Strategic Framework for Dam Safety Regulation

VICTORIA State Government | Energy, Environment and Climate Action

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We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.

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Revision History

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1.1	April 2014	DSE		Minor updates
2.0	July 2024	DEECA	Executive Director, Partnerships and Sector Performance	Updated considering: • ANCOLD 2022 *Guidelines on Risk Assessment* • *Environmental Protection Act 2017* • *Commonwealth Work Health and Safety Act 2011* • *Victorian Occupational Health and Safety Act 2004* • other relevant jurisdictional regulatory frameworks and ICOLD bulletins

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1. Introduction

1.1 Purpose

This document sets out the strategic framework for regulating the safety of Victoria's dams[1]. The framework does not alter current dam safety legislation or regulatory policy, but provides a structure to assist implementation, continuous improvement and assurance of dam safety management.

This version is an update of the April 2014 framework. Throughout this document the individual/s and/or entity that has primary ownership and/or management and operational responsibility for a dam is referred to as the dam operator. Also refer to the Glossary for details.

The framework:

- is underpinned by a risk management approach within an effective dam safety management system;
- is performance and outcome focussed;
- defines objectives and principles to guide the delivery of dam safety regulation (section 2);
- documents current regulatory arrangements, roles, responsibilities and performance requirements (section 3); and
- explains the regulatory approach (sections 4 and 5), highlighting:
  - risk-informed processes to direct regulatory approach, resources and effort toward those dams with high hazards and those with the potential to cause harm to life, property and environment.
  - key actions required by dam operators in line with ANCOLD guidelines, this framework and other Department guidelines.
  - regulatory approach changes and enhancements since 2014, principally involving:
    - adoption of *So Far As Is Reasonably Practicable* (SFAIRP) approach within risk management principles.
    - ANCOLD's updated *Guidelines on Risk Assessment* (ANCOLD, 2022).
    - introducing a Safety Case approach as an effective way to demonstrate that risks have been reduced SFAIRP and control measures are adequate particularly for certain classes of dams.
    - scope and benefits of an effective dam safety management system to support recognised good dam safety practices.

In applying this framework, dam operators should also have regard to ANCOLD guidelines but where differences arise, this framework takes precedence.

It is intended that this updated framework will assist dam operators with regulatory responsibilities, and in fulfilling their dam safety and due diligence obligations. The framework is consistent with the *Victorian Guide to Regulation* (DTF, 2016) and *Towards Best Practice – A Guide for Regulators* (BRV, 2022).

1.2 Background

Dam safety in Victoria is regulated under the *Water Act 1989* (the Act) and the *Water Industry Act 1994*. These acts are administered by the Department of Energy, Environment and Climate Action (Department) on behalf of the Minister for Water. The Department directly regulates water corporations and Parks Victoria dams. The majority of regulatory functions for privately owned dams and council dams have been delegated to five licensing authorities (water corporations). The Minister for Water's powers to give directions and undertake emergency actions where there is an immediate dam safety hazard to public safety, property, and the environment have been delegated to the Department and licensing authorities.

[1] Note that tailings storage facilities are regulated by the Earth Resources Regulator, a part of the Department of Energy, Environment and Climate Action. Most regulatory functions for tailings storage facilities are carried out under the *Mineral Resources (Sustainable Development) Act 1990* (see section 3.1.4).

Victoria's dam safety regulatory framework has served Victorians well for over two decades. However, much has changed during this period. Victoria has undertaken two reviews of its dam safety regulatory framework (2010 and 2020) which have suggested improvements to meet emerging dam safety management practices.

The updates in this document are in response to outcomes of the 2020 review, but also because:

- of the recent update of ANCOLD's *Guideline on Risk Assessment* (ANCOLD, 2022).
- some Australian States, such as New South Wales (NSW) and Queensland (QLD) have updated their frameworks. New Zealand has recently enacted dam safety regulations.
- many lessons have been learnt in the recent past from dam safety incidents and emergency exercises and from research programs.
- Victorian *Occupational Health and Safety Act 2004* and the *Environmental Protection Act 2017* have changed to requiring human safety and environmental risks to be eliminated or reduced So Far As Is Reasonably Practical (SFAIRP). NSW dam safety regulations have also adopted that 'so far as is reasonably practicable, the safety of persons and property is not put at risk from the dam. These changes now align with the Australian *Work Health and Safety Act 2011*, along with a number of other Australian hazardous industries.
- of several ICOLD publications, ICOLD 154 (2017), ICOLD 175 (2021), ICOLD 191 (2021), ICOLD 192 (2021).

Dam safety risk most commonly arises from the potential consequences of an uncontrolled discharge of water, as a result of a dam failure. While the likelihood of such events in Victoria is considered low, the history of catastrophic dam failure in other countries highlights the importance of effective dam safety management.

Compared to bushfire, flood and severe storm events, the risk to the community from dam failure in Victoria is relatively low. As this risk is linked to individual structures, it is generally more appropriate to implement measures that reduce the likelihood of the risk eventuating.

A desktop study in 2012 estimated that there are over 455,000 dams throughout Victoria (SKM, 2012), the vast majority of which are very small. Dam safety regulation focuses on a small subset of dams which, because of their size, location and potential risk, warrant a higher level of surveillance and oversight.

1.3 History of Dam Failures

To date there have been two recorded dam failures in Australia that have resulted in loss of life. The first occurred in the 1920s in Tasmania and resulted in 14 fatalities. The second occurred in Queensland in 2008 with one fatality. During the Victorian floods of 2010-11 and 2022, spillway outflows of some dams recorded their highest volumes. These two flood events caused over seventy-five dam safety incidents, mostly associated with small dams. Most were quickly resolved, and third-party damage was minimal.

While Victoria and Australia's dam safety record is good, the record of catastrophic dam failures internationally highlights the importance of maintaining effective regulation. In the US, for example, the Federal Emergency Management Agency (FEMA, 2009) noted 28 dam failures from 1874 to 1979, which had collectively resulted in 3,424 deaths. The failure of a private dam in 2006, Kaloko dam in Hawaii, resulted in seven fatalities. More recently, over 5,000 lives were lost in the September 2023 failure of cascading dams in Wadi Derna, Libya.

1.4 Dams and Flooding

Generally, large dams[2] in Victoria were built to provide water security for communities. These dams are not designed or operated for flood mitigation, although some flood mitigation effects can occur as a result of the flow being attenuated by a dam. There are also a number of flood retarding basins in urban areas in Victoria built to attenuate flooding associated with higher frequency rainfall events.

Only a small number of dams in Victoria have spillway gates, providing the capability to make additional flow releases prior to or during a flooding event. Such dams are owned by water corporations. The primary objective of a flood operating procedure is to safely route the flood through the dam's spillway, hence safeguarding the structural integrity of the dam.

[2] See definition for large dam in www.ancold.org.au and in section 6 below (Glossary and Acronyms)

Dam operators provide operational and flow data to assist the Victoria State Emergency Service (VICSES) and the Bureau of Meteorology (BOM) in informing and protecting downstream communities during flooding events.

A *Guideline for the use of rainfall forecasts to make releases from dams in Victoria* (DEECA, 2024) is available to assist dam owners in setting policies and procedures to utilise rainfall forecasts in making flow release decisions.

1.5 Implications of Climate Change

Australia is experiencing the impacts of climate change, and this will have challenges for managing dam safety. Climate change can amplify the risks. For instance, prolonged periods of drought can lead to ground shrinkage, movement, and cracking in dam embankments. Subsequent heavy rainfall following these droughts can intensify seepage through these cracks, joints, and other vulnerabilities that may have developed during the dry spells. Furthermore, climate change is altering the magnitude, frequency and duration of design floods. Change in climatic conditions will also need to be considered when planning for and responding to dam safety emergencies.

It is important that dam operators are aware of such potential implications along with associated uncertainties, and the need to factor them in when managing the safety of their dams.

Some useful references: Wasko et.al. (2021), Visser et.al. (2022) and Perera & Karunaratne (2022).

2. Objectives and Principles

The overarching objective for Victoria's strategic framework for dam safety regulation is that:

> Dams are regulated so that they are managed to protect the community and the environment using recognised good dam safety management practices.
>
> Dam safety regulation aims to ensure that the safety of dams is managed so that risks to persons (life safety - a key focus), property and the environment are eliminated or reduced So Far As Is Reasonably Practicable (SFAIRP), and therefore tolerable.

Key principles include:

Operator Responsibility: Under the Act, dam owners and operators are responsible for dam safety and accountable for the damage their dams may cause in the event of a dam failure (*Water Act 1989* sections 16, 17, 18 and 157).

Responsible dam management means establishing and maintaining good practices over the life of the dam such as:

- keeping the safety of dams under review and rectifying any deficiencies as soon as reasonably practicable;
- establishing effective operation and maintenance (including surveillance and monitoring) processes and plans;
- ensuring that dam safety programs are adequately funded and that dam safety activities are undertaken by competent persons;
- being prepared to manage dam safety incidents; and
- having an effective system for managing dam safety.

Regulatory Oversight: Regulation establishes dam safety regulatory governance and performance requirements, including emergency management processes and requires that dam operators operate within these requirements over the life of the dam. These are regularly reviewed to incorporate scientific and technological advances, latest safety management practices and reflect community expectations. The regulator monitors compliance against standards and requirements and can exercise enforcement powers where necessary.

Equity: Dams are built to benefit the community. However, individuals and society have a right to be protected. A dam should be managed to a level of safety so that the risk posed by the dam is reduced so far as is reasonably practicable and, as a minimum, does not add significantly to the background risk that the community lives with on a daily basis.

Efficiency: Society's resources are distributed and used to achieve the greatest benefit. Resources and expenditure on dam safety should be in balance with the level of risk being managed. Regulatory activities are prioritised and focused on those dams that could pose significant risks or where the hazards need greater controls.

Consistency: Dams with similar risk levels or potential consequences are subject to comparable dam safety requirements. While there are different regulatory arrangements for the State's larger dams operated by State agencies, (water corporations and Parks Victoria) and relatively smaller dams that are privately owned, outcomes for dam safety need to be consistent, irrespective of dam ownership or use.

Transparency: The Department and licensing authorities provide clear and balanced information to the community about good dam safety practices. Operators of significant portfolios of dams or with high-risk dams need to make information (subject to security limitations) on their dam safety programs available to the public.

Cooperation: The Department and licensing authorities maintain a cooperative and inclusive regulatory culture. This includes providing guidance to operators about how to achieve and demonstrate compliance

with dam safety regulatory requirements and engaging and fostering partnerships with them to strengthen dam safety practice.

3. Regulatory Structures and Arrangements

The *Water Act 1989* establishes dam owner and operator responsibility for dam safety and contains provisions for dam safety regulation. Regulatory arrangements are currently in place for dams managed by State agencies and private operators (Figure 3-1).

The Department has a regulatory role for water corporation dams and has a regulatory oversight role for dams that are licensed through licensing authorities. Five water corporations have been delegated the key dam safety regulatory responsibilities for privately owned dams and local government managed dams, through their licensing authority function, with the Department providing policy input to this process (refer section 3.1.2). The Department and licensing authorities may issue directions concerning dam safety on behalf of the Minister for Water (under sections 78 and 80 of the Act). They also have delegated powers to carry out works and recover reasonable costs of doing so from the occupier of the relevant works, if the Minister or the delegate considers that a person has failed to carry out works stipulated in a direction issued or it is necessary for the relevant works to be undertaken to protect public safety, property or the environment (section 81 of the Act).

The Department is also the Control Agency for all dam safety emergency incidents as per the *State Emergency Management Plan* (SEMP) (EMV, 2023).

3.1 Regulatory Arrangements

3.1.1 Statement of Obligations and Water Corporations

Water corporations own the majority of large dams in Victoria and are a key focus for dam safety regulation. Water corporation dams have an average age of about 70 years with a median age of 60 years, with the most recent of the major dams, being the Thomson dam, completed in 1984.

The Minister for Water has issued *Statements of Obligations* (SoO) made under the *Water Industry Act 1994* to each water corporation. These set out various requirements for the performance of their functions in delivering water supply and wastewater services, and are available on the Department's website as well as on each of the water corporations' websites.

The SoO includes a set of clauses which specify how each corporation should undertake their dam safety management across their portfolio of dams. These set out a risk-informed approach to the delivery of dam safety programs and require that corporations report annually to the Department on the status of their risks and risk management programs. The annual report contains information about the level of safety of the dams, including the results of quantitative risk assessments, and progress towards and proposals for the implementation of works to reduce risks SFAIRP. The Minister for Water may also periodically request independent auditing of the compliance of the corporations against the SoO, through the Essential Services Commission (ESC). The Department provides the audit scope for this process and reports the audit outcomes to the Minister.

