Dam Operator training:
Analysis of current trends and future outlook
May 2017
Summary

This report includes the results of the survey on current training options utilised by the owners of referable dams in Queensland, provides information on the training programs available locally, in other states of Australia and overseas, raises awareness of the recent changes to the Australian training framework, assesses future requirements and identifies options for regulatory involvement aimed at promoting/establishing appropriate knowledge base within the Queensland water industry involved in dam management.
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## Abbreviations

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<th>Description</th>
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<tr>
<td>ANCOLD</td>
<td>Australian Committee on Large Dams</td>
</tr>
<tr>
<td>ASQA</td>
<td>Australian Skills Quality Authority</td>
</tr>
<tr>
<td>AWA</td>
<td>Australian Water Association</td>
</tr>
<tr>
<td>CPD</td>
<td>Continued professional development</td>
</tr>
<tr>
<td>Defra</td>
<td>Department for Environment, Food and Rural Affairs, United Kingdom</td>
</tr>
<tr>
<td>DO</td>
<td>Dam operator</td>
</tr>
<tr>
<td>DS</td>
<td>Dam safety</td>
</tr>
<tr>
<td>EAP</td>
<td>Emergency Action Plan</td>
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<td>NSW DSC</td>
<td>New South Wales Dam Safety Committee</td>
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<tr>
<td>NWP</td>
<td>National Water Training Package</td>
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<tr>
<td>IEAust</td>
<td>Institution of Engineers Australia</td>
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<tr>
<td>RTO</td>
<td>Registered training organisation</td>
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<tr>
<td>RTP</td>
<td>Registered training provider</td>
</tr>
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<td>SOP</td>
<td>Standing Operating Procedures</td>
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<tr>
<td>TADS</td>
<td>Training aids for dam safety</td>
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<tr>
<td>VET</td>
<td>Vocational education and training</td>
</tr>
<tr>
<td>WIDWG</td>
<td>Water Industry Dams Working Group Victoria</td>
</tr>
<tr>
<td>WIOA</td>
<td>Water Industry Operators Association</td>
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<tr>
<td>WSAA</td>
<td>Water Services Association of Australia</td>
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### Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>Dam</td>
<td>Works that include a barrier, whether permanent or temporary, that does or could impound water; and the storage area created by the works. The term includes an embankment or other structure that controls the flow of water and is incidental to works mentioned above. The term does not include the following: - rainwater tank - water tank constructed of steel or concrete or a combination of steel and concrete - water tank constructed of fibreglass, plastic or similar material.</td>
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<tr>
<td>Dam inspection</td>
<td>A careful and critical viewing and examination of all visible aspects of a dam.</td>
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<tr>
<td>Dam owner</td>
<td>Any person, organisation or entity legally deemed to be the owner of a dam.</td>
</tr>
<tr>
<td>Dam operator</td>
<td>The person, organisation, or legal entity which is responsible for the control, operation and maintenance of a dam and/or reservoir and the appurtenant works.</td>
</tr>
<tr>
<td>Emergency action plan</td>
<td>An emergency action plan provides guidance for actions required during an emergency event at the dam, including downstream releases from dams as well as potential failure scenarios.</td>
</tr>
<tr>
<td>Failure impact assessment</td>
<td>A failure impact assessment of a water storage dam is the process used under the water supply act to determine the number of people whose safety could be at risk should a dam fail (population at risk). The results of the assessment are used to determine whether a dam is referable and the failure impact rating of a dam. A failure impact assessment must be certified by a suitably experienced and independent Registered Professional Engineer of Queensland.</td>
</tr>
<tr>
<td>Failure impact rating</td>
<td>A failure impact rating is a measure of the population at risk should a dam fail. There are two categories: Category 1—between two to 100 people at risk by the dam failing. Category 2—more than 100 people at risk by the dam failing. All category 1 and category 2 dams are referable dams under the water supply act. If less than two people are at risk by the dam failing, then the dam is not given a failure impact rating and is not referable under the water supply act. The chief executive imposes dam safety conditions on dams which are referable under the water supply act based partly on the failure impact rating. Dam safety conditions can be imposed either when a development permit relating to a dam which is a referable dam under the Water Supply Act is granted or, after the dam has been constructed (as safety conditions under the Water Supply Act, which are taken to form part of a development permit for the dam).</td>
</tr>
<tr>
<td>(Cat 1 and Cat 2)</td>
<td></td>
</tr>
<tr>
<td>Population at risk</td>
<td>Population at risk means the number of persons, calculated under the failure impact assessment guidelines, whose safety will be at risk if the dam, or the proposed dam after its construction, fails.</td>
</tr>
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</table>
1. Introduction

In ancient times, dams were built for the single purpose of water supply or irrigation. Now, dams are also constructed for flood control, navigation, sedimentation control and hydropower. Water is essential for our civilization and we need to be prepared to deal with ongoing challenges such as extreme weather – from drought to floods to storms – and the pressure of a growing population. Properly planned, designed, constructed, operated and maintained dams contribute significantly toward fulfilling our water supply requirements.

The Water Industry in Australia has an estimated annual revenue of $11.1 billion, adding $7.1 billion to the Australian economy in 2015-16 ('Water Industry Intelligence', Australian Industry Standards). The industry employs more than 30,600 people across its sub-sectors: water supply, sewerage, drainage services and pipeline transport (water). Occupations involved in these sectors cross a spectrum of activities including water industry operations (generalist, treatment, networks, source, hydrography, trade waste), treatment (drinking water, waste water) and irrigation. The focus of this report is on the operational dam personnel: their training needs, requirements and development opportunities available for this group in Queensland, other states of Australia and overseas.

Given the large number of dams in Queensland, the safe operation of dams has significant social, economic, and environmental relevance. A dam failure can result in extremely adverse impacts, including a large-scale loss of human life.

