides a summary of the considered and planned early responses if monitoring has indicated that a deteriorating trend exists that has heightened the risk of an inundation or inrush occurring or that the planned controls are not in place or operable. As part of this, TARPs prevent 'normalisation', which is the effect of accepting a slow deterioration of any indicator as normal because it is not much different from day to day. This can delay the decision making process until the hazard is out of control.

For Trigger Action Response Plans (TARP) to be effective all relevant people should be required to demonstrate they understand the triggers, actions and responses in order for effective monitoring (& evacuation if required) to occur.

Example TARPs are contained in Appendix C. Please see 'How to use this code of practice' in Scope and Application regarding the relevance of these examples. For the purpose of anonymity, one TARP's details have been omitted.

7 Audit and review

7.1 Audit

The mine operator must carry out audits of the inundation and inrush management plan, as part of the safety management system, under the WHS (Mines) Regulations:

WHS (Mines) Regulations

15 Performance standards and audit (cl 623 model WHS Regs)

The safety management system for a mine must include the following:

(a) performance standards for measuring the effectiveness of all aspects of the safety management system that:

(i) are sufficiently detailed to show how the mine operator will ensure the effectiveness of the safety management system, and

(ii) include steps to be taken to continually improve the safety management system,

(b) the way in which the performance standards are to be met,

(c) a system for auditing the effectiveness of the safety management system for the mine against the performance standards, including the methods, frequency and results of the audit process.

The primary purpose of the audit is to determine whether the controls for inrush and inundation hazard management are in place and measure their effectiveness, as required in clause 15(c) above. Aspects of the PMHMP that may be audited include:

- mine workers understand their responsibilities and carry them out
- training and testing has been carried out e.g. in accordance with the PMHMP
- plant required is fit for purpose, available and maintained, including an monitoring equipment
- inspections specified have been carried out
- appropriate response to any triggers which have occurred
- any required reports have been completed.

The audit will provide information regarding how well the plan is being maintained.

The mine operator should develop an audit plan for inclusion in the safety management system. The audit plan should include, in addition to the matters that must be addressed in the SMS under clause 15, the following:

- scope of the audit
- competency of the auditor
- those responsible to ensure the audit is conducted
- reporting protocol for the audit and
- those responsible for acting on the audit reports.

One performance standard that should be included in the audit plan is for the audit to find 100% compliance with legislation.

7.2 Review

The mine operator must review the inundation and inrush hazard management plan in accordance with the WHS (Mines) Regulations:

WHS (Mines) Regulations

...

25 Review (cl 629 model WHS Regs)

(1) The mine operator of a mine must ensure that a principal mining hazard management plan is reviewed and as necessary revised if a risk control measure specified in the plan is revised under clause 38 of the WHS Regulations or clause 10 of this Regulation.

Note: A principal mining hazard management plan is part of the safety management system for a mine (see clause 14 (1) (c) (i)), which must be audited under clause 15, maintained under clause 16 and reviewed and as necessary revised under clause 17.

(2) If a principal mining hazard management plan is revised, the mine operator must record the

> revisions, including any revision of a risk assessment, in writing in the plan.
>
> ...

The purpose of the review is to identify if the inundation and inrush plan is effective in managing the inundation and inrush hazards and how it may be improved.

The PMHMP for mine shafts and winding systems must also be reviewed as part of the Safety Management System for the mine:

> **NSW WHS (Mines) Regulations**
>
> **17 Review (cl 625 model WHS Regs)**
>
> (1) The mine operator of a mine must ensure that the safety management system for the mine is reviewed within 12 months of the commencement of mining operations at the mine and at least once every 3 years after that to ensure it remains effective.
>
> (details of penalty omitted)
>
> (2) In addition, if a control measure is revised under clause 38 of the WHS Regulations or clause 10 of this Regulation, the mine operator must ensure that the safety management system for the mine is reviewed and as necessary revised in relation to all aspects of risk control addressed by the revised control measure.
>
> (details of penalty omitted)

In the first part of the review, the process should examine the underpinning risk assessment to see that it is still appropriate to the hazards at the mine.