The Department maintains a database for over 1,000 dams (including flood retarding basins) managed by water corporations, with data provided by dam owners. Additional details are collected for over 300 dams that have an ANCOLD Consequence Category of Significant and higher (ANCOLD, 2012b and Appendix 2: ANCOLD Consequence Categories), or any dam that meets the ANCOLD definition of a large dam (section 6 Glossary and Acronyms and http://www.ancold.org.au/).

Water corporations are also subject to economic regulation by the ESC. Prices that water corporations charge for the delivery of water services are subject to approval by the ESC, and this has implications for expenditure on dam safety.

3.1.2 Licensing of Private Dams and Council Dams

Private dams include farm dams, recreational dams, hydropower, industrial and commercial water storage dams. Council dams are mostly ornamental and recreational dams. Dam safety regulation is implemented as part of a wider licensing regime under the Act dealing with the take, use, conveyance and storage of water in Victoria. The licensing function is delegated to five of the State's water corporations and the Department provides policy input and regulatory advice to assist this process.

The licensing authorities (see Appendix 1: Licensing Authorities for their areas of responsibility) are:

- Goulburn Murray Water;
- Grampians Wimmera Mallee Water;
- Lower Murray Water;
- Melbourne Water; and
- Southern Rural Water.

Licensing authorities issue licences under section 67 of the Act and monitor compliance against licence conditions including dam safety requirements. These cover the construction, alteration, operation, removal and decommissioning of works. There are additional licence conditions for hazardous category dams.

There are approximately 6,000 dams that are currently licenced, at the time of the publication of this Framework, of which about 1,400 are subject to licence conditions relating to dam safety.

The *Policies for Managing Works Licences* (DELWP, 2016) provides requirements for dams that qualify for licensing, along with licensing conditions for the construction, alteration, operation, removal, abandon and decommissioning dams. It also defines a 'potentially hazardous dam' effectively equivalent to a hazardous category dam (the term used in this document and DEECA, 2024), along with other relevant requirements.

3.1.3 Regulation of dams operated by State Government and other agencies

Parks Victoria, a statutory authority of the Victorian Government, is responsible for managing a vast and diverse area of Victoria and ensures parks are healthy and resilient for current and future generations. Parks Victoria manages a number of dams that are essentially used for recreation. Eleven of Parks Victoria dams are regulated through an exchange of letters with the Department which requires Parks Victoria to comply with dam safety obligations for its dams. These obligations are consistent with those for water corporations.

The Department also owns and manages a number of small dams that are primarily ornamental dams or used for firefighting. These dams are self-regulated.

3.1.4 Regulation of Mine and Quarry Dams

Earth Resources Regulator, part of the Department undertakes the majority of regulatory functions for mine and quarry dams used as tailings storage facilities and slime dams, settling ponds or process dams. The Minister for Energy and Resources is responsible for the administration of the *Mineral Resources (Sustainable Development) Act 1990*. As part of this responsibility, Earth Resources Regulator manages approvals for the design, construction, operation and decommissioning of these dams, monitors compliance with work plans and licence conditions and undertakes enforcement activity as necessary. Earth Resources' Regulator policies for the management of tailings storage facilities are set out in the *Technical Guideline for Design and Management of Tailings Storage Facilities* and *Environmental Guidelines for the Management of Small Tailings Storage Facilities*.

ANCOLD has also released updated guidelines on the planning, design, construction, operation and closure of tailings dams – Revision 1 (ANCOLD, 2019).

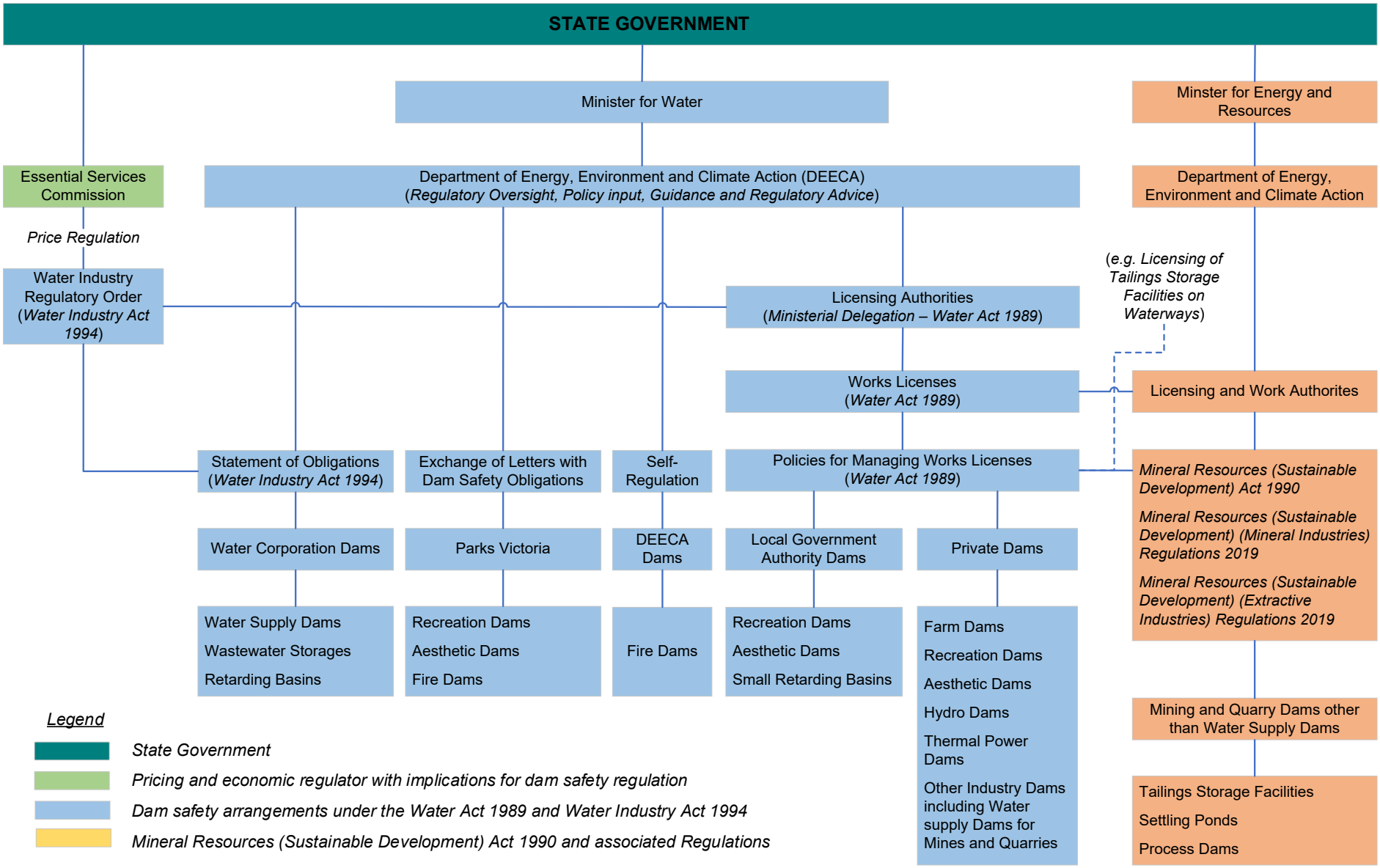
The construction and operation of mine and quarry dams for the purposes of the 'take and use' of water from a waterway, or the storage of water, are subject to licensing framework established under the *Water Act 1989*, in the same way as any other privately owned water supply dams (DSE, 2004).

In some circumstances, tailings storage facilities, settling ponds and process dams may also require a works licence under the *Water Act 1989*, for example where a proposed dam is on a waterway. In such cases, Earth Resources Regulator will facilitate the approval process for the mining or quarry proposal and address any matters that the relevant licensing authority has identified as pertinent to the determination of the works licence.

3.2 Dam Safety Expert Advisory Panel

The Dam Safety Expert Advisory Panel (formerly known as the Dam Safety Advisory Committee) was established in 2011 and provides independent expert input and advice to the Department on dam safety regulation. This guidance extends from policy and research matters to the management or operation of dams. The Panel is appointed by and reports to the Executive Director, Partnerships and Sector Performance Division in the Water and Catchments Group of the Department. The Panel does not have any statutory functions or decision-making responsibilities on dam safety regulatory matters.

Figure 3-1: Current Dam Safety Regulatory Arrangements in Victoria



3.3 Australian National Committee on Large Dams (ANCOLD)

ANCOLD is an incorporated voluntary association of organisations and individual professionals with a common interest in encouraging improvements in the safety and operation of dams in Australia. Founded in 1928, it is a member of the international body ICOLD (International Commission on Large Dams). ICOLD has National Committees from more than 100 countries containing most of the world's large dams. The Department has actively participated as a member of ANCOLD for many years through the ANCOLD Regulators Forum. The forum includes representation from all states and meets annually.

ANCOLD has produced a series of guidelines (www.ancold.org.au) that are recognised by the Department as generally representing a sound industry position for dam safety management but require some adjustment as identified in this framework document to meet Victoria's dam safety regulatory policies and specific circumstances. The SoOs for water corporation dams and most licensing conditions for private and council dams refer to ANCOLD guidelines, as do regulations and guidance material of other jurisdictions across Australia. Earth Resources Regulator guidelines on tailings storage facilities also reference ANCOLD guidelines.

The ANCOLD guidelines have provided a reference for improvement and investment in dam safety, and a basis for dam safety performance assessment throughout Australia for many years. They have both influenced and drawn from current international practice and guidance (such as ICOLD Bulletins), particularly in the adoption of risk management practices over the last two decades. The guidelines cover aspects such as design standards for flood and earthquake loading conditions, and methodologies for risk assessment and decision making. ANCOLD (2022) follows and relies on the generic process established by AS ISO 31000 (2018) *Risk Management – Guidelines*.

3.4 Comparison with Regulatory Approaches of other Jurisdictions

In Australia, dam safety regulatory arrangements are in place in Victoria, New South Wales, Queensland, Tasmania and the Australian Capital Territory. As yet, there is no dam safety regulation in Western Australia, South Australia or the Northern Territory, although dam owners broadly follow ANCOLD guidelines.

Victoria's mode of dam safety regulation, particularly for the water corporations which owns the majority of the larger dams of significance, is characterised by an oversight approach. This approach sets and monitors objectives and principles for dam safety, while maintaining adequate powers in legislation to intervene if necessary.

Victoria conducts periodic reviews of its regulatory approach. The first such review was undertaken in 2010 (Sih et.al, 2010). In 2020, the Department undertook a review of dam safety regulation in Victoria (Ram et.al, 2021). This included a comparative analysis of dam safety regulation in the Australian and international jurisdictions as well as the regulation of the Australian offshore petroleum industry as an example of another hazardous industry.

The review assessed that overall, the Victorian dam safety regulatory framework is mature and well formulated. Victoria is a leading jurisdiction with regard to a number of dam safety assurance elements and is a leading and influencing practice in other jurisdictions in several areas.

Since this review, New South Wales and Queensland have updated their guidance on regulatory arrangements and New Zealand has enacted dam safety regulations supported by guidelines.

An independent external peer review of dam safety risk policies and methodologies for three US Federal agencies - United States Army Corps of Engineers, US Department of the Interior, Bureau of Reclamation and Federal Energy Regulatory Commission, was undertaken in 2015 (Wood & RJH Consultants Inc., 2015). The review was broad ranging and is considered an informative reference on risk management and dam safety good practice in relation to this framework and associated guidance note (DEECA, 2024).

The World Bank has also published a global comparative analysis of dam safety regulatory frameworks where elements of Victoria's dam safety regulation are featured (World Bank, 2020).

4. Victoria's Regulatory Approach

This section sets out the key processes that the Department and licensing authorities use to regulate dam safety. This is shown in Figure 4-1 below.

Figure 4-1: Regulatory Approach

* Risk Management within a Dam Safety Management System

4.1 Risk Management[3]

Dam safety regulation in Victoria is underpinned by a risk management approach within an effective Dam Safety Management System (DSMS).
Resources and effort are focused towards identifying and addressing dams with unacceptable risks.
For dams with the potential to have significant impacts on persons, property and the environment, eliminate or reduce risks So Far As Is Reasonably Practicable (SFAIRP) so that risks are considered tolerable.

