

The Role of Dams

Background on the Australian National Committee on Large Dams (ANCOLD)

The Australian National Committee on Large Dams Inc. (ANCOLD) is an Australian based non-government, non-profit and voluntary association of organisations and individual professionals with a common technical interest in dams. ANCOLD currently has 53 member organisations covering all aspects of the dams industry, and 153 individual associate members.

Individual members and associates are typically specialist professional civil, mechanical, electrical and environmental engineers or allied practitioners working in the dam industry and corporate members comprise a range of public and private sector dam owners, consultants, contractors, government agencies and other organisations with a professional interest in dams. Further details about ANCOLD can be found at our website www.ancold.org.au.

ANCOLD is an active member of the International Commission on Large Dams (ICOLD) which has 92 member countries and meets annually to share international practice and new techniques to advance all aspects of dam engineering and ensure the sustainable development and management of the world's water resources. Australia has a high level of internationally recognised dam engineering expertise to provide leading edge professional advice. Further details about ICOLD can be found at their website www.icold-ciqb.net

ANCOLD is not an advocate for dams but an apolitical industry body that focuses on disseminating knowledge, developing capability and providing guidance in achieving excellence for all aspects of dam engineering, management and associated issues.

ANCOLD does not comment on any specific dam issue, project or development. It is considered that the final decision for the development of dams is the responsibility of the community, which must weigh up the positives and negatives of any particular dam proposals and make a decision. These important decisions are generally made by the responsible elected government. In the course of their business activities many ANCOLD members are involved in developing business cases and ANCOLD strives to ensure they are well informed in national and international practice to provide the best outcomes for the Australian community.

ANCOLD prepares and issues guidelines which represent the best Australian and international engineering practice. These guidelines are widely used in Australia and provide consistency across the dams industry. Australia, as a result, is recognised as a world leader in the safe design, management and operation of its dams.

Dam Safety Legislation and Regulations

Whilst there is no federal legislation covering the safety of dams, the development and surveillance of dams is controlled by legislation and regulations in Queensland, NSW, Victoria and Tasmania. The other states and territories do not currently have specific dam safety legislation. The legislation varies but covers safety, environmental, cultural heritage and other issues of value to the community. In most cases the regulations require compliance with the ANCOLD guidelines. ANCOLD members have been involved in the drafting and operation of dam legislation and regulations. ANCOLD encourages and supports the state regulators, all of whom are active ANCOLD members, to meet and identify improvements to achieving consistent dam safety outcomes.

The Role of Dams

The following information is provided as general information on dams and dam engineering.

Water Supply

Water is necessary for nearly all aspects of a community's well being. It is required for domestic use, sanitation, industry and agriculture as well as recreation (boating, swimming, fishing and visual amenity). Water also provides clean renewable energy through hydro electric generation.

Research has shown that the wealth of a country is directly proportional to the volume of stored water to meet these needs. A large part of the world's growing population is water stressed and does not have adequate clean water to meet basic needs. As the driest populated continent in the world, Australia is a fortunate country with high quality water supplied to the majority of the population through sophisticated water storage and delivery infrastructure.

Rain for water supply in Australia is not consistent or predictable. There are periods of high rainfall followed by long droughts. Rainfall patterns and locations can be patchy and inconsistent and rain does not always fall when and where we wish it. For this reason dams play a valuable role in storing water in times of plenty for when it is required during low rainfall periods. This has allowed many marginal arid areas to be developed into high yielding food bowls.

Meteorological models show that this trend of flood and drought will be more pronounced with global climate change and the temporal and spatial distribution of rainfall will change. This will require a rethink of water management policy storage requirements in the long term.

Whilst there are a range of water supply options available (eg desalination, ground water, recycling), dams remain a cost effective solution for the provision of water.

Environmental Considerations

There will nearly always be an effect on the natural environment as a community develops its capability to maintain and improve the quality of life. There needs to be strong political leadership to ensure there is informed debate on the impacts of developing our water resources, to achieve the best outcome for the community.

ANCOLD recognises that the prudent consideration of environmental and social issues related to dams is an increasingly important aspect for the community and to our members. ANCOLD has made this a key focus of its activities building on the outcomes of the World Commission on Dams report (WCD 2001). As a result, ANCOLD's activities and membership has broadened significantly beyond its traditional technical focus over the last decade.

Water Storage Projects

It takes many years to develop a large dam project which may provide water to the community for centuries. These schemes are, therefore, planned and built with a view to future community need. That future need should be a key part of the business case and debate. The future benefits need to be clearly communicated as they can be difficult to understand and will be weighed up against environmental, land use, heritage and other impacts that are immediately apparent. Australia's quality of life is dependant on the water it has available through current storage. It stands to reason that new storages need to keep pace with the requirements of population and industry growth to maintain and advance Australia's standard of living.

Valuable economic development generally occurs following the implementation of a reliable water supply scheme. eg Snowy Mountains Scheme, Murrumbidgee Irrigation Scheme, Ord River Scheme, Goulburn-Murray Scheme to name a few. The establishment of a secure water supply is a fore-runner to economic, regional and social development. This has resulted in governments rather than private industry leading the development of water resources. Private industry then returns the investment once their industries are established.

The efficient use of our water resource is becoming more important due to the shortage of reliable fresh water supplies. The reuse of grey water, storm water or treated sewerage is becoming more popular. This water can be held in off stream storages (dams) for domestic, industrial or agricultural use.