In undertaking the review, workers and their health and safety representatives at the mine must be consulted and the following questions should be considered:

- Is the risk of inundation and inrush adequately managed?
- Are the control measures working effectively in both their design and operation?
- Are the relevant workers aware of the control measures and do they understand them?
- How effective is the risk assessment process? Are all hazards being identified?
- Have new work methods or new equipment been introduced to make the job safer? What is their impact on existing hazards, risks and control measures? Are safety procedures being followed?
- Has instruction and training provided to workers been successful?
- If new legislation or new information becomes available, does it warrant a review of current controls?
- What has been the industry experience with inundation and inrush since the last review?
- Have any incidents occurred for inundation or inrush at mines and what are the outcomes/trends identified from them?
- What is the current industry best practice for the management of inundation and inrush hazards and whether any activities have been benchmarked against them?
- Have there been technological advances made that may be of assistance in managing the risks of inundation and inrush?
- Have there been any industry publications or technical reports published that may assist in the management of the hazards of inundation and inrush?.

If problems are found, the mine operator should revisit relevant points in the risk management process, review the information and make further decisions about risk control.

8 Inundation and inrush hazard management plan contents

The WHS (Mines) Regulations require the mine operator to prepare a principal mining hazard management plan, as set out below in the greyed part of the table below. In the right hand unshaded column of the table, guidance is provided on what details may be written in order to fulfil the legislated requirements:

24 Preparation of principal mining hazard management plan (cl 628 model WHS Regs)	**Guidance on what may be included in the plan details to satisfy the legislation**
(1) The mine operator of a mine must prepare a principal mining hazard management plan for each principal mining hazard associated with mining operations at the mine in accordance with this clause and Schedule 1. (details of penalty omitted)	The mine operator must prepare a plan for each principal mining hazard. The level of detail in the plan will depend on the nature, complexity, location and risks of the mining operations (refer to clause 14(2) for the mine safety management system content, of which the principal mining hazard management plan is an element). The contents of schedule 1 (Principal mining hazard management plans - additional matters to be considered) for part 2 Inundation and Inrush are set out in Ch 3.
(2) A principal mining hazard management plan must:	
(a) provide for the management of all aspects of risk control in relation to the principal mining hazard, and	A summary of how the controls identified in the risk assessment will be managed to control the principal mining hazard. This may include the management functions of planning, doing, acting and checking. The activities involved may include at least consulting with workers, organising resources, audits and reviews.
(b) so far as is reasonably practicable, be set out and expressed in a way that is readily understandable by persons who use it.	The plan may be read and used in part or in full by persons, so each part of it should be complete and appropriate for the potential needs. The use of headings, diagrams and common words may assist understanding.
(3) A principal mining hazard management plan must: (a) describe the nature of the principal mining hazard to which the plan relates, and	This is a description of the principal mining hazard and how it may occur at the mine. For example, an inrush hazard may be gas, liquid or combination of them.
(b) describe how the principal mining hazard relates to other hazards associated with mining operations at the mine, and	How the principal mining hazard impacts on other hazards and the nature of their relationship should be described so that this understanding is used as an ongoing consideration in managing their interactions e.g. if roof support for strata/ground control fails this may cause an inundation of gas.
(c) describe the analysis methods used in identifying the principal mining	State the hazard identification technique(s) that will be used (if it is a general one,