Dam owners are responsible for employing adequate staff numbers and their availability since safe dam operation; maintenance and surveillance are dependent upon staff to carry them out. The operations personnel are those who look after the dam on a day to day basis. Their primary duties include:

- Water distribution, release, irrigation, catchment services and dam operation activities to ensure fit for purpose.
- Surveillance and inspections of dam related infrastructure to ensure their safe and efficient operation.
- Operation and monitoring of dams and other infrastructure during floods and other emergencies.

All dam operators need to be suitably experienced and/or trained in aspects of operation of the owner’s dam. Dam surveillance is vital for the early detection of possible dam failures or problems so that remedial action can be carried out. The proper and ongoing education of dam owners and associated personnel is essential to maintain an effective dam safety program aimed towards detecting possible deficiencies and minimizing the risk of dam failure.

The lack of national/state qualifications requirements makes it difficult to have assurance that dam operators receive adequate training to perform their duties. In most Australian states training of personnel responsible for management of dams is left up to the individual dam owner. Diversity of operational requirements and variable financial capacities of dam owners make it difficult to nominate specific qualification based upon dams duties alone. While many large Water Authorities and Corporations in Australia encourage or require their operating personnel to have formal qualifications in Water Operations, the ability of the smaller dam owners to provide similar level of support is questionable.

In August 2016, the Australian Water Industry Reference Committee (WIRC) issued a paper listing key water industry and skills-related trends, domestically and internationally impacting on the industry:

- Regulatory and Technological Changes (increased regulation and reporting requirements, drones, automation of plant and water delivery, digital literacy)
- Aging Workforce (recruitment and mentoring)
- Climate Change/Environmental management (more extreme weather conditions bringing focus on the development of planning and forecasting skills)
- Infrastructure Demands (ongoing maintenance and renewal requirements bringing demand for appropriately skilled labour and management personnel)
- Big Data Capture and Analysis (automation and remote operation, real-time decision making and safety management systems)

The findings of the WIRC report bring attention to the fact that appropriate changes to the training, skills, competencies and workforce planning in the water industry are required to meet future workforce demand.

This report includes the results of the survey on current training options utilised by the owners of referable dams in Queensland, provides information on the training programs available locally, in other states and
overseas, raises awareness of the recent changes to the Australian Training Framework, assesses future requirements and identifies options for regulatory involvement aimed at promoting/establishing appropriate knowledge base within the Queensland Water Industry involved in the dam management.

2. Dam Safety Regulation in Australia

In Australia, dam safety is a state matter. This means that the relevant legislation and regulation can be found at the state level. Currently, there are five states that have dam safety regulations:

Australian Capital Territory (ACT) Department of Urban Services (DUS)
New South Wales (NSW) NSW Dams Safety Committee (DSC)
Queensland (QLD) Department of Energy and Water Supply (DEWS)
Tasmania Department of Primary Industries, Water and Environment (DPIWE)
Victoria Department of Sustainability and Environment (DSE)

The results of the desktop analysis on the regulatory training requirements in these states are presented below. At present, there is no dam safety legislation in South Australia, Western Australia and Northern Territory, so no research on the training requirements and options in these states has been undertaken.

2.1 Queensland

In Queensland, all referable dams are subject to the jurisdiction of the Water Supply (Safety and Reliability) Act (2008) and are regulated by the chief executive of the Department of Energy and Water Supply. The principal objective of the Dam Safety group within this Department is to ensure the ongoing safety of 105 referable dams.

Under the Queensland Water Supply (Safety and Reliability) Act (2008) and common law, responsibility for the safety of a dam rests with the dam owner and dam owner may be liable for loss and damage caused by the failure of their dam and/or the escape of water from a dam. Under the provisions of the WSA the chief executive of the Department of Energy and Water Supply is responsible for the regulation of water dams that would, in the event of failure, put two or more people at risk. Such dams are called ‘referable’ dams in the Act.

To ensure dam owners are aware of their responsibilities, the following guidelines developed by the Dam Safety group can be found by searching the department’s website at www.dews.qld.gov.au:

- Guidelines for failure impact assessment of water dams
- Queensland dam safety management guidelines
- Provisional Emergency Action Planning For Referable Dams Guidelines –
- Guidelines on acceptable flood capacity for water dams
- Referable dams planning guideline

The redacted Emergency Action Plans for Referable Queensland dams, the CRC-Forge application, information on recent dam reviews and authorised dam safety officers are also available on our website.

In accordance with Queensland Dam Safety Management Guidelines, dam owners are required to develop a program for keeping the skills of their dam operation staff up to date through training programs, courses and ‘on the job’ training.

Many different types of entities own and operate referable dams in Queensland:

- Government corporations
- Local governments
- Private companies
- State Government
• Mining companies.

The Queensland Government established several commercial businesses in water: SunWater; South East Queensland Water (Seqwater) and Gladstone Area Water Board (GAWB). SunWater and Seqwater own the majority of the larger dams in Queensland: SunWater’s portfolio include 22 referable dams and Seqwater 26 referable dams.

SunWater and Seqwater have their own internal dam safety management system committing them to maintain appropriate safety standards in accordance with the relevant Queensland and ANCOLD Dam Safety Guidelines. Both companies have significant technical expertise and are proactive in providing appropriate training to their personnel.

SunWater usually runs two dam safety training sessions each year with the number of attendees capped at 20 and, when available, offers spare spots to the non-SunWater personnel (generally from the companies who are already receiving consultancy services from SunWater). The training is provided by SunWater’s engineers and two presenters from the NSW DSC. It is delivered over three days and includes an inspection of the local dam and an open book examination. Considering significant number of operators within SunWater, the opportunity for others to undertake this training is not always available, so every two to three years the dam safety group from the department has been organising an additional course to meet the demand for dam safety training. In 2015, dam operators from eight organisations (21 persons) participated in the course delivered by the department utilising the same presenters from the NSW DSC.