This approach for proposed and existing dams is generally guided by the ANCOLD series of guidelines, in particular guidelines on dam safety management, risk assessment and consequence categories and includes:

- ensuring that dams with the potential to cause significant impacts in the event of a dam failure or from inadequate operations/management are subject to regulation (section 3.1);
- having in place by operators, recognised good practices consistent with the potential consequence and risk of these dams (section 4.1.3);
- maintaining a higher level of regulatory overview for those dams with the potential to cause high or greater consequences should they fail; and
- identifying unacceptable risks and targeting of resources and effort so that dam operators address these risks.

While minimisation of life safety risk is the highest priority for regulation, dams also have the potential to pose significant environmental, social and economic risk. This section provides a general description of the application of the risk informed regulatory approach within an effective DSMS.

More explanation of Victoria's risk informed approach to regulation of High and Extreme Consequence Category dams is presented in section 5.

4.1.1 Dam Safety Regulation and Tolerability of Risk Framework

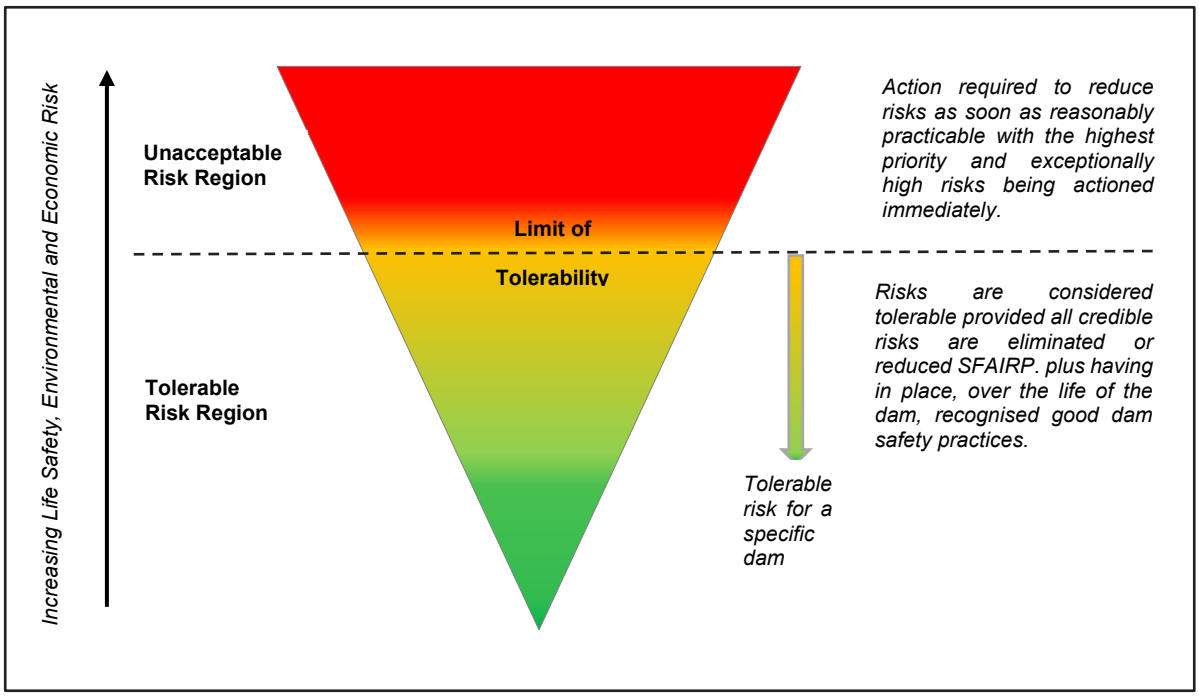
The tolerability of risk framework is a key component of the dam safety regulatory approach, incorporating the principles of both equity and efficiency. It provides for the protection of society and individuals, while recognising that society's limited resources should be distributed to achieve the greatest benefit, and that expenditure and effort on dam safety should be in balance with the level of risk being managed.

The Victorian Tolerability of Risk Framework (Figure 4-2) has been developed from:

- ANCOLD (2022) which utilises the principles based on the tolerability of risk framework developed by HSE (2001) for the regulation of hazardous industries within the United Kingdom, but with appropriate amendments related to contemporary dam safety risk assessment philosophy; and
- substituting ALARP with SFAIRP.

[3] Risk Management within a Dam Safety Management System

Figure 4-2: Victorian Tolerability of Risk Framework (adapted from HSE (2001) & ANCOLD (2022))



Dam safety regulation in Victoria utilises this tolerability of risk framework to provide a basis for evaluating the level of safety of a dam and to assist with targeting regulatory effort and resources.

The upper region of the framework above the limit of tolerability (Figure 4-2) represents the range of risk which is clearly unacceptable except under exceptional circumstances (refer ANCOLD, 2022). Operators of dams with failure risk levels that fall within this region are required to develop and implement plans, such as interim measures and upgrade works, to reduce risks as soon as reasonably practicable to below the limit of tolerability and subsequently SFAIRP. Where a dam is found to pose an exceptionally high level of risk, for example where there is an imminent risk of a dam failure, immediate action is required to mitigate the risk including, if appropriate, activating the Dam Safety Emergency Plan (DSEP).

The lower region represents a range of risks that society is prepared to tolerate because it brings with it a net tangible benefit. As a minimum, dam operators are required to achieve a level of dam safety which is tolerable. In particular, operators of dams with life safety risk should be able to demonstrate that the risk of a dam failure has been eliminated or reduced SFAIRP, or where this is not the case, undertake further measures to eliminate or reduce the risks SFAIRP. The SFAIRP approach applies to environmental and property (including economic) risk, but the disproportionality used between impact/costs and benefits (compared with life safety risks) are generally considered as being lower and can result in no disproportionality factors applied depending on the circumstances. (Refer DEECA (2024) section 5.4 for more details).

What is required to eliminate or reduce risks SFAIRP is the responsibility of the dam operator, who is best placed to make such judgements. A dam operator, on a dam-by-dam basis, should be satisfied that all credible risks have been eliminated or reduced SFAIRP.

Further guidance for Victorian dam operators on reducing risks to SFAIRP and making key dam safety investment decisions is provided in section 4.1.2.1 and in *Guidance Note on Dam Safety Management* (DEECA, 2024).

4.1.2 Use of ANCOLD Guideline on Risk Assessment

4.1.2.1 Tolerable Risk, ALARP and SFAIRP Approach Relationships

The ANCOLD (2022) defines:

- **risk** as a: *"measure of the probability and severity of an adverse effect to life, health, property or the environment."* Dam safety risk is associated with the potential consequences of an uncontrolled discharge of water as a result of a dam failure. Dam safety regulation aims to ensure that dams are

managed to a level of safety such that the risks to people (with emphasis on life safety), property and the environment are eliminated or reduced SFAIRP and, are therefore tolerable.

- **tolerable risk** as: *"A risk within a range that society can live with so as to secure certain net benefits (1). It is a range of risk that we do not regard as negligible or as something we might ignore, but rather as something we need to keep under review and reduce it still further if and as we can. In the context of these guidelines, tolerable risk means that risks are reduced to such levels that ALARP conditions are continually met (2)."* From a dam safety regulation perspective, the first part (1), requires dam operators to take a systems perspective of their dam assets and test that the wider system, within which a specific dam is a part, benefits from the presence and function of the dam without excessive impact. This evaluation is an important periodic activity for a dam operator, in consultation with stakeholders, and where the test fails decommissioning may need to be seriously considered. The second part (2) of tolerability requires dam operators to keep close watch on their dams and take a range of measures to understand and reduce risk SFAIRP, importantly in an ongoing manner.
- **ALARP** as: *"That principle that states risks lower than the limit of tolerability are tolerable only if risk reduction is impracticable or if its cost is grossly disproportionate (depending on the level of risk) to the improvement gained".* However, section C11-7-5 "More detailed ALARP Commentary" of the guidelines identifies other considerations/factors which contributes to judgement that risks are ALARP. Steps required to demonstrate ALARP (i.e. risks are tolerable) are described in the guidelines in section C11-7-4.

ANCOLD (2022) states *"In ANCOLD's view, the way in which ALARP is addressed in these guidelines makes it equivalent to the common understanding of the requirements to reduce risks SFAIRP."*

The concept of ALARP (principle) described in ANCOLD (2022) is considered to closely mirror the intent of the SFAIRP approach.

However, from the SFAIRP approach perspective, what is also important when assessing whether risks are ALARP (ANCOLD, 2022) is that the dam operator:

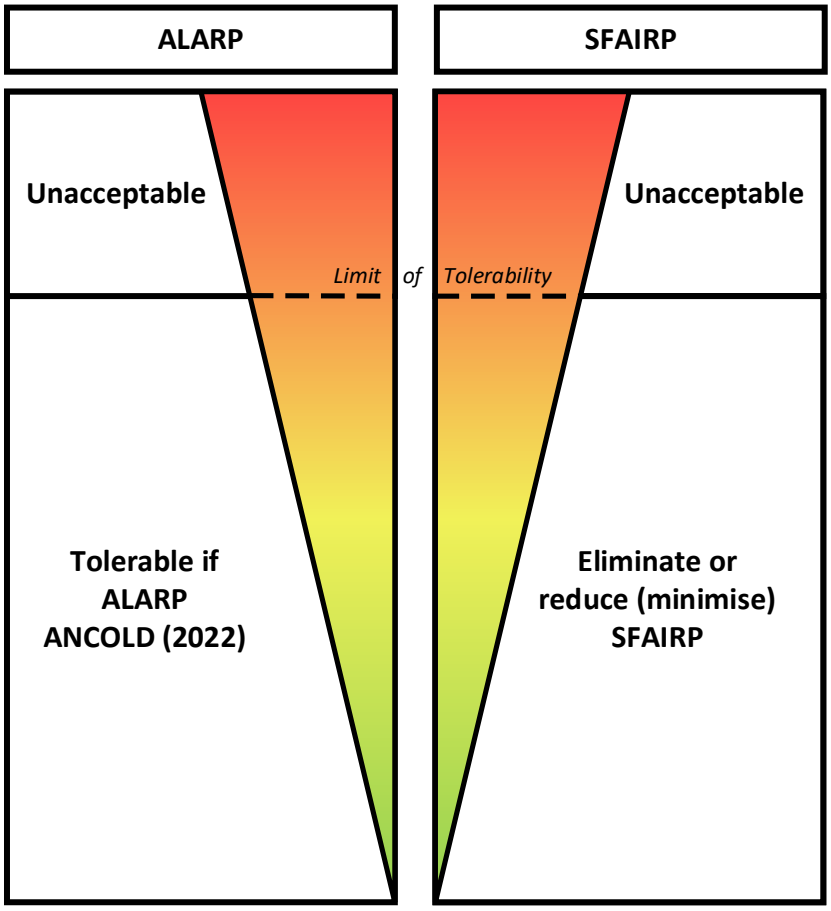
- has identified all known and reasonably foreseeable credible hazards/risks/failure modes and associated loading states (refer section 4.1.3 Implications of Climate Change for an important contemporary example of a reasonably foreseeable risk);
- has identified all practicable risk reduction measures (engineering and management controls including governance) for all credible failure modes;
- has identified which practical controls and other influencing key factors/considerations reasonably maximise risk reduction supported by documented evidence (i.e. benefits outweigh the risks from a reasonably practicable perspective)[4];
- reduces credible risks SFAIRP as soon as reasonably practicable which recognises the severity of the risks and gives measures/controls required to reduce unacceptable risks high priority and, if necessary, through emergency action;
- has (or will have in place as soon as reasonably practicable) recognised good dam safety practices which provides the confidence that all credible risks are reduced and should remain reduced SFAIRP over the life of the dam; and
- has considered whether a safety case is warranted (refer section 4.1.3.2 for details).

Refer Pearce et.al (2021) for further reference.

Overall, ANCOLD's ALARP definition effectively means achieving the same outcomes as SFAIRP as described in WHS legislation – refer Figure 4-3 below.

[4] Refer DEECA (2024) for details.

Figure 4-3: ALARP as defined by ANCOLD (2022) and SFAIRP



In summary, the Department concludes that an ALARP evaluation in accordance with ANCOLD (2022) together with guidance from this framework would satisfy the regulatory requirement that dams are managed to a level of safety such that the risks to persons, property and the environment are eliminated or reduced to SFAIRP and therefore risks are considered tolerable.

4.1.3 Risk Management Processes

From a regulatory perspective, risk management within an effective DSMS is considered to involve the following key assessment processes:

- *consequence assessment and category determination* in accordance with ANCOLD (2012);
- *risk identification* including all credible hazards/risks/failure modes/loading states (reference ANCOLD, 2022) and other dam safety literature;
- *standards-based approach* (traditional engineering analysis and comparison with design standards associated with all credible failure modes and control systems) as described in ANCOLD guidelines, this framework and other dam safety literature.