	hazard to which the plan relates, and	nominate this and/or its source), who will be involved (e.g. workers) and resources to be used eg. Codes, technical publications, and the specific mine data used to identify the potential hazards from inundation and inrush
(d)	include a record of the risk assessment conducted in relation to the principal mining hazard, and	Records of the risk assessment must be included in the PMHMP. The record may be placed in one or more documents that make up the PMHMP , which may cross reference documents within the plan
(e)	describe the investigation and analysis methods used in determining the control measures to be implemented, and	State the risk management technique(s) that will be used (if it is a general one, nominate this and/or its source) to develop the control measures
(f)	describe all control measures to be implemented to manage risks to health and safety associated with the principal mining hazard, and ,	List the control measures so the reader gains an overall understanding of what is to be implemented, but specific details and implementation may be referenced to separate documents, such as procedures. The mine operator may consider providing summary details for risk assessment of the individual and cumulative effects of inundation and inrush hazards. The details may also include assessment of the interaction with other related hazards at the mine under clause 23(3).
(g)	describe the arrangements in place for providing the information, training and instruction required by clause 39 of the WHS Regulations in relation to the principal mining hazard, and	Clause 39 is titled ‘Provision of information, training and instruction’ and requires a PCBU to ensure it is suitable and adequate, depending on the nature and risks of the work, and control measures to be implemented. The plan should address how the mine operator will communicate and deliver the arrangements to the workers exposed to the principal mining hazard. For example, maintaining a training schedule and register.
(h)	refer to any design principles, engineering standards and technical standards relied on for control measures for the principal mining hazard, and	These may be identified in the risk assessment. They should be listed and how/where they can be accessed
(i)	set out the reasons for adopting or rejecting each control measure considered.	These may be stated in a summary in the plan and the risk assessment records referenced

References

Documents that do not form part of the code

Below is a list of some published documents that may be useful to refer to in the management of inundation and inrush hazards in mines. These documents, whether or not referred to in the text of this code, do **not** form part of this code.

Please note the list below is not an exhaustive list of references that may be relevant to inundation and inrush hazard management, and compliance with any one or more of the following documents does not guarantee compliance with WHS laws.

The documents are useful information that persons may refer to so as to possibly support their compliance with WHS laws in relation to inundation and inrush management at mines.

Books

Galvin, J.M. (2008). Geotechnical Engineering in Underground Coal Mining: Principles, Practices and Risk Management. Manual, Workshop 1: Fundamental Principles and Pillar Systems, ACARP Project No. C14014

Potvin Y (ed) *Handbook on Mine Fill* Australian Centre for Geomechanics, Perth 2005.

Electronic documents (all viewed 17 December 2014)

'Archival Research: Investigations to be completed when researching or planning to mine in and around Old Workings - A Guide', compiled by Karen Inglis, I & I NSW – Minerals, and Kevin Price, Brunskill Pty Ltd, 15th October 2010
www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0004/372289/Archival-Research-Guidelines.pdf

Mine Inundation Case Histories, by V.S.Vutukuri and R.N.Singh, Mine Water and the Environment, Vol 14, Annual Issue, Paper 9, 1995, PP 107-130

www.imwa.de/bibliographie/14_14_107-130.pdf

NSW Dam Safety Committee Guidance Sheet – Tailings Dams – June 2012

www.damsafety.nsw.gov.au/DSC/Download/Info_Sheets_PDF/Dam/DSC3F.pdf

NSW Dam Safety Committee Guidance Sheet – General Dam Safety Considerations– June 2010

www.damsafety.nsw.gov.au/DSC/Download/Info_Sheets_PDF/Dam/DSC3G.pdf

NSW Dam Safety Committee Guidance Sheet – Acceptable Flood Capacity for Dams – June 2010

www.damsafety.nsw.gov.au/DSC/Download/Info_Sheets_PDF/Dam/DSC3B.pdf

NSW Mining Design Guideline, MDG 1024 – Guideline for Inrush Hazard Management, April 2007, NSW Trade & Investment

www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0007/419524/MDG-1024.pdf

NSW Mining Design Guideline, MDG 1031 - Guideline for Managing the Risk of an Air blast MDG 1031, NSW Trade & Investment

www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0012/420132/MDG-1031.pdf

NSW Guideline, MDG 3008 - Guideline for managing the risk of inrush with hydraulic fill systems. August 2011.