The 2016 SunWater’s Dam Safety training covered the following topics:

- Dam types, design and construction
- Risks to dam
- Lessons from dam incidents
- Queensland dam regulation requirements
- Documentation and operational issues
- Cracking and movement
- Piping
- Monitoring and instrumentation
- Operation and maintenance
- Post-earthquake inspection
- Dam spillways
- Inspection of concrete and embankment dams
- Spillways and outlet works
- Emergency Action Plans

Considering tight training schedule and a wide range of possible emergency arrangements for each dam, the Emergency Action Plans could not be covered in sufficient detail during this course and an additional (either internal or customised) training incorporating their emergency exercise should be arranged by the dam owners for their operators.

A similar arrangement is utilised by Seqwater, where all dam operators working at the gated dams are required to undertake regular dam safety training following by the site specific EAP training. The course requires operational staff to achieve competency in the following areas:

- the requirements of the flood manual
- the requirements of the Emergency Action Plans
- the operation and maintenance of the flood release infrastructure
- any restrictions on the operations of flood release infrastructure
- the requirements for dam safety monitoring and surveillance during flood events.

In order to maintain and enhance the abilities of flood operations staff, Seqwater also requires them to attend:

- Annual briefing (prior to 1 October each year) on the safety status of Dams including any operational restrictions that have been applied to the Dams, Flood Forecasting System updates and Spillway Adequacy Assessments
• Annual flood exercise that simulates a Flood Event and tests the application of the Dam Safety Strategy for their Dam.

The following desirable skills and experience are normally included in the vacant dam operator positions advertised by Seqwater:

• Relevant trade certificate or Water Industry Operations Certificate III.
• General knowledge of water infrastructure, water flow principles, and the operation of associated equipment and plant.
• Experience in the operation and maintenance of small plant and equipment.
• Minimum three years’ experience in operating water-related infrastructure.
• Sound computer skills including knowledge of SCADA and telemetry systems.
• Possess an Unrestricted C Class Driver’s License for manual vehicle (mandatory).
• Certificate in Confined Space Entry Systems (desirable).
• Senior First Aid Certificate. (desirable).
• Recreational Marine Driver’s License (desirable).
• Four Wheel Driving Basics (desirable)

Dam operators in Queensland, similar to staff in other states have access to the annual Dam Operator Forums and training courses delivered by ANCOLD and other Water Industry Associations (Section 4).

The Queensland Water Panel (Institution of Engineers Australia) also regularly organises technical presentations, workshops and symposiums related to the field of water engineering. The format and content of this well-established symposium series has been developed to encourage a forum of active participation for the sharing of new technologies, ideas, practices and information. These tend to be targeted at professional engineers.

2.1.1 2016 Dam Operator Training Survey

The first Referable Dam Operator Training Survey was carried out in in October 2016. The purpose of this survey was to assess compliance with the training requirements outlined in the Queensland Dam Safety Management Guidelines. The survey also provided an opportunity to gather information on the available Dam Safety courses, gauge level of satisfaction with the received training and to assess the need for Dam Safety Regulator involvement.

Considerable assistance during preparation for this survey was provided by the Coordinator Dams and Catchments from Townsville City Council. Information from the council was also incorporated in the survey. The questionnaire (Appendix A) was distributed on the 18th of October 2016 to thirty-one referable dam owners. Twenty-two responses were received during November -December 2016. The details of the 2015 Dam Surveillance training organised by the department and attended by the dam operators from Toowoomba, Tablelands and South Burnett Regional Councils, Cloncurry Shire Council and Evolution Mining were also utilised for supplementing this survey bringing the total percentage of responses to the questionnaire to 90 percent.

The results of the survey demonstrated that most Queensland referable dam owners comply with the training requirements and utilise at least one of the following training options:

• customised dam operator training delivered by the engineering consultancies (GHD Pty Ltd, Cardno Pty Ltd or WSP Parsons Brinckerhoff)
• SunWater’s dam operator training incorporating Safety Surveillance course delivered by the NSW DSC members
• Internal Seqwater dam operator training
• DEWS Dam Safety Surveillance course incorporating presentations and materials delivered by the NSW DSC members
• ANCOLD conferences, courses and seminars
• TAFE courses or studies through registered Training providers towards specific qualifications in Water Industry Operations (Mackay RC, Seqwater, Sunwater and Townsville City Council).

Though several dam owners have listed recognised qualifications as one of the training undertaken by their operators, it should be noted that in most instances this training covers other specialisations and may not
include specific units (‘Source’) relevant to the dam operation. To ensure these units are included in the training, the TCC operators have been split into three separate groups according to their work units and tasks performed. This allowed each group to undertake three core units and mixed electives from the Certificate III in Water Operations covering generic basics (water testing and operation of the chlorine disinfection system), water treatment processes, waste water treatment and dam operations (monitoring and operation of gated spillways, dam inspection and maintenance, instrumentation monitoring).

The cost of training undertaken by the dam operators in the last 2 years varied from $500 per person (every two years) for non-accredited courses to $10,000 per person (one-off) for achieving Diploma of Water Industry Operations. In the last two years, around 60 percent or eighteen dam owners utilised the non-accredited training provided by SunWater and DEWS through the NSW DSC. On average, exclusive of the accredited qualifications, the training cost for a 3-day dam safety training in 2015-2016 was around $1500 - $2250 per person. Frequency of the training is determined by the dam owner and varies from being provided to the operators annually to about 2 and 5-yearly.