  This effectively applies to all regulated dams, as it is incorporated in contemporary engineering and dam safety standards and practices for new dams and is included in comprehensive inspections, safety reviews and risk assessments of existing dams.

  The standards-based approach should still include consideration of the SFAIRP approach (refer section 4.1.2.1) by the dam operator. The SFAIRP approach could be undertaken with available information and less rigorous analysis than under a quantitative risk assessment, but will need to be conservative to provide adequate assurance that risks have been reduced SFAIRP, such as all risks have been analysed and there are no safety controls beyond achieving standards that are considered practicable and reasonable to implement.

It may also initially include a qualitative risk assessment such as a risk index, scoring systems or matrix schemes (ANCOLD, 2022, section 6.1) which, for example can be used for existing dams to assist with priorities for:

  - further dam safety investigations; or
  - a portfolio of dams requiring quantitative risk assessments; or
  - how dam safety risks fit within the dam operator's business risks; or
  - design standards upgrades;

- *quantitative risk assessment* supported by standards-based approach, including risk identification, analysis, evaluation and treatment incorporating tolerable risk framework involving the application of the SFAIRP approach highlighted in section 4.1.2.1 above in accordance with ANCOLD (2022) and guidance from this framework.

  This assessment should be applied to dams which have a High or greater Consequence Category (one loss of life or more or major or greater economic, social and environmental impacts) or otherwise where a dam's potential risks warrant such an assessment.

  Refer section 4.1.3.1 Quantitative Risk Assessment and Table 4-1 Broad Regulatory Approach and Dam Operator Action, for more details;

- *risk control and monitoring* involving:
  - safety in contemporary design of works (new, alterations including upgrades and decommissioning/removal) which ensures risks have been eliminated or reduced SFAIRP and recognised good dam safety practices are put in place;
  - construction and commissioning of works which achieves the design safety/risk and good practice criteria and ensures construction risks are reduced SFAIRP;
  - existing dams (operating phase) which ensures required risk reduction measures (both engineering and management) to achieve risks reduced SFAIRP (tolerable risk) are undertaken as soon as reasonably practicable and recognised good dam safety practices remain in place over the life of the dam; and
  - review of the risk management processes and outcomes as part of *comprehensive inspections* or as otherwise required.

- *safety case* to strengthen the demonstration that all credible risks are and will remain reduced SFAIRP and thus providing a greater quality assurance and due diligence (common law duty of care) and contributing to continuous improvement. Refer section 4.1.3.2 Safety Cases for Dams for more details, in particular, on the use of a safety case in the context of this framework.

DEECA (2024) provides more details, including a flow diagram, on a typical risk management process for dams incorporating the SFAIRP approach and associated generalised risk management roles. While its focus is on quantitative risk assessments (either for the first time or for an update) it can be applied, in general terms, to qualitative assessments.

4.1.3.1 Quantitative Risk Assessment

ANCOLD (2022) defines risk assessment as: *"the process of reaching a recommendation on whether existing risks are tolerable and present risk control measures are adequate, and if not, whether alternative risk control measures are justified or should be implemented,"* and further explains that *"risk assessment involves the analysis, evaluation and decision about the management of risk and all parties must recognise that adverse consequences might materialise and owners will be required to deal effectively with consequences of the failure event."*

ANCOLD (2022) provides a structured framework and methodology for quantitative analysis of public safety risk and sets out the following tolerability of risk guidelines as a basis for assessing whether the level of safety is unacceptable or tolerable:

- societal risk (limit of tolerability);
- individual risk: and
- the ALARP principle.

The ALARP principle, together with other considerations in ANCOLD (2022) and guidance from this framework are used to assess whether risks are reduced SFAIRP and therefore considered tolerable. Determining whether risks are tolerable comprises both quantitative (such as societal and individual risk, cost benefit analysis (CBA) including cost to save a statistical life (CSSL) and qualitative assessment (such as some other factors/considerations and the overall SFAIRP approach – refer section 4.1.2.1).

To present information about the societal risk for a dam, an F-N curve is plotted on the Societal Risk Graph. The example F-N curve as shown on Figure 4-4 represents the cumulative output of analyses of potential dam failure modes and consequence scenarios for an existing dam and aligns with ANCOLD (2022), Figure 7.4 ANCOLD Societal Risk Guideline: Existing Dams, but with “ALARP principle” replaced by “SFAIRP approach”. These analyses are undertaken to determine whether the dam will perform to a tolerable level under wide range of loading states, from normal operating conditions to floods and seismic events of extreme rarity.

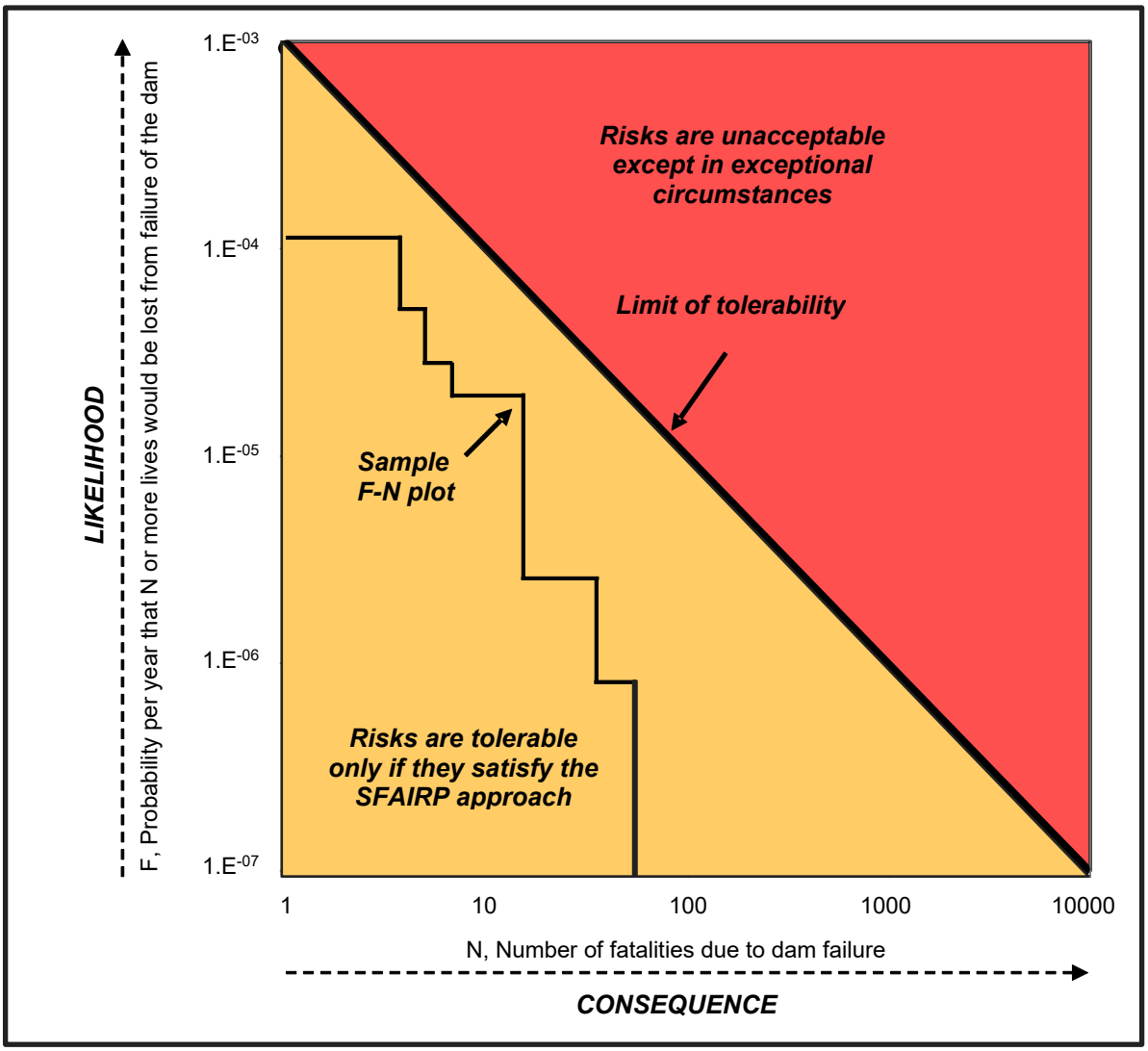
If the F-N plot of the dam intersects the area above the *‘limit of tolerability’* line on the societal risk graph (Figure 4-4), this indicates that the level of safety of the dam is unacceptable and priority must be given to interim measures/remediation works to lower the risk below the limit of tolerability soon as reasonably practicable (ASARP), after which risk reduction should satisfy the SFAIRP approach. In some cases it may not be possible to get below the limit of tolerability with interim measures/remediation works, so it makes it a higher priority to then reduce risks SFAIRP and overall satisfy the SFAIRP approach.

If the F-N plot is below the limit of tolerability, risks should be reduced SFAIRP and as ASARP based on the severity of risk and overall satisfy the SFAIRP approach for risks to be tolerable.

Implicit in the F-N plot is that the greater the adverse consequences that a dam could cause, the higher the performance requirements it should meet.

Individual risk is the total increment of risk (from all credible failure scenarios) imposed on the person most at risk by the existence of a dam. This increment of risk is an addition to the background risk to life, which the person would live with on a daily basis if the dam did not exist. Individual risk is categorised as unacceptable where the value estimated for an existing dam is higher than the threshold (limit of tolerability) value of 10^{-4} per annum, however, individual risk higher than 10^{-5} per annum should only be regarded as tolerable after careful consideration of the age of those at risk and their minimum background risk, night and day variations and direct dam benefits - refer ANCOLD (2022). Furthermore, no matter the level of the individual risk, it is to be reduced SFAIRP.

Figure 4-4: ANCOLD (2022) Societal Risk Guidelines for Existing Dams, adjusted for SFAIRP



Results of risk assessments are used to determine the seriousness of dam safety deficiencies and to make decisions such as whether interim/short-term risk reduction measures are needed, or whether a longer-term approach can be taken in implementing risk control measures. Risk assessment is also used in developing solutions to repair dams, and in determining the most cost-effective solution where a number of options are available. Quantitative analysis such as CBA including CSSL are used to determine if practical risk control measures are reasonable (i.e. all credible risks are reduced SFAIRP). Where an operator has a large portfolio of dams, quantitative risk assessment may be utilised to prioritise and schedule dam safety works and capital expenditure. This approach is further explained in DEECA (2024).

ANCOLD (2022) includes a further Figure 7.5 ANCOLD Societal Risk Guideline: New Dams and Major Augmentations which also requires replacing “ALARP principle” for “SFAIRP approach”.

4.1.3.2 Safety Cases for Dams

Safety cases are a feature of major hazard facility regulation in Victoria and other jurisdictions applicable under workplace health and safety legislation and regulations. WorkSafe Victoria has published a series of guidance notes to assist hazardous facility owners to prepare a safety case. The safety case approach is a well-recognised method for demonstrating major infrastructure safety quality assurance, due diligence and contributing to continuous improvement.

The use of safety cases for dams is developing and a suitable format and process is yet to be agreed to in the dams industry. Some dam operators have trialled within their dam safety management system the inclusion of a safety case, which is currently under consideration by ANCOLD as part of updating the *Guidelines on Dam Safety Management* (2003).

Accordingly, the following is the current advice on a Safety Case within the DSMS:

- dam operators who can demonstrate that they have:
  - undertaken a risk assessment and safety review in accordance with ANCOLD (2022);
  - in place recognised good dam safety practices including an effective DSMS as described in section 4.1.4 Dam Safety Management; and
  - included the other guidance on risk management set out in section 4.1.3 Risk management Processes (excluding a safety case) of this framework,

  would at this stage, from a regulatory perspective, be deemed to satisfy a Safety Case.
- dam operators, in fulfilling their duty of care (due diligence), may consider a safety case is warranted, especially for dams with:
  - extreme consequence categories;
  - risks remaining high but below the limit of tolerability or having significant uncertainties, after applying the SFAIRP approach;
  - unacceptable risks but where a case for ‘exceptional circumstances’ is being considered; and
  - where a risk assessment upgrade/safety review is due.

In these circumstances dam operators should consider the value of the following references: Engineers Australia/Royal Engineering Society (2014), McGrath et al (2016) and McGrath et al (2020).

The approach to safety cases will continue to be monitored by the Department.

Additional information on Safety Cases is included in DEECA (2024).