www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0015/420270/MDG-3008.pdf

NSW Safety Alert – Water Inrush from Raisebore Hole, SA11-01, January 2011

www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0007/372319/SA11-01-Water-inrush-from-raisebore-hole.pdf

Preventing inrushes at underground mines, Health and Safety Executive, Bulletin HD 4-2011, 23 September 2011

www.hse.gov.uk/safetybulletins/minesinrush.htm

The Prevention of Inrushes in mines Approved Code of Practice, Health and Safety Executive, 1993

www.hse.gov.uk/pubns/priced/l46.pdf

Fatal inundation and inrush incidents (see appendix A below)

Bronzewing

Safety Bulletin No. 55, Potential hazards associated with mine fill, WA Department of Mines and Petroleum (Department of Minerals and Energy), 29 June 2000

www.dmp.wa.gov.au/documents/Bulletins/MS_GMP_SB_55potentialhazards.pdf

Minesafe Vol. 2 No.2 (page 4), WA Department of Mines and Petroleum (Department of Minerals and Energy), June 2000

www.dmp.wa.gov.au/documents/Magazine/009_MineSafe.pdf

Annual Report 2001/2002 (pp 21-23), Office of the State Coroner Western Australia,

www.parliament.wa.gov.au/publications/tabledpapers.nsf/displaypaper/3620450a56a552a06a360d3c48256c6800274297/$file/coroner2002.pdf

Emu

Emu Mine Disaster, Department of Mines Western Australia, Significant Incident Report No.11, 10 April 1990

www.dmp.wa.gov.au/documents/Significant_Incident_Reports/MS_GMP_SIR_011emumine.pdf

Gretley

Report of a formal investigation under Section 98 of the Coal Mines Regulation Act 1982 by his Honour Acting Judge J.H. Staunton (Summary of findings), NSW Trade & Investment (Department of Mineral Resources)

www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0004/87160/Gretley-Inquiry-summary.pdf

Lessons from Gretley - Mapping for Today and Tomorrow, Rex Hutchison, 8 March 2011

www.minesurveyors.com.au/files/Lessons-from-Gretley-Mapping-for-today-and-tomorrow.pdf

APPENDIX A - Fatal inundation and inrush incidents

YEAR	MINE	FATALITIES	CAUSE
1918	Eclipse	1	Water from old workings
1966	Mount Isa	1	Rush of mud swept down ore pass when a pillar between two filled stopes was being extracted
1982	Pasminco Roseberry	1	Inrush from ore pass
1986	Mount Isa	1	Rush of saturated fill
1989	Emu Mine	6	Water flooded decline from creek
1989	Mount Isa	1	Rush of fill while operating LHD
1991	Mount Charlotte	1	Discharge of rocks and water from an ore pass
1996	Gretley	4	Holed flooded old workings
2000	Bronzewing	3	Fill barricade ruptured

Source: NSW Trade & Investment Mining Fatality Review Database www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health/publications/statistical-publications/international-mining-fatality-review

For further information on the Gretley, Emu and Bronzewing incidents, please refer to References above.

APPENDIX B - Additional information when working within the ICZ

Plans

Consideration should be given to maintaining the following plans when working in an ICZ:

- the proposed workings layout plan, paying particular attention to the location of barriers to be left against inrush hazards
- depth of cover contour plan
- solid rock depth of cover contour plan (if relevant)
- working thickness contour plan
- working grade contour plan
- detailed geological structure plan, particularly in strata/ground to be left as a barrier
- plan of relevant borehole logs of the strata/ground above the workings to the surface, below the workings and the workings itself. Precise detail for the workings, strata or ground above and below will need to be provided. The distance to be covered will be dependent on the nature and magnitude of the risk. This should include the written log for these latter areas. Particular attention should be paid to rock that may degrade and/or change nature under the influence of moisture, pressure and flow. Consideration should be given to providing relevant cross sections for the area, linking several bore logs on the one plan
- plan showing surface features (if relevant, for example shorelines, the extent of surface impoundments or reservoirs etc)
- plan showing other workings, including those in the same and adjacent horizons.