The level of dam owner satisfaction with the received training (delivered by DEWS, SunWater or engineering consultants) measured on a scale from 0 to 5, varies from acceptable (3) to very satisfied (5). The following comment/issues were provided by the respondents:

- The need to re-vamp the outdated Dam Safety Course delivered by the NSW DSC members
- Difficulty to find a Registered Training Provider in Queensland
- Relevance of the training to the actual dam being operated.

Several smaller dam owners (2 mining companies and 2 private dam owners) do not provide any dam safety training to their staff sighting existing maintenance or water qualifications (treatment) as sufficient substitute, while two other private dam owners are utilising the available technical reports and Emergency Action Plans for their training purposes. One of the Local Councils reported that inadequate dam operator training has been recently identified and plans put in place for relevant staff to attend dam safety training in 2017. These responses highlight the areas where support from the Dam Safety Regulator may be appropriate.

A summary of the 2016 survey on the training requirements for Dam Operators in Queensland is presented in the Appendix B.

2.2 Australian Capital Territory (ACT)

The Utilities (Technical Regulation) Act 2014 sets out technical requirements for energy and water utilities in ACT. The specifics of any requirements are set out in technical codes such as dam safety and emergency planning.

The Director-General of the Environment and Planning Directorate is the Technical Regulator of utilities services. The group supporting the Technical Regulator is the Utilities Technical Regulation team (UTR) within Access Canberra, the regulatory arm of the Chief Minister Treasury and Economic Development Directorate (CMTEDD).

The ANCOLD Guidelines and NSW Dams Safety Committee Technical Guidance Sheets are the applicable Guidelines under the ACT Dam Safety Code. This Code also outlines the requirements for the Utility to provide adequate emergency training and ensure that its employees and officers understand, and have had training in, their duties and authorisations during an Emergency Event.

Thirty-four registrable dams are listed on the Access Canberra website with the selection based on the criteria specified in Table 3 of the ANCOLD Guidelines on Assessment of the Consequences of Dam Failure.

The training requirements outlined in the 2003 Dam Safety Management Guidelines and applicable to the registered dams in ACT are listed in s. 4.1 of this paper. The NSW Dam Operator training requirements have been utilized in ACT and these are explained in the Section 2.3. The NSW Dam Safety Committee (DSC) is one of the training providers operating in ACT. In 2016, the Committee run the first Accredited Dam Safety Surveillance Course in this state.
2.3 New South Wales

The mission of the NSW Dams Safety Committee (DSC), an independent statutory body, is to ensure the safety of prescribed dams. To achieve its mission, the DSC has set a number of objectives, which are defined in the DSC’s Strategic Plan and are aligned with the requirements of the Dams Safety Act 1978 which constitutes the DSC and defines its functions.

Under its Act, the DSC has roles to:

- Protect the safety, welfare and interests of the community from dam failure by ensuring that risks from prescribed dams are tolerable;
- Ensure that DSC safety requirements are met, that risks are properly managed, are regularly reviewed, and are further reduced to a level as low as reasonably practicable; and
- Ensure the risks to dams and their stored waters from the effects of mining are properly managed and tolerable.

To achieve its roles, the DSC follows a goals-based approach to dam safety regulation. With such regulation, the means of achieving compliance is not specified but instead goals are set that allow alternatives for achieving compliance. The responsibility for dam safety lies principally with the dam owner, while the DSC has a challenge/audit role. As of 30th June 2016, there were 390 prescribed dams in NSW, with ownership broadly grouped as shown in the table below:

<table>
<thead>
<tr>
<th>Dam Owner</th>
<th>Prescribed Dams</th>
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<tbody>
<tr>
<td>Water Corporations (Government owned)</td>
<td>59</td>
</tr>
<tr>
<td>Snowy Hydro Ltd (part Government owned) and other Power Generating Companies</td>
<td>34</td>
</tr>
<tr>
<td>Local Government (Councils and Water Utilities)</td>
<td>146</td>
</tr>
<tr>
<td>Other NSW Government Authorities</td>
<td>12</td>
</tr>
<tr>
<td>Mining Companies (Water and Tailing Dams)</td>
<td>108</td>
</tr>
<tr>
<td>Private Owners</td>
<td>28</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>390</strong></td>
</tr>
</tbody>
</table>

In accordance with the Technical Guidance Sheets DSC2F ‘Operation and Maintenance for Dams’ and DSC2C ‘Surveillance Reports for Dams’, ‘owners of prescribed dams are required to ensure that there are appropriately trained and experienced personnel available to operate, undertake surveillance and maintain their dams in accordance with their Operation and Maintenance Manuals. Owners of Extreme, High and Significant Consequence Category Dams are required to have training plans in place for their staff and ensure that their staff have attended a recognised course in dam safety. Further, those owners shall have a policy of ongoing staff education to include, as a minimum, refresher courses at regular intervals (i.e. 5 yearly for Extreme and High A Consequence Category dams ranging out to 10 yearly for Significant Consequence Category dams) to ensure they are kept up to date with latest developments in surveillance practices and maintain their knowledge of surveillance procedures’.

The DSC believes that dam safety and surveillance training is very important for operators of NSW prescribed dams. During 2015/16 the DSC was involved in organising and running three dam safety training courses:
• Two dam safety/surveillance courses for water dam operators and other dam staff held at Port Macquarie (one in late 2015 and the other in early 2016. These two courses each attracted close to the fully subscribed 30 participants); and
• The DSC’s second ever TAFE accredited dam safety/surveillance course also held in 2016 in Tamworth and it was attended by a fully subscribed complement of 20 participants.

Since the inception of the standard training program more than twenty years ago and enhancement since then, these training courses have resulted in a noticeable improvement in the general standard of dam owners’ dam safety management. This training course work is seen as an important part of the DSC’s education role for dam owners.