4.1.4 Dam Safety Management

4.1.4.1 Recognised Good Dam Safety Practice

Numerous dam failures that have occurred overseas and a number of near misses in Australia demonstrate that serious consequences can occur as a result of inadequate design and construction of dams or the lack of effective ongoing management. There are instances where even the failures of relatively small dams have caused multiple fatalities (e.g., Graham, 1999). Therefore, dam safety regulation in Victoria requires that operators of dams (existing or proposed) with the potential to cause significant impacts demonstrate that recognised good practices remain in place, which includes an effective dam safety management system. Other dam safety practices include:

- ensuring new dams are designed and constructed to meet contemporary engineering and dam safety standards;
- assessing and regularly reviewing the level of risks, safety and performance of dams;
- undertaking works and management improvements to rectify safety deficiencies as soon as reasonably practical which recognises the severity of the risks;
- undertaking regular surveillance and monitoring;
- having effective operations and maintenance procedures;
- ensuring emergency preparedness and response;

- having adequate stakeholder and community engagement;
- ensuring adequate resourcing;
- having competent persons in undertaking dam safety activities; and
- maintaining adequate knowledge management.

4.1.4.2 Dam Safety Management System

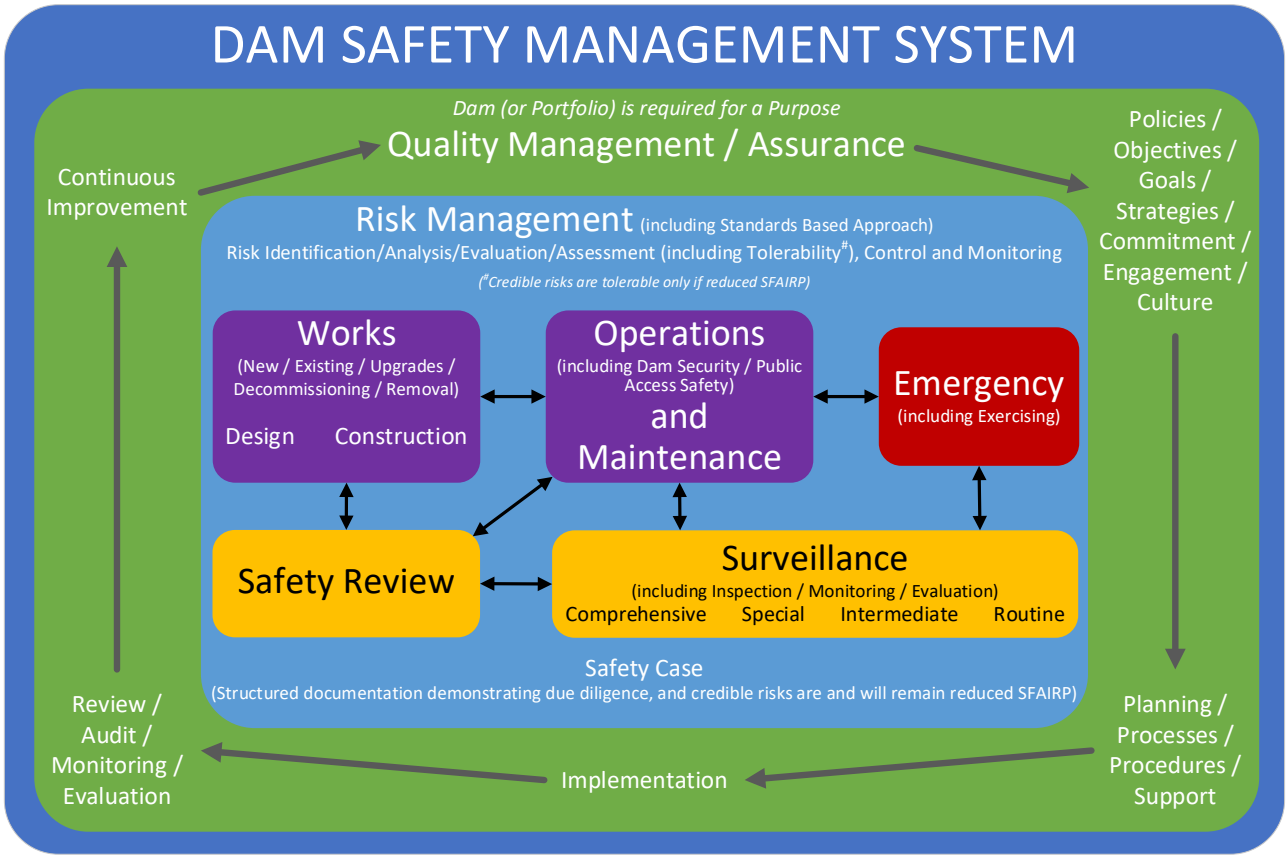
An effective dam safety management system (DSMS) provides a systematic approach for dam operators to effectively address dam safety and provides confidence that good practices are in place. It is viewed as the primary means for dam operators for ensuring SFAIRP, the safety of persons, property and the environment are not put at risk from the dam. Consequently, it is important that dam operator's organisational objectives and wider strategic plans align with the DSMS.

ANCOLD (2003) provides guidance and a diagram on managing a dam safety program or in effect a dam safety management system. Since its publication there have been emerging improvements in dam safety management as identified in section 1.2 Background and as follows:

- dam owner demonstrating commitment to dam safety with a governance framework appropriate to adequately addressing dam safety risks;
- appropriate business (or property) management integration (such as planning, resourcing, operations including works/improvement programs, performance assessment, information and quality systems and communications) for dams;
- potential benefits of consistency of/similar terminology and appropriate processes with AS ISO 55001 (2014) and AS/NZS ISO 9001 (2016);
- publication of ICOLD Bulletin 154 (2017), Bulletin 175 (2021), Bulletin 191 (2021) and Bulletin 192 (2021);
- clearer procedures on how compliance with regulatory performance requirements is being met;
- identified additional management areas including:
  - public safety around the dam and storage surrounds and on the storage; and
  - dam infrastructure, information system and cyber security.
- impact of climate change
- clearer demonstration of due diligence.

In recognition of these improvements, an updated typical dam safety management system diagram has been developed for this regulatory framework – refer Figure 4-5 below.

Figure 4-5: A typical dam safety management system



As indicated in the above figure, the main interrelated central elements of a dam safety management system (works, operations and maintenance, surveillance, emergency and safety review) are all underpinned by risk management, which is the key element for assessing whether risks are reduced SFAIRP including, if considered warranted, a safety case to further strengthen quality assurance, due diligence and continuous improvement.

While *risk management* underpins dam safety, quality management/assurance including adequate documentation is fundamental to an effective DSMS and providing confidence in the level of safety achieved. Adequate documentation means that, if an auditor turns up on any given day, the dam owner should be able to readily provide sufficient documented evidence that all credible risks are and remain reduced SFAIRP (i.e. risks are or will be after timely improvements considered tolerable and will remain so, or if not, be able to readily provide sound and compelling justification). The sub-elements identified in the quality management/assurance element of the DSMS should be applied to all the DSMS elements (including the DSMS itself). These sub-elements are based on a combination of the system elements in the following references - AS ISO 55001 (2014) and AS/NZS ISO 9001 (2016) where both standards have elements aligned and with ICOLD Bulletin 154 (2017).

Refer to section 4.1.5 for an explanation of how the key elements of a DSMS are broadly regulated.

More details of the DSMS and its elements are included in DEECA (2024) including relationships and use of ANCOLD guidelines.

ANCOLD (2003) sets out various levels of practice in accordance with the Consequence Category of the dam (ANCOLD, 2012), which is considered fundamental along with risks associated with the dam in determining the extent and thus cost of dam safety management. Consequently, Very Low and Low Consequence Category dams would require much less detail in the management system and thus lower cost. High and Extreme Consequence Category dams would be expected to have a comprehensive and integrated management system but potentially with slightly less detail for lower risk dams compared to higher risk dams. Significant Consequence Category dams would require adequate detail of the management system which recognises the level of risk.

Thus, an effective DSMS should be scalable based on consequences / risks, and complexity (including type, size and location) of the dam.

In summary, this means that a dam operator with a non-complex dam (or dams which are not large - see large dam definition in www.ancold.org.au) and low on-going consequences/risks should be able to prepare a relatively simple management system. Whereas an owner with a complex dam or a portfolio of dams or a dam with high consequences/risks will require a more comprehensive system to ensure that all safety elements are adequately managed and implemented. This should include monitoring of performance, documentation and quality assurance.

4.1.5 ANCOLD Consequence Category and Regulatory Approach

The ANCOLD Consequence Category (ANCOLD, 2012) is a classification of a dam based on a quantitative assessment of the possible impact on surrounding and downstream populations, the environment, property and infrastructure in the event of a dam break. The Consequence Category is not a measure of the chance or likelihood of a dam failing but provides an initial indication of the level of dam safety practice that should be applied to when managing a dam. Dam operators are responsible for undertaking Consequence Category assessments as a basis for developing an appropriate dam safety management system consistent with this framework, ANCOLD Guidelines and other national and international literature on good practice.

The ANCOLD guidelines define the following Consequence Categories (Appendix 2: ANCOLD Consequence Categories):

- **Very Low**: this category would apply to those dams where the consequences of a failure would be insignificant (for example, small farm dams in remote regions);
- **Low, Significant, High A, High B and High C**: these categories provide a graded range between the Very Low Category and Extreme Category; and
- **Extreme**: this category includes those dams where the effects of a failure would have immense consequences in terms of damage to property, infrastructure and the environment and could put many lives at risk with the potential for large loss of life if the dam fails (e.g. large dams with major population centres downstream).

The Department and licensing authorities use the Consequence Category (ANCOLD, 2012) as a preliminary basis for determining which dams have the potential to pose significant risks and should be subject to a greater level of regulation and management practice. Table 4-1 provides a broad regulatory approach and operator actions required for regulated dams.

In general, dams with High and Extreme Consequence levels are subject to a more detailed regulatory approach which is further explained in section 5. In particular, dam operators are expected to undertake comprehensive dam safety reviews, including quantitative risk assessment, to verify the level of safety of these dams.

While a less detailed approach to Low and Very Low Consequence is generally appropriate, decisions about the level of regulation or action about a particular dam are made considering specific information about the level of safety of the dam and the adequacy of the operator’s practices. For instance, some dams categorised as Low Consequence, while not posing a direct life safety risk, may have the potential to cause third party impacts such as localised damage to commercial and community infrastructure, or localised environmental impacts if poorly managed.

Table 4-1: Broad Regulatory Approach and Dam Operator Action

CONSEQUENCE CATEGORY	REGULATORY APPROACH	DAM OPERATOR ACTION
High and Extreme	• Highest priority for regulatory oversight and monitoring, involving frequent interaction with dam operators with significant deficiencies. Dams with the potential for high loss of life and economic and environmental consequences are a particular priority. • Operators of large dams or portfolio of dams that are not issued with an operating licence provide comprehensive annual reporting and are reviewed by the Department to prioritise regulatory intervention and, where necessary, commission external audits (section 5) • Licensed dam operators may be requested to provide regular reporting. • For licensed dams, surveillance results and other dam safety information may be reviewed as part of the licence renewal process.	• *Safety Reviews*, overseen by a suitably qualified professional and include an appropriate independent review, should be undertaken (having regard to ANCOLD (2003)): – periodically between 10 to 20 year intervals depending on risk levels - recommend 10-15 years for Extreme Consequence Category and high risk dams and 10–20 years for High Consequence Category dams; or – where deficiencies are detected or a change in dam safety standards or following a significant loading event or as otherwise stated in ANCOLD (2003) section 6.2; and – include a comprehensive inspection; • *Quantitative Risk Assessments (including standards-based approach and SFAIRP approach)*, overseen by a suitably qualified professional and include an appropriate independent review and having regard to ANCOLD (2022), to be: – undertaken as part of a new dam design and construction; or – undertaken/updated in conjunction with a safety review or if otherwise required. (Alternatively, for some High C Consequence Category dams (but not large dams) with low Potential Loss of Life (PLL) values, a Standards-based Assessment to confirm the safety of the dam may be sufficient where it can be soundly justified with appropriate documentation, unless a Quantitative Risk Assessment is requested by the Department or licensing authorities); and – reviewed as part of a comprehensive inspection (ANCOLD (2022) section G1-10); • *Surveillance, Operation and Maintenance* procedures/plans are developed and undertaken by a suitably qualified professional and reviewed as part of comprehensive surveillance inspections or as circumstances change (and periodically independently audited), all having regard to ANCOLD (2003) and this framework; • *Dam Safety Emergency Plan (DSEP)* is in place and in accordance with Departmental requirements, developed and regularly reviewed with the input of a competent person and regularly exercised. For dams that are not large, the dam operator may consider using DSEP template (e.g. DELWP (2014)) which is based on ANCOLD (2003); • *Dam Safety Management System (DSMS)* is in place as described in this framework and reviewed as part of the comprehensive inspection (ANCOLD (2003) section 5.6) or when significant management changes occur; and • *Safety Case* – dam operators consider the value of undertaking a safety case as described in this framework (section 4.1.3.2), to further strengthen quality assurance, due diligence and continuous improvement.