The proposed workings plan should be capable of being overlain on the other plans.

Data

The following data is recommended to be maintained, while working in the ICZ, and readily available for persons/workers.

- barrier dimension in metres (this measurement should be the minimum barrier dimension)
- barrier mining height in metres (dimensions here should be from either side of the barrier if they are not the same)
- the maximum credible pressure head that acts, or could act, upon the barrier
- a conservative estimation of the volume of fluid material held within the impoundment that could enter the mine should the barrier fail in any way.
- a discussion of the nature of mine strata or rock forming the barrier, for example, cindered, heavily sheared or structure affected
- magnitude of the hazard (includes the size, nature, energy content and description of the mechanism by which it might occur

APPENDIX C – Examples of trigger action response plans

Trigger Action Response Plan for mud rush or water inrush situations (from NSW Trade & Investment MDG 1031 Guideline for Managing the Risk of an Air blast (NSW))

Please see 'How to use this code of practice' in Scope and Application regarding the relevance of these examples.

SAMPLE TARP A

INRUSH HAZARD MONITORING & TRIGGER LEVELS AT A METALLIFEROUS MINE USING A CAVING METHOD						
HAZARD	**FORM OF REVIEW**	**REVIEW PERIOD**	**TRIGGER LEVELS**	**PLANNED RESPONSE**	**AGREED TRIGGER REPORTING TO THE REGULATOR***	**COMMENT (can be for corporate memory)**
Mud rush risk	(1) Shift supervisor inspections of draw points	Daily	Visual observation of suspected "damp" Draw points".	Inform line management of any concern and raise Hazard Report.	Nil	
	(2) Take sample from LHD bucket/s away from 'damp' draw point for fines and test for moisture content.	When hazard report is submitted.	Fine Damp or Fine Wet material present at draw point(s).	Remote loading procedures apply on fine damp and fine wet draw points.	Notify Regulator if remote loading commences	Fine Damp or Fine Wet Based on latest test work, defined in mud rush study as: Fine >30% (-50mm). Dry < 10%MC. Damp 10%-15%MC Wet> 15%MC. MC = Moisture Content
	(3) Draw point observations for fines & moisture content by Technical Services Group. Moisture content sampling of wettest draw points.	Fortnightly	Fine Damp or Fine Wet material present at draw point(s).	Remote loading procedures apply on fine damp and fine wet draw points.	Continue to notify Regulator of results	

INRUSH HAZARD MONITORING & TRIGGER LEVELS AT A METALLIFEROUS MINE USING A CAVING METHOD						
HAZARD	**FORM OF REVIEW**	**REVIEW PERIOD**	**TRIGGER LEVELS**	**PLANNED RESPONSE**	**AGREED TRIGGER REPORTING TO THE REGULATOR***	**COMMENT (can be for corporate memory)**
Water inrush risk	Monitor rainfall such that rainfall events producing more than 100mm over eight days can be identified.	Monthly	Rainfall event generating greater than 4.3 ML per day percolated into the cave catchment. i.e. >50 l/s.	Inform Production Superintendent to monitor pump usage on a shift by shift basis.		50 litres per second is two-thirds of pumping capacity.
	Shift by shift monitoring of pump usage.	Continual – shift by shift.	If levels are forecast to exceed 2/3 of mine pump capacity at 50l/s.	Pump out the water using existing main pumps. Continuous monitoring of pump usage.	Notify Regulator if continues to be over 50 litres per second for two shifts.	Wetting of the cave dirt expected to take some weeks / months. Only 9 events in 100yrs over 2ML per day in catchment. Probability of exceeding 50l/s is 1 in 1000 if the maximum rainfall event was to occur. Even the maximum events recorded of 5.53ML and 14.1ML can be pumped from 2 to 4 days respectively.
	Continuous monitoring of pump usage.	Continual	Pumping capacity exceeded (>75 l/s).	Extra take up water storage can be placed in lower level and lower decline. Commission separate pump system as back up.	Continue to notify Regulator of results	
	Continuous monitoring of pump usage.	Continual	Pumping and storage capacity exceeded.	Evacuate Mine.	Continue to notify Regulator of results	This will allow organised steady evacuation of the mine – unlikely to result in sudden engulfment.