Topics covered in both courses:

• Regulatory requirements
• Types of dams and their design
• Historical incidents involving dams
• Surveillance inspection of embankment dams
• Surveillance inspection of concrete dams
• Surveillance inspection of spillways, outlet works
• Reporting on inspections
• Surveillance inspection after earthquake
• Operation of dams
• Maintenance of dams
• Dam Construction
• Legal obligations of dam owners/operators
• Site Inspections of two local dams
• Dam Security and Access issue

2.3.1 Non-Accredited Dam Safety Surveillance Course

Based on the course flyer for 2017, the non-accredited course runs for a total of 4 days and Certificate of attendance is awarded after the course. The cost is $2650, which covers accommodation, meals, two manuals (Practical Surveillance Inspection of Dams Manual and Field Manual of Dam Surveillance) and the course handouts of Power Point presentations.

Recently the course assessment process has become more rigorous as the seminar is becoming aligned with the 4 Certificate III units Water Industry Training Package and include the following three phases:

• Preparation of an Inspection Report on an actual dam visit
• An examination covering the training material
• A one-on-one question and answer session based on Power Point slides of various dam issues.

2.3.2 Accredited Dam Safety Surveillance Course

The course runs for a total of five days. A TAFE Skill Set Certificate (4 modules of Certificate III Water Operations – Dam Safety) is awarded to successful attendees after the course (otherwise Certificate of Attendance is awarded). The cost is $4,100 which covers accommodation, meals and other materials as per ‘Surveillance course’

The Certificate III Units are as follows:

• Monitor and Control Dam Operations
• Monitor and implement Dam Maintenance
• Inspect and Report on Concrete Dams Safety
• Inspect and Report on Embankment Dams Safety
• Conduct and Report Dam Safety
• Instrumentation Monitoring

The assessment procedure consists of the following four phases:

• Preparation of an Inspection Report on an actual dam visit;
• Examinations;
• A one-on-one question and answer session based on Power Point slides of various dam issues;
• A dam project started at the course and completed after the course and submitted to the Dams Safety Committee (DSC) as a PDF file.
2.3.3 Other training materials

The NSW DSC Training Library provides a link to the Training Aids for Dam Safety (TADS): a self-paced training course in Dam Safety Practices available from the FEMA Publications Warehouse at no cost. Alternatively, the 21 TADS manuals could be viewed on-line or downloaded as PDF files from the NSW DSC website. The movies supporting the manuals are too large for uploading and can be borrowed from DSC as a Video or DVD for 4 weeks.

The 21 manuals consist of the following:

**10 Manuals on Dam Safety Inspection**

(These manuals are designed for engineers with little or no inspection experience and for technicians with some familiarity with dams.)

1. Preparing to conduct a Dam Safety Inspection
2. Documenting and Reporting Findings from a Dam Safety Inspection
3. Inspection of Embankment Dams
4. Inspection of Concrete and Masonry Dams
5. Inspection of the Foundation, Abutments and Reservoir Rim
6. Inspection of Spillways and Outlet Works
7. Inspection and Testing of Gates, Valves and other Mechanical Systems
8. Identification of Material Deficiencies
9. Instrumentation for Embankment and Concrete Dams

**5 Manuals on Dam Safety Awareness, Organisation and Implementation**

(These manuals are designed primarily for dam owners and operators.)

11. Dam Safety Awareness
12. How to Organise a Dam Safety Program
13. How to Organise an Operation and Maintenance Program
14. How to Develop and Implement an Emergency Action Plan
15. Identification of Visual Dam Safety Deficiencies

**6 Manuals on Data Review, Investigation, Analysis and Remedial Actions for Dam Safety**

(These manuals are designed dam safety program managers, dam owners and operators, and experienced engineers. The focus of these modules is on the when, why, and typically what investigations and analyses are conducted. The modules do not explain how to conduct specific investigations or analyses)

16. Evaluation of Hydrologic Adequacy
17. Evaluation of Seepage Conditions
18. Evaluation of Embankment Dam Stability and Deformation
19. Evaluation of Concrete Dam Stability
20. Evaluation of Hydraulic Adequacy
21. Dam Safety Process

The DSC published a list of articles (dated from 1979 to 2012) relevant to dam safety and available for viewing at the Dams Safety Committee office in Parramatta. The committee also prepared and published on their website a series of Guidance Sheets to assist dam owners, related stakeholders and the public in obtaining relevant information on dams and aspects that affect their safety. These sheets are split into three sections: general guidance, dam guidance and mining guidance. The following topics are covered in the first two sections:

1. **General guidance**
   - DSC Background, Functions and Operations.

2. **Dam guidance**
   - Consequence Categories for Dams
   - Acceptable Flood Capacity for Dams
Eleven templates identifying specific information required by the Committee from dam owners are currently published on their website. These forms cover the following topics:

- Basic Data Form for dams
- Notice of intention to design or modify a dam
- Notice of intention to construct a dam
- Notice of completion of construction of a new or modified dam
- Surveillance Report Type 3 (Appendix 3)
- Flood Security Status Form
- Dam Owners Address Form
- Construction Certificate
- Status of Safety Management System Reporting Form
- Requirements for Surveillance Reports
- Checklist for Formulating Dam Safety Emergency Plans (DSEPs)

The NSW DS Committee's website also outlines specific actions and information required from the dam owner during design, construction and the whole lifespan of a dam.

### 2.4 Victoria

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 Water Group of the Department of Environment and Primary Industries (DEPI) on behalf of the Minister for Water.

The DEPI regulates dams owned and managed by public entities such as water corporations (over 300 dams), local government and Parks Victoria, and private dams owned by farmers and hydro-power producers. The Dam Safety Advisory Committee provides specialist advice to DEPI on regulation of dam safety.