CONSEQUENCE CATEGORY	REGULATORY APPROACH	DAM OPERATOR ACTION
Significant	• Moderate level of regulatory oversight and monitoring, with frequent interaction with the operators with significant deficiencies. • Dams with the potential for major economic or significant environmental impacts are subject to a higher level of regulatory oversight. • Operators of large dams or portfolio of dams that are not issued with an operating licence provide annual reporting, which is reviewed by the Department to prioritise regulatory intervention and, where necessary, commission external audits. • For licensed dams, surveillance results and dam safety information may be reviewed as part of the licence renewal process.	• *Safety Reviews*, overseen by a suitably qualified professional, should be undertaken (having regard to ANCOLD (2003)): – Periodically, no more than 20 years, but less for higher risk dams; or – where deficiencies are detected or a change in dam safety standards or following a significant loading event or as otherwise stated in ANCOLD (2003) section 6.2; and – include a Comprehensive Inspection and normally include Standards-Based Approach (including risk identification); • *Quantitative Risk Assessments*, overseen by a suitably qualified professional and having regard to ANCOLD (2022), may also be warranted, where, for example, there is the possibility of unacceptable risk levels or there is uncertainty in the analysis of public safety risks or whether such risks are reduced SFAIRP or there is the potential for major economic or environmental consequences or requested by the Department or licensing authorities and would be: – undertaken as part of a new dam design and construction; or – undertaken/updated in conjunction with a safety review or if otherwise required; and – reviewed as part of a comprehensive surveillance inspection (ANCOLD (2022) section G1-10). • *Surveillance, Operation and Maintenance* procedures/plans are developed by a competent person or as appropriate by a suitably qualified professional and reviewed as part of comprehensive surveillance inspections or as circumstances change, all having regard to ANCOLD (2003) and this framework. For small dams (that is not a large dam) this action may include use of appropriate separate guidance / templates provided by the Department such as Dam Safety Surveillance, templates for Very Low, Low and Significant Consequence Category Dams (DELWP, 2015b) • *Dam Safety Emergency Plan (DSEP)* is in place and regularly reviewed and, as appropriate exercised, where there is a population at risk downstream or if required by regulation, and is in accordance with Departmental requirements. The dam operator may consider using DSEP template (e.g. DELWP (2014)) which is based on ANCOLD (2003); and • *Dam Safety Management System (DSMS)* is in place in an adequate form as described in this framework and reviewed as part of the comprehensive surveillance inspection (ANCOLD (2003) section 5.6) or when significant management changes occur.

CONSEQUENCE CATEGORY	REGULATORY APPROACH	DAM OPERATOR ACTION
Low and Very Low	• Generally subject to broad level of regulatory oversight with less frequent interaction between dam operator and regulator and a basic level of monitoring. • Operators of large dams or portfolio of dams that are not issued with an operating licence are subject to a similar level of regulatory oversight and reporting requirements as Significant Consequence Category dams. • For private dams, surveillance program results and dam safety information may be reviewed as part of the licence renewal process.	• If required by the regulator, *Safety Reviews* undertaken by a suitably qualified professional where deficiencies are detected, such as through the surveillance inspections or following a significant loading event. Such reviews would normally include appropriate level of *Standards-Based Approach* (including risk identification) and as appropriate have regard to ANCOLD (2003); • *Surveillance, Operation and Maintenance* procedures/plans as described in ANCOLD (2003) but in a simplified form or include use of appropriate guidance / templates provided by the Department such as DELWP (2015b) and reviewed as circumstances change; • *Dam Safety Emergency Plan (DSEP)* is in place and regularly reviewed and as appropriate exercised if required by the regulator. The dam operator may consider using DSEP template (e.g. DELWP (2014)) which is based on ANCOLD (2003); and • Dam safety actions for large dams should be undertaken similar to the actions stated for Significant Consequence Category dams.
All Consequence Categories	• The Department and licensing authorities to address unacceptable risks. • The Department and licensing authorities publish and disseminate information to promote good dam safety practice. • The Department and licensing authorities have the authority to monitor compliance and undertake enforcement action where necessary.	• New dams and dam upgrades are designed and constructed to meet contemporary engineering and dam safety standards, practices and risk precautions (having regard to ANCOLD guidelines, this framework and other dam safety literature), by a suitably qualified professional; • Consequence categories are reviewed periodically (at least during comprehensive inspections and at dam works licence renewals) or following downstream development or when requested by the Department or licensing authorities; • Dam safety improvements/works and operations and maintenance including surveillance and monitoring are undertaken by competent persons; • Works to rectify deficiencies/reduce risks are designed, supervised and certified by a suitably qualified professional; • Risk reduction measures/safety deficiencies required are undertaken as soon as reasonably practicable which recognises the severity of the risks, with any required interim measures given the highest priority. Operators of large dam portfolios may address deficiencies through a progressive risk prioritised dam safety upgrade/improvement program; • Department or licensing authorities are promptly notified in accordance with Departmental requirements when there is a dam safety emergency or a significant incident occurs or deficiency is found; • All relevant dam safety documentation and information are maintained for the life of the dam; and • Dam safety reporting to the Department or licencing authorities effectively occurs as regulated or requested.

4.2 Awareness, Knowledge and Skills

4.2.1 Awareness and Knowledge

Making clear and balanced information available to dam operators and the community about dam safety risk, due diligence responsibilities of dam operators, regulatory and performance requirements and good dam safety practice are important tasks for the Department and licensing authorities.

The Department and licensing authorities disseminate information on good practice, regulatory requirements and performance and emergency management arrangements to dam operators and also maintain information on dams with the potential to cause damage in the event of a dam failure.

The Department engages with dam operators to raise and maintain their awareness of good dam safety practice, regulatory obligations and due diligence responsibilities, through measures such as:

- participating in and contributing to the Victorian Dams Working Group (VDWG) and interagency emergency management forums;
- coordinating periodic seminars on various aspects of dam safety and emergency management;
- providing relevant information on the Department website;
- conduct appropriate training programs to dam operators and their executives; and
- support and participation in the water corporations' earthquake monitoring network and warning arrangements.

The Department and licensing authorities will continue to collect and refine information on dam safety, and as appropriate, make it available to the community. The dam safety improvement program is an example of such information.

4.2.2 Skills

The Department and licensing authorities develop, maintain and regularly review their skills and resources to enable the successful delivery of dam safety regulation. The Department supports industry initiatives to build and maintain skills in dam safety management.

Effective and efficient dam safety outcomes and the implementation of regulation cannot be achieved without adequate skills and sufficient financial and human resources. The Dam Safety Expert Advisory Panel (formerly known as the Dam Safety Advisory Committee), established in November 2011, supplements the Department's dam safety and technical expertise and provides guidance on the development and implementation of regulatory processes by both the Department and licensing authorities. The Department will continue to develop and regularly review its skills, training and resources to enable a sufficient skill base for the successful delivery of its regulatory program so that regulatory personnel have the:

- training and capacity to oversee dam operator performance and responsibilities and promote guidance on good dam safety and emergency management practices; and

- ability and judgement to, where necessary, enforce compliance as a last resort.

Obtaining adequately skilled personnel, consultants and contractors with relevant experience is a widespread challenge across the dam industry, and may worsen unless proactively addressed. The dams industry in particular is undergoing a major loss of experienced engineers as the workforce ages. The Department will continue to work and support the VDWG and ANCOLD in initiatives to address skills shortages, such as the National Training Package for the water industry. These include promoting the availability and quality of training through water industry training providers and tertiary institutions, and promoting the development of contractual relationships between dam operators to enable the sharing of skills and resources.

4.3 Performance Requirements and Guidance

The Department and licensing authorities set performance requirements based on latest safety approaches reflecting community expectations, scientific understanding and current industry good practice and provide support and guidance to dam operators to achieve these. The Department maintains a broad oversight of dam safety regulation in Victoria.

Dam safety performance requirements are set and communicated through regulatory instruments and guidelines. These include the SoO for water corporation dams, and *Policies for Managing Works Licences* (DELWP, 2016) for licensed dams. Performance requirements form a basis for quantifying and monitoring the level of safety of a dam and how well a dam is being managed.

Where needed, the Department and licensing authorities provide broad guidance and support to dam operators to assist in understanding and meeting dam safety requirements. This framework is part of such guidance and support along with the publication of other dam safety and emergency management guidance documents on the Department's website.

Appendix 3 provides a diagram of guidance documents and how they are inter-linked.

Dam safety performance requires that dam owners "have regard to" ANCOLD guidelines and the Department guidance documents, including this framework. The Department, other regulators and the dam industry in general in Australia have contributed to the development of the ANCOLD guidelines over many years which provides a national approach to dam safety management. While some regulators do not directly cite ANCOLD guidelines within their regulations, Victoria's current regulatory approach continues to benefit from "having regard to" ANCOLD guidelines.

While continuing to actively participate in the development of ANCOLD Guidelines, the Department separately considers further specific regulatory requirements relative to local circumstances. It provides supplementary guidance on aspects of good practice in dam safety as well to improve clarity in areas not fully covered in ANCOLD guidelines. Central to this is the Department's interaction and exchange of information with dam safety practitioners in the water industry through participation in the VDWG. The Dam Safety Expert Advisory Panel also supports the Department in this task.

Performance requirements cover key aspects of good practice over the life of a dam such as:

- design (including planning issues such as required setbacks[5]), construction and decommissioning[6];
- dam safety assessment against contemporary risk guidelines and engineering standards;
- operation and maintenance procedures;
- surveillance and monitoring programs;
- incident investigation;
- emergency planning, preparedness (including mapping of inundation zones) and exercises;
- dam safety improvement programs and their progress;
- dam safety management system;
- community engagement[7] including public information; and
- performance reporting.

4.4 Performance Monitoring, Compliance and Assurance

The Department and licensing authorities monitor and evaluate the performance of dam operators in meeting dam safety requirements.

While the onus of compliance with dam safety requirements rests with the dam operator, the Department and licensing authorities maintain an overview of performance against dam safety obligations and licence conditions. Where the Department or the licensing authority identify significant inadequacies in the management of a dam, they will liaise with the dam operator to rectify these.

Water corporation and some large dam operators form a key focus for dam safety monitoring because of their size, generally higher consequences and their importance to the community. They are required to provide detailed annual reporting on their dam safety programs to the Department (Ryan & Perera, 2010). This includes information and performance on:

- the characteristics of the dams;
- safety surveillance, monitoring, operations and maintenance and emergency preparedness;
- safety incidents;
- safety risks; and
- proposals and timing for safety improvement and progress against improvement programs.

The Department maintains a web-hosted portal of all annual reporting data and engages with large dam operators on the status of their dam safety programs and their performance. The Department also produces an annual report of state-wide results to enable industry benchmarking and to encourage continual improvement in dam safety practice and performance.

In addition to the annual reporting requirements, the Minister for Water, through the Essential Services Commission, may periodically request independent auditing of the compliance of water corporations with

5 Refer DELWP (2022), *Guidance Note on Setbacks Near Dams*

6 Refer DELWP (2022), *Decommissioning Dams – A Guide for Dam Owners*

7 Refer DELWP (2015a), *Engaging Communities on Dam Safety* and DEECA (2024) *Guidance Notes on Dam Safety Management* (section 5.5)

specific clauses within the SoO. The Department provides the audit scope for this process and reports to the Minister on the outcome. The SoO also provides for the Minister to conduct random audits or reviews of any matter specified by the Minister in relation to performance of a water corporations' functions and exercise of its powers.

Dams that require a licence under section 67 of the *Water Act 1989* (refer section 3.1.2) are regulated through the conditions of the "works" licence, which amongst other things, require the licence holder to work with a suitably qualified professional and provide the licensing authority with information such as:

- design and construction reports;
- surveillance plans and dam safety emergency plans; and
- notification of any significant deficiencies.

Dams that are classified as 'Hazardous category dams' will require additional conditions to maintain and improve their safety.

4.5 Enforcement

Where a dam poses an unacceptable risk to downstream communities and the dam operator's response is inadequate, the Department or licensing authorities, as the Minister for Water's delegates, can issue directions to address the situation and if necessary, can directly undertake remedial works.