Smaller farm and industrial dams

There is much focus on large dams and water management schemes, however, the role and value of small and medium dams should not be understated. Many of these dams are being developed by farmers and small industrial projects and do not require large capital funds or the engineering

sophistication of the larger schemes. The cumulative value of these smaller dams is substantial.

Mining dams

The safe containment and management of mining tailings is an important aspect of the mining industry. Mining tailings can have concentrations of heavy metals, highly acidic waters, and other environmentally damaging substances. The tailings are typically transported from the mine to the storage site in a water slurry. The tailings are contained behind a purposely designed dam where the solids settle out. The resulting tailings water generally needs to be treated to remove heavy metals and reduce acidity before being released back into the natural environment.

The science and management of mining tailings has greatly improved over recent years. ANCOLD is in the process of finalising a guideline on the design, construction and management of these dams.

Flood Management

ICOLD reports that floods represented 30% of all natural disasters between 1975 and 2000. Meteorological models indicate that intense rainfall is more likely in the future due to climate change.

Australia's population is concentrated where there is available water supply in fertile river valleys. This puts pressure on Authorities to release land in flood plains for development.

Dams with significant storage capacity can be designed and operated to provide flood mitigation through the storage of water during peak flood flow, to be released slowly at a later time when natural river levels are lower. There are several ways this can be achieved, including:

- Having storage available within a reservoir to hold flood water.
- Gated spillways which can be operated to control the outflows
- A small primary spillway that restricts the outflow

During a large flood the ability of a dam to attenuate a flood may be exceeded resulting in the need to release water to maintain the safety of the dam itself.

The protection of the population from the more frequent small to medium floods gives an expectation that they are also protected from the more infrequent large floods. There is a need to raise awareness of the hazards associated with development within a flood plain. It may not be economic or practical to provide protection from all floods.

There are purpose built flood retention basins typically situated within urban environments to reduce the effects of flash flooding.

Hydro Electric Power Generation

Most large hydro electric opportunities have been developed in Australia, however, the value of small and mini hydro schemes associated with water supply dams is increasing. The value of hydro electric power has increased with the introduction of the National Electricity Market and consumer demand for non-polluting power sources.

Pumped storage schemes will become more viable as a peaking power source as we require more non polluting sources of energy. These schemes pump water into an elevated holding reservoir when the price of power is low (over night) and release it through a hydro turbine when the price is high during peak periods.

The value of wind-hydro schemes will also increase for remote areas. In this scheme wind provides power to pump water to an elevated pond. Power supply can then be regulated through the generation of hydro electricity.

River Navigation

River barrages, locks and low head weirs are a specific type of dam. River navigation, particularly along the River Murray, provided a major role in developing the agricultural potential of northern Victoria and southern NSW. The River Murray lock and weirs continue to keep the river navigable, however, road and rail transport has largely taken over the transport of goods.

River barrages can be used for the release of environmental flows and to hold back sea water from the fresh water environment.

Safety of the Population and the Environment

Australia has an enviable reputation and track record for the safe management of dams. This has been achieved by significant government and private sector investment in safe dam development and management. This is supported by a high level of dam engineering expertise, dam safety legislation (in four states), and responsible ownership.

ANCOLD produces a range of industry guidelines which are influenced by national and international standards for other hazardous industries. The ANCOLD guidelines are recognised as leading international practice for safe dam management, and are also used in many other countries.

The key failure modes of a dam are flood overtopping and consequent erosion, structural failure, uncontrolled leakage and internal erosion through earth dams, and earthquake.

Flood

Dams can be designed to release a large discharge during a flood event without threatening the safety of the dam. Current practice dictates that a

dams should have spillway capacities so as not to expose the downstream population and environment to an intolerable risk of dam failure.

Meteorological and hydrological modelling has greatly advanced over the past two decades. This and the impact of climate change has resulted in design floods for dams generally increasing. These floods remain rare events but the safety of the dam and protection of the public have required the upgrading of many spillways throughout Australia and indeed the world.

Structural failure

Large dams in Australia are generally well built and structural failures are rare. Advances in engineering knowledge have, however, led to upgrades to ensure structural integrity. For example, a number of Australian concrete gravity dams have been strengthened with the placement of stressed steel tendons securing the dam to the rock foundation.

Leakage and Erosion through Earth Dams

Leakage and erosion is a mode of failure for earth dams, which is more common in small dams. Larger earth dams tend to be well designed to meet the more obvious requirement to provide the necessary safety for the potential 'Hazards' they pose.

Earthquake

The understanding of the effect of earthquake on dams has developed over the past two decades. This has been due to the availability of computer modelling and from the experience of dams that have survived or failed in large earthquakes.

Dams in earthquake prone areas are generally designed to not fail catastrophically in an earthquake. The most prone areas are along the boundary fault lines on the earth's crust plates. Only one dam failure, resulting in the loss of life, during the recent massive earthquake in Japan was reported by ANCOLD's counterpart, the Japanese National Committee on Large Dams.

Australia is fortunate that it is not located over or near a continental plate boundary and the risk to dams is substantially lower. Australian large dams are generally designed and assessed for their capacity to withstand the types of earthquakes that could credibly occur in our area.

Community Awareness

The community will decide the future of water resources and dams in the 21st century. To this end it is essential there be informed and rational debate on the development of our water resources and infrastructure to support our community.