Under the Water Act 1989 dam owners are responsible for dam safety and accountable for the damage their dams may cause if they fail. Dam safety regulation in Victoria requires that all managers of dams with the potential to cause significant impacts have dam safety management programs in place, and demonstrate a sound level of dam safety practice. This includes the use of suitably qualified and trained personnel in undertaking dam safety activities.

Victoria’s state-owned water sector is made up of 19 water corporations constituted under the Water Act 1989. The safety of dams owned by Victoria’s water corporations is regulated through a Statement of Obligations (SoOs) issued to water corporations by the Minister for Water under the Water Industry Act 1994. Guidelines produced by ANCOLD are recognised by DEPI as representing the current industry position for dam safety management. The SoOs for water corporation dams and the licensing conditions for private dams refer to these documents, as do regulations and guidance material of other jurisdictions across Australia.
The majority of regulatory functions for privately owned dams in Victoria, including powers to undertake emergency action where there is an immediate dam safety risk to the community, have been delegated to five licensing authorities (water corporations):

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

The Strategic Framework for Dam Safety Regulation published by the Victorian Government in 2014, outlines current and future regulatory approach towards sustaining appropriate level of knowledge and skills in the water industry, including:

- coordinating periodic seminars on various aspects of dam safety
- providing information on dam safety, duty of care, due diligence and risk management in the director development program for water corporation boards and
- support and participation in the water corporation’s earthquake monitoring network and warning arrangements.

The Water Industry Dams Working Group (WIDWG) formed in 1997 by the Victorian Regulator, consists of representatives from Water Corporations with large dams within Victoria and major public and private dam owners. DEPI has continued to be a member of the WIDWG to maintain direct links between dam operators and the Dam Safety Regulator. Some of the WIDWG achievements include the funding of a State-wide seismic monitoring network, development of Dams Decommissioning and Training guidelines, conducting a workshop on the Dam Safety Implications of Drought, input to National training modules, ANCOLD guideline reviews, facilitating work experience placements between members and an improved understanding of the industry requirements for members who do not have full time reservoir and dams engineering staff.

The DEPI continues to work and support the WIDWG and ANCOLD in their initiatives to address skills shortages, such as the National Training Package for the water industry. These include promoting the availability and quality of dam safety training through water industry training providers and tertiary institutions, and promoting the development of contractual relationships between dam managers to enable the sharing of skills and resources.

In 2014 the DEPI hosted a free training session for local Councils on dam safety, maintenance and surveillance. A similar training was offered by the Victorian Department of Sustainability and Environment (DSE) and SMEC consultants in 2013. This training session was targeted towards dam owners and operators responsible for the operation and maintenance of small but potentially hazardous dams and retarding basins.

The DEPI website provides links to other useful resources such as ANCOLD, Bureau of Reclamation (US), NSW Dam Safety Committee and Australian Water industry bodies. The following local associations assisting their members by organising industry training through conferences, workshops, visits and study tours have been also listed on the DEPI website:

- Water Industry Operators Association (WIOA)
- Australian Water Association (AWA)
- Institute of Water Administration (IWA)
- Victorian Water Industry Association (VicWater)
- Water Services Association of Australia (WSAA)

Most of the training offered by these organisations covers water and wastewater treatment operations. However, one of the associations involved in organising/providing training related specifically to the dam operations is VicWater - the peak industry association for water corporations in Victoria.

In 2015, the VicWater ran free (excluding cost of dinner and accommodation) 2-day ‘Victorian Water Industry Dams Seminar’ which included a set of topics ranging from risk based surveillance, instrumentation and innovation, operation and maintenance, to the emergency management and dam decommissioning.
Engineering consultancies such as SMEC and GHD also offer dam safety training to the water industry in Victoria.

In 2006 the WIDWG developed the first Victorian Dam Operators Training Guideline based on the then current version of the Water Training Package (WTP) which provided guidance on the minimum training requirements for operators to demonstrate competency in routine and emergency operation of dams:

<table>
<thead>
<tr>
<th>Level</th>
<th>Level of Dam Related Responsibility</th>
<th>Minimum Module Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQF2</td>
<td>Under supervision of an experienced person, undertakes:</td>
<td>NWP241A – Catchment Flood Routing and Surveillance (not required if all dams are off-stream storages).</td>
</tr>
<tr>
<td>AQF3</td>
<td>Undertakes surveillance on High to Extreme Hazard dams</td>
<td>NWP320A(4) Inspection and Coordination of Dam Operation and Maintenance.</td>
</tr>
<tr>
<td>AQF4</td>
<td>Supervisors in charge of team managing High Hazard dams as part or whole of position responsibility.</td>
<td>NWP511A – Manage Dam Safety Surveillance.</td>
</tr>
</tbody>
</table>

# Training modules to be a minimum entrance level requirement OR completed within 24 months of an appointment.

Notes:
1. The above competencies are based on staff responsibilities and Hazard categories outlined in ANCOLD Guidelines on Assessment of the Consequences of Dam Failure.
2. Competency requirements are not lessened if operator duties are less than full time on dams.
3. Dams Operators includes engineers/managers of dams who may have existing qualifications but no dams specific training.
4. A Workbook for module NWP320A has been written for Barwon Water in conjunction with Ballarat TAFE.
5. Proposed module could incorporate Regulators training requirements, types of exercising (i.e. Desktop), emergency types, participating organisations, documentation, etc.
2.5 Tasmania

The Water Management Act 1999 (‘the Act’) and the Water Management (Safety of Dams) Regulations 2015 (‘the Regulations’) ensure owners of existing dams meet their dam safety responsibilities.

At present, the Legislation is administered by the Department of Primary Industries, Parks, Water and Environment (DPIPWE).