While the preferred approach of the Department and licensing authorities to dam safety regulation is through cooperation, the *Water Act 1989* has a number of provisions enabling stronger enforcement approaches if warranted. Any decision to use enforcement would consider the level and urgency of the risks posed by a dam, and the capacity and responsiveness of the dam operator to undertake effective remedial action.

The Department and licensing authorities have delegated powers under the Act (sections 78 and 80) to issue directions to operators of any dam (licensed or not). Directions may be issued in emergency situations, or if a dam is threatening downstream communities or is likely to become so. Directions may include requirements such as making improvements to the dam, partially or fully emptying the dam, keeping the dam under increased surveillance and, in exceptional circumstances, removing the dam.

Where there is an immediate threat to persons, property or the environment, and if dam operators are uncooperative or ineffective in undertaking appropriate action, the Department and licensing authorities have delegated powers to decide to undertake remedial works and then recover costs under section 81 of the Act. Licensing Authorities also have powers to issue notice of contravention under section 151 of the Act.

In certain circumstances, dam operators may also be subject to prosecution and penalties for non-compliance.

The Department reviews any enforcement undertaken and makes appropriate improvements required to regulatory processes.

4.6 Continuous Improvement

The Department and licensing authorities work in partnership with dam operators, industry groups and other stakeholders to encourage and assist continued improvement, innovation and consistency in dam safety practice.

This is achieved through supporting and participating in existing industry forums such as the VDWG. The Department is continuing to work to extend these networks and enable effective information exchange with all dam operators of hazardous category dams.

The Department promotes and contributes to national and international guidelines on dam safety and their consistent application through regulation. This is pursued through working with industry, other Australian and international regulators and dam safety practitioners to support ongoing effort, research and investment in the review, update and implementation of ANCOLD guidelines. Key to this is the Department's participation and contribution to the National Regulators' forum.

The Department undertakes regular reviews of its regulatory practices and compares its dam safety framework with other national and international jurisdictions. Updates to this framework and other supporting documents are made on an ongoing basis as better knowledge, good practices, and improvement opportunities become known.

4.7 Emergency Management

The Department and licensing authorities provide guidance to dam operators and support agencies about emergency preparedness and ensure effective incident control in escalating situations.

Victoria's multi agency framework for emergency management operates under the *Emergency Management Act 2013*. The framework sets out most of Victoria's emergency management structures and assigns roles and responsibilities.

The *Emergency Management Act 2013* provides for the development of the *State Emergency Management Plan* (SEMP) which is published by Emergency Management Victoria (EMV, 2023) and contains key policy and planning documents for emergency management in Victoria. The SEMP identifies the Department as the Control Agency responsible for dam safety incident response. Dam operators are required to develop dam safety emergency plans (DSEPs) for dams that they own or operate. VICSES is the Control Agency for flooding downstream of dams, either due to dam failure or riverine flooding passing through a dam. VICSES works closely with the Department when a dam safety incident occurs.

The following state arrangements from the SEMP apply to dam safety emergencies:

- SEMP sections including Planning core capability, Operational Management core capability and Impact Assessment core capability;
- SEMP Roles and Responsibilities; and
- SEMP Flood Sub-Plan.

The latest version of the SEMP and relevant sub-plans can be found on the EMV website.

As the Control Agency responsible for dam safety incidents, the Department maintains a Dam Safety Response Plan that covers arrangements for assessing, escalating and managing escalated dam safety incidents and emergencies (DELWP, 2021). This Dam Safety Response Plan applies to all Victorian dams including privately owned dams.

Under the Dam Safety Response Plan, the Department requires that dam owners/operators:

- notify the Department through the State Duty Officer – Water of any dam safety emergencies with a risk level of medium or high, or with the potential to escalate to this level; and
- manage the emergency response at the dam site, by appointing an incident controller, until the emergency is either resolved or the situation escalates to a level which requires the Department to make a replacement appointment.

If a dam safety incident or emergency occurs, relevant and timely community information and warnings are issued by a State Warnings and Advice Duty Officer (WADO) through VicEmergency. These are based on scale and consequence of the incident or emergency as assessed by the Incident Controller.

Further emergency management requirements are set out in the SoO for water corporations, and in *Policies for Managing Works Licences* (DELWP, 2016) for private dam operators with licence conditions. In addition, the Department and licensing authorities produce guidance material to assist in the preparation of DSEPs and liaise with the operators of large dams to promote regular review and exercising of DSEPs (DELWP, 2014). The Department also engages in ongoing dialogue with other agencies with dam safety emergency responsibilities to maintain and improve clarity in roles, responsibilities and procedures.

5. Regulatory Oversight of High and Extreme Consequence Dams

High and Extreme Consequence dams with the potential to cause loss of life are a high priority for regulatory overview and monitoring. Typically, these dams also have the potential to cause major environmental and economic impacts.

For these dams, operators should take a precautionary approach when assessing the safety of the dam and when assessing risks are tolerable (reduced SFAIRP).

Dams managed by water corporations and other operators of large dams are thus a key focus for regulation in this respect.

Under the SoO, water corporations are required to report annually to the Department on the risk profiles of their dams, progress in completion of risk reduction works and their proposals for further dam safety improvement works. To comply with dam safety obligations, water corporations are expected to undertake detailed safety reviews for High and Extreme consequence dams including both quantitative risk assessments and standards-based approach, to provide a comprehensive understanding of the level of safety of these dams. Standards-based approach can provide a useful reference in understanding risks and, where appropriate, justify decisions.

The Department uses this information, as well as results from periodic external audits, as a basis for monitoring the adequacy of the water corporations' dam safety programs and management systems and for prioritising and targeting its regulatory activities. In particular, the Department evaluates the results for individual dams to determine the level and type of regulatory response, particularly if the dam does not yet meet tolerable risk guidelines (section 4.1.1).

The Victorian dam safety regulatory regime includes a risk-informed approach so that such decisions are made in a systematic and consistent way and that regulatory actions and resources are efficiently prioritised. This is similar to the decision-making risk framework used by the United States Bureau of Reclamation *Public Protection Guidelines: A Risk Informed Framework to Support Dam Safety Decision Making* (USBR, 2022). While the level and type of response is proportionate to the severity of the risk, regulatory overview is maintained across all dams with the potential to cause significant impacts in the event of a dam failure.

While the safety status of the dam is a key criterion in assessing the level of regulatory response, the adequacy of the dam operator's risk management program and processes and overall dam safety management system is also important in deciding on the most effective course of action.

When dam operators implement actions to reduce risk such as upgrade works and operational and management improvements, or as better information is provided on the safety status of a particular dam, the level of regulatory response is re-evaluated accordingly.

5.1 Risk assessment results showing very high risks

In the majority of cases where risk analyses have generated very high risk results, there have been no indications of active failure modes in progress. Typically, a particular dam would have operated satisfactorily for many years. However, assessment against current standards and using contemporary risk analysis methods may have identified a significant design or construction flaw in the dam that needs to be addressed in the short to medium-term to ensure its ongoing safe operation SFAIRP. In many circumstances, this risk can be significantly lowered as soon as reasonably practicable in the short-term by imposing an interim measure such as an operating restriction (lowering the level of water in the dam) or minor structural works, and perhaps considering a non-structural control measure such as an emergency warning system until longer-term measures can be carried out.

Sometimes, a very high risk result may be obtained where a screening or preliminary level risk assessment is used when initially assessing the safety of the dam. In this case, more conservative parameters may have been selected for the risk analysis due to the higher level of uncertainty associated with less detailed investigations. Typically, after obtaining a very high risk result, more investigations and data gathering will be undertaken, and following input of this information into the risk analysis, a much lower (though rarely below the 'limit of tolerability') result may be obtained.

6. Glossary and Acronyms

The following glossary of terms is taken from various documents including the *Guidelines on Risk Assessment* (ANCOLD, 2022) and *Guidelines on Dam Safety Management* (ANCOLD, 2003).

TERM	DEFINITION
ALARP	As Low As Reasonably Practicable Principle. That principle which states that risks, lower than the 'limit of tolerability' are tolerable only if risk reduction is impracticable or if its cost is grossly disproportionate (depending on the level of risk) to the improvement gained (ANCOLD, 2022).
ANCOLD	Australian National Committee on Large Dams. https://ancold.org.au/
Competent Person	A person who, in exercising an activity in relation to a dam or dam safety, has acquired (through appropriate qualifications, experience, education and training) adequate knowledge, skills and ability relevant to that activity, so as to be capable of effectively undertaking that activity.
Consequence	In relation to risk analysis, the outcome or result of a risk being realised. Includes flood impacts in the downstream as well as upstream areas of the dam resulting from failure of the dam or its appurtenances, as well as indirect impacts over an indefinitely large area.
Consequence Category	A classification of adverse consequences resulting from a dam failure (ANCOLD, 2012b).
Dam Operator	The individual/s and/or entity that has primary ownership and/or management responsibility for a dam. Dam operators of public dams in Victoria include the following State entities/agencies - Water Corporations, Local Government, Parks Victoria and the Department of Energy, Environment and Climate Action. For private dams included in a works licence, the dam operator is the holder of the licence. For other private dams, the dam operator is the dam owner.
Dam failure	In the general case, the inability of a dam system, or part thereof, to function as intended. Thus, in terms of performance to fulfil its intended function, the inability of a dam to perform functions such as water supply, prevention of excessive seepage or containment of hazardous substances. In the context of dam safety, failure is generally confined to issues of structural integrity, and in some contexts to the special case of uncontrolled release of the contents of a reservoir through collapse of the dam or some part of it.
DEECA	Department of Energy, Environment and Climate Action (formerly known as DELWP, DEPI and DSE). https://www.deeca.vic.gov.au/
DELWP	Department of Environment, Land, Water and Planning, Victoria (now DEECA).
DEPI	Department of Environment and Primary Industries, Victoria (now DEECA).
DSC	Dams Safety Committee. Former New South Wales dam safety regulator. https://www.damsafety.nsw.gov.au/
DSE	Department of Sustainability and Environment, Victoria (now DEECA).
DSEP	Dam Safety Emergency Plan. A continually updated set of instructions and maps that deal with possible emergency situations or unusual occurrences at or related to a dam or reservoir.

TERM	DEFINITION
Emergency management	The organisation and management of resources for dealing with all aspects of emergencies. Emergency management involves the plans, structures and arrangements which are established to bring together the normal endeavours of government, voluntary and private agencies in a comprehensive and co-ordinated way to deal with the whole spectrum of emergency needs including prevention, response and recovery (EMV, 2023).
EMV	Emergency Management Victoria leads emergency management in Victoria by maximising the ability of the emergency management sector to work together and to strengthen the capacity of communities to plan for, withstand, respond to and recover from emergencies. EMV supports the Emergency Management Commissioner to lead and coordinate emergency preparedness, response and recovery across Victoria's emergency management sector in conjunction with communities, government, agencies and business. EMV is an integral part of the broader emergency management sector and shares responsibility with a range of agencies, organisations and departments for ensuring the system of emergency management in Victoria is sustainable, effective and community focussed https://www.emv.vic.gov.au/about-us.
ESC	Essential Services Commission. Victoria's independent economic regulator of essential services supplied by water and sewerage, electricity, gas, ports and rail freight industries. https://www.esc.vic.gov.au/
Hazard	Threat or condition, which may result from either an external cause (e.g. earthquake, flood, or human agency) or an internal vulnerability, with the potential to initiate a failure mode. A source of potential harm or a situation with a potential to cause loss.
Hazardous category dam	A dam on a waterway or a dam not on a waterway as described in section 67(1A) of the Water Act, that is classified as Significant, High (C, B or A) or Extreme Consequence Category based on the current *ANCOLD Guidelines on Consequence Categories for Dams (2012).*
HSE	Health and Safety Executive. The national independent watchdog for work-related health, safety and illness in the United Kingdom. It is an independent regulator and acts in the public interest to reduce work-related death and serious injury across Great Britain's workplaces. https://www.hse.gov.uk/
ICOLD	International Commission on Large Dams. This is a non-governmental international organisation which provides a forum for the exchange of knowledge and experience in dam engineering. ICOLD has National Committees from over 100 countries with approximately 10,000 individual members. https://www.icold-cigb.org/
Incident	An event which could deteriorate to a very serious situation or endanger the dam.