* In this TARP the requirement to notify the regulator are based on the mine operator's processes, rather than a legislated requirement.

SAMPLE TARP B (Metalliferous mine)

Trigger or Key Decision Point	Has breach occurred?	Accountability	Action required	Current Status
1 Cave Management				
Broken material including ore above uppermost active production level (average value rounded down to nearest 5m)	>250m→No	Mining Manager		
Cave profile changes significantly with step-out of production levels	Yes	Mining Manager	Cave expansion monitoring. Surface subsidence cracks are progressing to the East – monitor. Investigate geophysical techniques for scanning e.g. cave profile.	Monitoring instrumentation closest to expansion show movement. Draw control in place. Expansion zones isolated with mullock bunds, design standards updated to include expansion management.
2 Cave Management (water)				
Excessive rainfall event: 100mm over 24hrs.	No	Mining Manager	Monitor perched water in subsidence zone.	Pool of perched water in the subsidence zone is shrinking ($69m^2$).
Water inflow: Flow is > 80% of pumping capacity.	No	Mining Manager & Engineering Manager		
Water inflow: Water beginning to flow from draw points.		Mining Manager & Engineering Manager	Review of mine water management to be carried out by Mine Planning Pumping capacity of 90 l/s	Alert status condition green. Minor seepage at bottom of cave
Significant change in monitoring bores		Mining Manager		No significant changes noted

3 Mine Excavations, Production & Ore Handling (water/mud)				
Rill angle in draw point or base of ore pass / raise bore	No	Production Superintendent	Nil	
Water inflow from drill hole or open structure		1st Person	Monitor structures which showed signs of increased water.	Slight increase in water reporting from blast holes in operational areas. Water inflow from structure in operational area, $<0.5L/min$.
Proximity of un-grouted drill hole to development	No	Work Area Supervisor	No breach of procedure occurred. No unidentified or uncontrolled mining into drill holes reported.	Risk assessed and risk level shown on mining plans. Safe Work Procedure invoked where high risk identified.
Breakthrough into abandoned workings	No	Mining Manager	Nil	
Water & % fines in draw points (SLC, ore passes or raises)	No	Mining Manager	Nil	Geotechnicians assess and record levels of fines & water at draw points.
Observation of surface landslides	No	Mining Manager	Nil	
Surface flood levels	No	Mining Manager	Nil	
4 General				

Improvement identified from inspection or audit	No	Relevant Manager	Nil	
Unsatisfactory audit result	No	OH&S Superintendent	Nil	
Unsafe condition observed	No	1st Person	Nil	
Significant incident event at this or another site	No	Relevant Superintendent		
Repeated Significant incident event at this or another site	No	Relevant Superintendent	Nil	
Containable Significant incident event	No	Work Area Supervisor	Nil	
Uncontainable Significant incident event	No	Work Area Supervisor	Nil	