The water industry in Tasmania comprises three bulk water authorities and twenty-nine local government authorities. A typical entry to the industry is through the plumbing trade. Some councils employ plumbers to operate their water facilities, and development of specific water industry skills normally occurs in the workplace. The main additions to plumbing trade skills required to work in the water industry are in the areas of hydraulics and knowledge of environmental issues. Other councils and bulk water authorities tend to employ staff under the traineeship system, through the Certificate II Water Industry Operations.

Previously, the majority of training demand in Tasmania was met through the TAFE system. However, two of the Tasmanian bulk water authorities were accessing the Victorian Water Industry Training Centre for staff training in the Certificate III Water Industry Operations qualification. This provider was considered to hold the necessary specialist skills for training water industry workers that were not available in Tasmania. The RTO search in November 2016, demonstrated that at present there is one company (Water Training Australia) with a Funding Agreement to deliver a subsidised training for apprentices and trainees in Tasmania (i.e. for Certificate III in Water Operations a subsidy of $3801.00 is available to existing employees).

Analysis of the consultancies listed on the DPIPWE website revealed that Hydro Tasmania (ENTURA) and GHD also provide dam safety training.

Hydro Tasmania (ENTURA) offers two types of training:

- 1 day Dam safety overview course includes topics such as: legislative requirements, industry practice, risk assessment and management, governance and
- 5 – 7 days Dam safety principles and practice course includes consideration of types of dams and related structures such as earth filled dams, rockfill dams, concrete dams, spillways and floodgates, forebays, diversions, intakes and outakes, and tailraces. This course is aimed mainly at Dam safety managers and engineers, but can be customised in content and duration to suit participant requirements.

Topics covered in the 5 – 7 days dam safety course:

<table>
<thead>
<tr>
<th>BACKGROUND AND OVERVIEW OF DAM SAFETY</th>
<th>History of dams and dam safety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Types of dams</td>
</tr>
<tr>
<td></td>
<td>Elements of an effective dam safety program</td>
</tr>
<tr>
<td></td>
<td>Governance, legal compliance and liability</td>
</tr>
<tr>
<td></td>
<td>Industry practice and guidelines</td>
</tr>
<tr>
<td></td>
<td>National and international standards</td>
</tr>
<tr>
<td>DAM SAFETY PLANNING</td>
<td>Dam safety risk assessment</td>
</tr>
<tr>
<td></td>
<td>Dam safety program design</td>
</tr>
<tr>
<td></td>
<td>Portfolio risk assessment</td>
</tr>
<tr>
<td></td>
<td>Dam break modelling</td>
</tr>
<tr>
<td></td>
<td>Emergency response planning</td>
</tr>
<tr>
<td>DAM OPERATION AND MAINTENANCE</td>
<td>Inspections</td>
</tr>
<tr>
<td></td>
<td>Monitoring</td>
</tr>
<tr>
<td></td>
<td>Data management</td>
</tr>
<tr>
<td></td>
<td>AMS (automated dam monitoring system)</td>
</tr>
<tr>
<td></td>
<td>Condition and deficiency evaluations</td>
</tr>
<tr>
<td></td>
<td>Operation and maintenance</td>
</tr>
<tr>
<td></td>
<td>Dam upgrades</td>
</tr>
<tr>
<td></td>
<td>Failure modes surveillance</td>
</tr>
<tr>
<td></td>
<td>Failure modes response</td>
</tr>
</tbody>
</table>
Further research revealed that the RTO status obtained by Entura, allows the company to deliver accredited courses in the dam safety field for eight qualifications from Certificate II to diploma level programs with:

- Six of these are qualifications under the generation sector training package, with a focus on hydropower operations and maintenance and
- Two qualifications in water operations primarily focused on dam safety. To achieve this skill set the candidate would normally demonstrate competency in at least three units of competency from those listed below:
  
  a. NWPSOU022 – Monitor and control dam operations
  b. NWPSOU023 – Monitor and implement dam maintenance
  c. NWPSOU024 – Inspect and report on concrete dam safety
  d. NWPSOU025 – Inspect and report on embankment dam safety
  e. NWPSOU029 – Conduct and report dam safety instrumentation monitoring

3. Australian Quality Training Framework and changes to the National Water Training Package (NWP)

The Australian Quality Training Framework (AQTF) is the national set of standards which assures nationally consistent, high-quality training and assessment services for the clients of Australia’s vocational education and training system. The AQTF defines all Australian qualifications. It provides a single framework for all qualifications from Secondary School to PhD where the Dam Operator qualifications are covered by the Vocational Education and Training (VET) sector.

In April 2014, the Council of Australian Governments (COAG) Industry and Skills Council agreed to six objectives for reform of the VET system. One of those objectives was ‘a national system of qualifications that is able to respond flexibly to major national and state priorities and emerging areas of skills needs’.

In October 2014, the Review of Training Packages and Accredited Courses discussion paper was released which initiated a suite of reforms to the training system. During public consultations, stakeholders expressed a high level of support for a stronger role for industry in the development of training packages, including views of small and medium enterprises.

On 21 April 2015, the new model for Training Product Development for Australian Industry was announced. To improve responsiveness and flexibility in the system, the new model places industry at the centre of training product development through industry reference committees which are overseen by the industry-led Australian Industry and Skills Committee.

The Industry Reference Committees (IRCs) are made up of people with experience, skills and knowledge of their particular industry sector.

This model enables industry to prioritise the development and review of training packages based on the risk associated with the particular qualification, industry demand for skills, now and into the future, and technological and regulatory changes. Under the current system of training packages, units are ‘owned’ and developed by an industry and housed in that industry’s training package.