TERM	DEFINITION
Independent Review	The review (which can be called a range of terms such as a technical review or expert review) should be independent from the project team undertaking the activity under review and report separately to the dam operator (or representative). Reviewers: • must be suitably qualified professionals; • have relevant expertise which adequately covers the technical and as appropriate administrative requirements of the activity, preferably at a level equal to or broader than the corresponding subject specialists or persons in the project team managing the activity under review; and • should have skills which reflect the challenges (especially the technical issues) of the activity and the actions required of a reviewer. For activities under review with low complexity, the review may only involve one suitably qualified professional but for more complex activities a range of suitably qualified professionals will likely be required.
Individual risk	The increment of risk imposed on a particular individual by the existence of a hazardous facility. This increment of risk is an addition to the background risk to life, which the person would live with on a daily basis if the facility did not exist.
Large Dam	A large dam (refer: www.ancold.org.au) is defined as one which is: (a) more than 15 metres in height measured from the lowest point of the general foundations to the 'crest' of the dam, (b) more than 10 metres in height measured as in (a) provided they comply with at least one of the following conditions: (i) the crest is not less than 500 metres in length; (ii) the capacity of the reservoir formed by the dam is not less than 1 million cubic metres; (iii) the maximum flood discharge dealt with by the dam is not less than 2,000 cubic metres per second; (iv) the dam is of unusual design. No dam less than 10 metres in height is included.
Likelihood	A qualitative description of probability and frequency.
PAR	Population at Risk. All those persons who would be directly exposed to floodwaters assuming they took no action to evacuate.
PLL	Potential Loss of Life. The part of the population at risk that could lose their lives in the event of a dambreak.
Risk	Measure of the probability and severity of an adverse effect to life, health, property, or the environment. In the general case, risk is estimated by the combined impact of all triplets of scenario, probability of occurrence and the associated consequence. As a special case, average (annualised) risk can be estimated by the mathematical expectation of the consequences of an adverse event occurring (that is, the product of the probability of occurrence and the consequence, combined over all scenarios).
Risk analysis	The use of available information to estimate the risk to individuals or populations, or property or the environment, from hazards. Risk analyses generally contain the following steps: scope definition, hazard identification, and risk estimation.

TERM	DEFINITION
Risk assessment	The process of reaching a decision recommendation on whether existing risks are tolerable and present risk control measures are adequate, and if not, whether alternative risk control measures are justified or will be implemented. Risk assessment incorporates, as inputs, the outputs from the risk analysis and risk evaluation phases. Consistent with the common dictionary definition of assessment, viz. "*To analyse critically and judge definitively the nature, significance, status or merit of [risk]*", risk assessment is a decision-making process, often sub-optimal between competing interests, that results in a statement that the risks are, or are not, being adequately controlled. Risk assessment involves the analysis, evaluation and decision about the management of risk and all parties must recognize that the adverse consequences might materialise and owners will be required to deal effectively with consequences of the failure event.
Risk-based	Primarily uses the outcomes of the risk assessment.
Risk-informed	Risk outcomes are used to inform decisions, taking account of uncertainties and adopting professionally prudent and pragmatic considerations.
Risk management	The systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, controlling and monitoring risk.
SFAIRP	So Far As Is Reasonably Practicable. A legal term enshrined in Australian law, especially the model Work Health and Safety legislation.
Societal risk	The risk of widespread or large-scale detriment from the realisation of a defined hazard, the implication being that the consequence would be on such a scale as to provoke a socio/political response, and/or that the risk provokes public discussion and is effectively regulated by society as a whole through its political processes and regulatory mechanisms. Such large risks are typically unevenly distributed, as are their attendant benefits. Thus, the construction of a dam represents a risk to those close by and a benefit to those further off, or a process may harm some future generation more than the present one. The distribution and balancing of such major costs and benefits is a classic function of government, subject to public discussion and debate.
Statement of Obligations (SoO)	Is a regulatory instrument issued by the Minister for Water to water corporations, which imposes obligations and guiding principles in relation to performance of their functions and the exercise of their duties.
Standards-Based Approach	The traditional approach to dams engineering, in which risks are controlled by following established rules as to design events and loads, structural capacity, safety coefficients and defensive design measures.

TERM	DEFINITION
Suitably Qualified Professional	A person who is a Competent Person (see definition) in: • the type, size, complexity (including associated potential risks and the consequence category) of the dam involved; • as appropriate, dam design, construction supervision, operations and maintenance, surveillance, emergency management, consequence category determination, risk assessment, safety reviews and safety management; and • understanding relevant regulatory and guidance documents; and is: • registered under a law that provides for the registration of professional engineers, or • a member (or would be eligible to be a member) of Engineers Australia with the status of Chartered Professional Engineer, or • entered on the National Professional Engineers Register administered by the Institution of Engineers Australia, or • the holder of professional qualifications in a relevant speciality (related to dams or dam safety) or is registered in a relevant speciality (related to dams or dam safety) by an Australian professional organisation. A suitably qualified professional: • is required to have appropriate insurance, in particular, professional indemnity insurance; and • for activity with low complexity, may be the only suitably qualified professional involved, but for more complex activities, would oversee a project team which includes other suitably qualified professionals.
Tailings Storage Facilities	Tailings Storage Facilities (TSF) are built structures used to confine mine tailings. The term refers to the overall facility, and may include one or more tailings dams. The primary purpose of a TSF is to safely contain tailings to achieve solid sedimentation and consolidation, and to facilitate water recovery or removal without impacting on the environment. The nature of TSF design and operation is fundamentally different from a water dam in the way water is managed and in rehabilitation and closure.
Tolerable risk	A risk within a range that society can live with so as to secure certain net benefits. It is a range of risk that we do not regard as negligible or as something we might ignore, but rather as something we need to keep under review and reduce it still further if, and as we can. In the context of this framework, tolerable risk means that risks are reduced to such levels that SFAIRP (ALARP) conditions are continually met (ANCOLD, 2022). Refer section 4.1.2.1 of this document for further clarification of the definition of “tolerable risk” from the Victorian regulatory perspective, including the use of SFAIRP instead of ALARP.

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NOTE: References included here are the latest at the time of publication of this framework. However, readers should refer to the latest version or as amended references.

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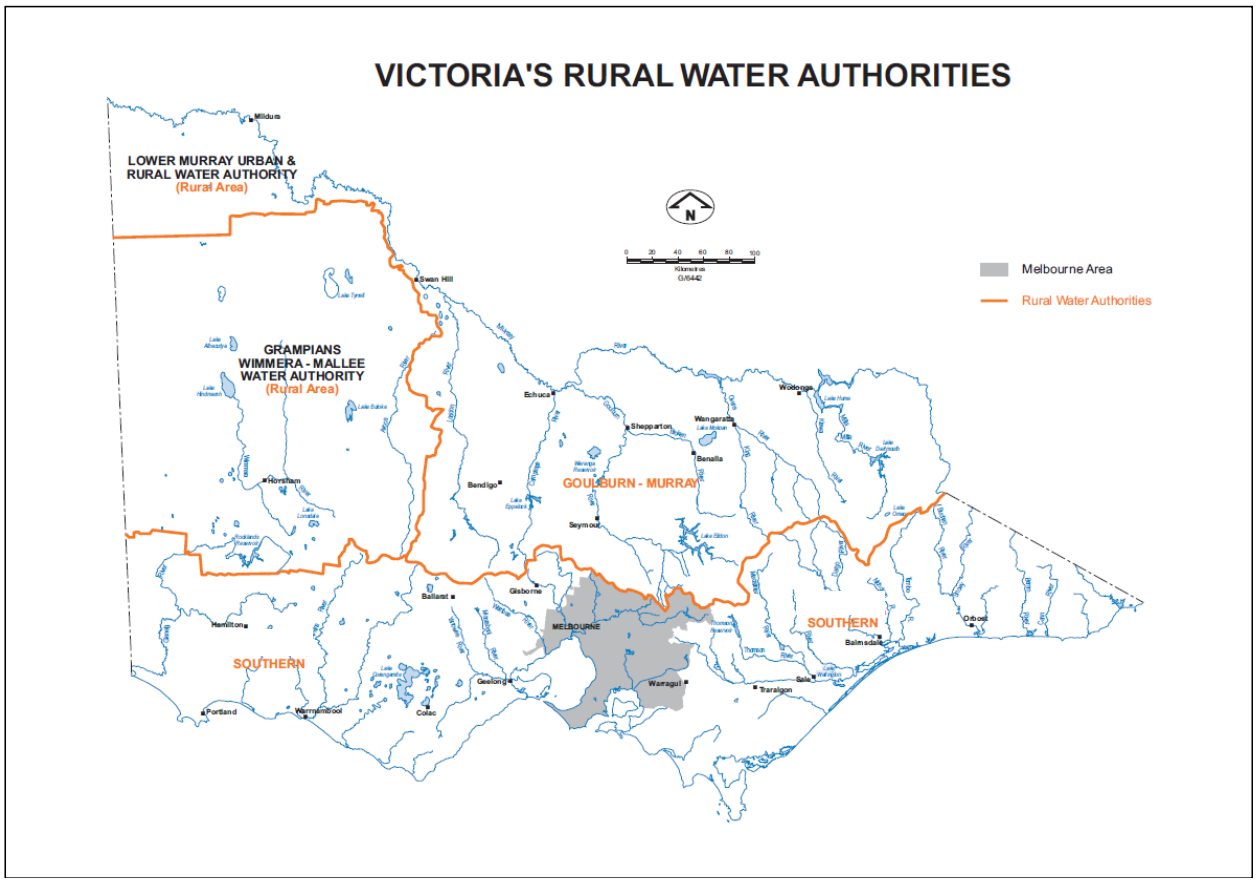
Appendix 1: Licensing Authorities

Figure A1-1: Areas of responsibility of licensing authorities



Regulatory requirements, information, and guidance on making an application to construct and operate a dam can be found from licensing authorities:

- Melbourne Water
- Southern Rural Water
- Goulburn Murray Water
- Grampians Wimmera Mallee Water
- Lower Murray Water

Appendix 2: ANCOLD Consequence Categories

The *Guidelines on the Consequence Categories for Dams* (ANCOLD, 2012) sets out two methods for assigning a Consequence Category. The first, shown in Table A2-1, uses estimates of the population at risk (PAR) and environmental, economic and social damage if a dam failed. The guidelines state that 'the PAR includes all those persons who would be directly exposed to flood waters assuming they took no action to evacuate.' The second method (Table A2-2), which is a more detailed approach, is based on undertaking an assessment of the potential loss of life (PLL) that could be caused by a dam break. The PLL is defined by the guidelines as 'the part of the population at risk that could lose their lives in the event of a dam break.'

In relation to the assignment of consequence categories, it is important to take note of this reference from the ANCOLD Consequence Guidelines – "*However the complexity of determining the various parameters that make up each Consequence Category means that only experienced dam engineering professionals should interpret and use these Guidelines when making decisions that could impact on community safety, community cost and services, infrastructure, natural environment, heritage, and the owner's and other businesses*." In undertaking a consequence category assessment, the information provided in the below tables should not be used without taking into account the full guidance provided in the Guidelines.

Table A2-1: ANCOLD Consequence Categories based on Population at Risk (Table 3 ANCOLD 2012)

Population at Risk (PAR)	SEVERITY OF DAMAGE AND LOSS (*e.g. health and social, environment, infrastructure and business cost*)			
	MINOR	**MEDIUM**	**MAJOR**	**CATASTROPHIC**
<1	Very Low	Low	Significant	High C
≥ 1 to 10	Significant *(Note 2)*	Significant *(Note 2)*	High C	High B
≥ 10 to <100	High C	High C	High B	High A
≥ 100 to <1,000	*(Note 1)*	High B	High A	Extreme
≥ 1,000		*(Note 1)*	Extreme	Extreme

- *Note 1*: With a PAR in excess of 100, it is unlikely damage will be minor. Similarly with a PAR in excess of 1,000 it is unlikely damage will be classified as medium.
- *Note 2*: Change to "High C" where there is the potential of one or more lives being lost.

Table A2-2: ANCOLD Consequence Categories based on Potential for Loss of Life (Table 4 ANCOLD, 2012b)

Potential Loss of Life (PLL)	SEVERITY OF DAMAGE AND LOSS (*e.g. health and social, environment, infrastructure and business cost*)			
	MINOR	**MEDIUM**	**MAJOR**	**CATASTROPHIC**
<0.1	Very Low	Low	Significant	High C
≥ 0.1 to <1	Significant	Significant	High C	High B
≥ 1 to <5	*(Note 1)*	High C	High B	High A
≥ 5 to <50		High A (*Note 2*)	High A	Extreme
≥ 50		*(Note 1)*	Extreme	Extreme

- *Note 1*: With a PLL equal to or greater than one (1), it is unlikely damage will be minor. Similarly, with a PLL in excess of 50 it is unlikely damage will be classified as medium.
- *Note 2*: Where PLL is in the range =>5 to <10, the Category level can be reduced to High B

Appendix 3: DEECA Guidelines and Documents