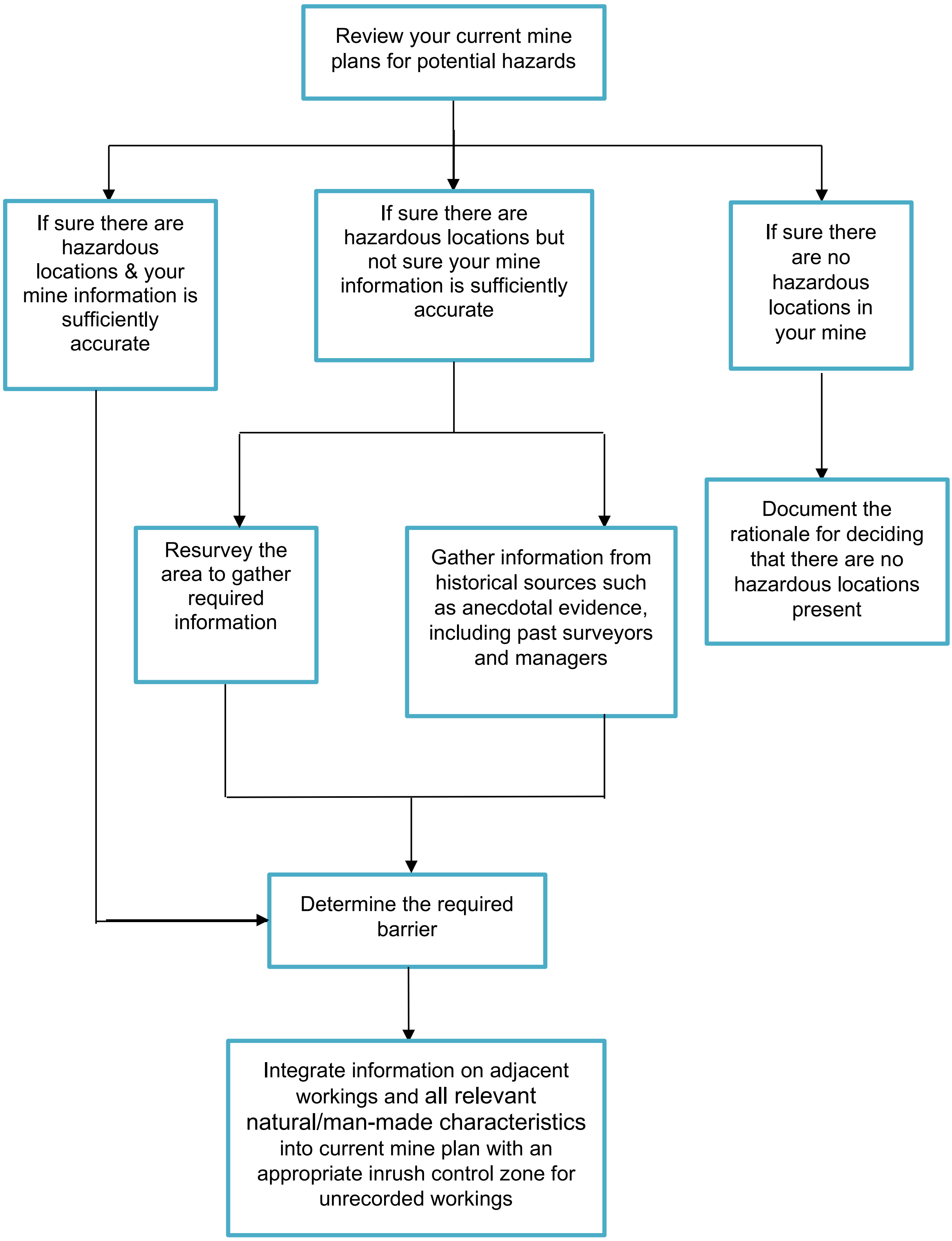
This report has been reviewed by:

Date	**Name (printed)**	**Role**	**Signature**
		General Manager	
		Mining Manager	
		Senior Geotechnical Engineer	

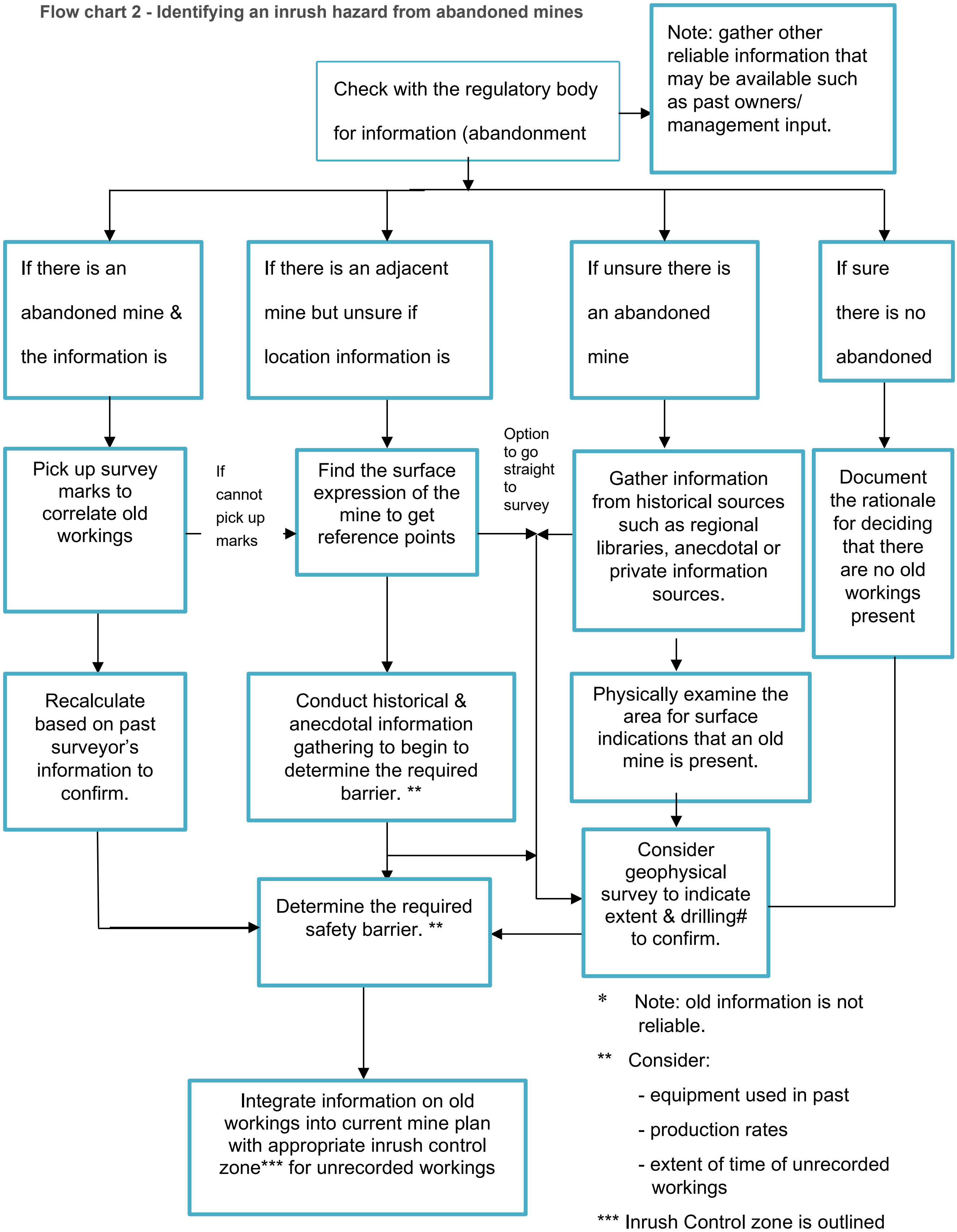
APPENDIX D – Examples of identifying inrush hazards

Note: the steps in the following flow charts are indicative only. There may be other means to obtain the information. Also some of these steps may not be able to be carried out to assist the mine operator in identifying inrush hazards.

Flow chart 1 - Identifying an inrush hazard from existing workings in your own mine



Flow chart 2 - Identifying an inrush hazard from abandoned mines



* Note: old information is not reliable.

** Consider:

- equipment used in past
- production rates
- extent of time of unrecorded workings

*** Inrush Control zone is outlined

Flow chart 3 - Identifying an inrush hazard from workings in another current mine