New arrangements for developing training products came into effect on 1 January 2016 and the Water Industry Reference Committee (WIRC) has been assigned responsibility for the National Water Training Package. The committee is led by John Harris (Wannon Water) and George Wall (Water Industry Operators Association of Australia). The focus of the committee is on helping industry to develop world-class qualifications for their workforce.

3.1 New Qualification in Water Operations

The new NWP National Water Training Package came into effect from December 2015 and contains the following qualifications:

- Certificate II in Water Industry Operations (NWP30215 new/NWP30107 old)
• Certificate III in Water Industry Irrigation
• Certificate III in Water Industry Treatment
• Certificate III in Water Industry Operations
• Certificate IV in Water Industry Treatment
• Certificate IV in Water Industry Operations
• Diploma of Water Industry Operations

NWP Water Training Package provides the only nationally recognised VET qualifications for occupations involved in: water industry operations (generalist, networks, source, irrigation, hydrography, trade waste), treatment (drinking water, waste water) and irrigation:

1. The general qualification covers the skills required to operate in a broad range of water operations
2. The networks specialisation covers the skills required to monitor, operate and maintain water and/or wastewater network operations.
3. The source specialisation covers the skills required to monitor, operate and maintain source operations (catchment, weirs, locks, dams, rivers, reservoirs, bulk water and groundwater management).
4. The hydrography specialisation covers the skills required to monitor, operate and maintain hydrography operations.
5. The irrigation specialisation covers the skills required to build, operate and maintain irrigation delivery and drainage infrastructure.
6. The treatment specialisation covers water treatment and recycled water management.

Where a defined specialisation is completed, the resultant testamur can include a field of study, e.g. Certificate II in Water Industry Operations (Source).

Eleven units of competency are required for each level of qualification: two core units and nine elective units. The following tables identify the unit requirements within the Certificate II and Certificate III studies.

Methods of assessments vary from unit to unit and require competencies to be assessed in an operational work environment utilising workplace resources and equipment. The industry strongly encourages practical assessment of skills and knowledge and encourages on the job assessment, mentoring and coaching. However, assessment in the workplace is not always possible and in some cases, it is not practical or safe to conduct assessment in the workplace and it will be necessary to provide a simulated environment.

Please refer the Appendix D for information on the units available within each Certificate.

### 3.2 Qualifications in Water Operations, Queensland

The details of the registered training providers (RTP) and available funding/subsidies are provided on the Queensland Skills Gateway website: www.skillsgateway.training.qld.gov.au

The number of RTPs offering services in Queensland has increased from six in August 2016 to eight in November 2016 with four organisations (Chisholm Institute, Simmonds and Bristow Pty Ltd, TAFE Queensland Skills Tech and Water Training Australia) funded through different schemes, though only two of them (Simmonds and Bristow Pty Ltd and Water Training Australia) are offering the ‘source’ specialization.

The Australian Department of Education and Training (myskills) provides information on the financial support offered for specific training in every state. For example, subsidies are available for people undertaking:

- Certificate II in Water Operations - in NSW, Tasmania and Victoria

The Certificate III in Water Industry Operations training offered in NSW (TAFE-Riverina Institute) is subsidised by the NSW Government and the fee for eligible students is $1370 and at the TAFE-Western Institute – up to $1600 for eligible students.


At present, Queensland TAFE does not offer Certificate III with ‘source’ specialisation, however funding for this qualification is available under the User Choice Program for existing and new water industry employees in Queensland. Both Certificate II Water Operations and Certificate III Water Operations are currently subsidised.
as ‘Priority 1’ qualifications under the *User Choice Program* and the attainment of previous qualifications does not necessarily have an impact on eligibility unless the prior qualification/s were also funded through User Choice. As per the current User Choice Policy, a participant can access *User Choice* funding twice (i.e. complete two funded qualifications) provided that the second funded qualification is a Priority 1, a higher level than the first and higher priority than the first.

Only Registered training organisations (RTOs) that are pre-qualified suppliers with the Department of Education and Training (DET) can deliver training under the *User Choice Program*. The subsidy is paid directly to the RTO on completion of units and reporting to DET. Registered training organisations (RTOs) are training providers registered by ASQA (or, in some cases, a state regulator) to deliver vocational education and training (VET) service.

A compulsory student services fee (paid by the employer or employee) must be charged by the RTO, this is a per nominal hour fee and is generally in the vicinity of $600-800 per student (for Certificate II and III Water Operations qualifications).

Students must be signed up to a formal training contract though an Apprenticeship Network Provider to access *User Choice* funding. For further details on specific eligibility requirements local Apprenticeship Network Advisor should be contacted.

### Table 1.- High priority qualifications for User Choice and Certificate 3 Guarantee Programs 2016-17, Queensland (Last updated 5 September 2016)

<table>
<thead>
<tr>
<th>Industry Training Group</th>
<th>Qualification Description (Traineeship)</th>
<th>Qualification Code</th>
<th>User Choice</th>
<th>Cert. 3 Guarantee</th>
<th>Max. Payable Competencies</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilities - Water</td>
<td>Certificate III in Water Industry Operations</td>
<td>NWP30215</td>
<td>V</td>
<td>V</td>
<td>11</td>
<td>$6,270</td>
</tr>
<tr>
<td>Utilities - Water</td>
<td>Certificate III in Water Industry Treatment</td>
<td>NWP30315</td>
<td>V</td>
<td>V</td>
<td>11</td>
<td>$6,270</td>
</tr>
<tr>
<td>Utilities - Water</td>
<td>Certificate III in Water Industry Irrigation</td>
<td>NWP30415</td>
<td>V</td>
<td>V</td>
<td>11</td>
<td>$6,270</td>
</tr>
</tbody>
</table>

For more details please refer to the Appendix E ‘Queensland Government, Subsidised training and incentives’.

On the 29 August 2016, Qldwater initiated a survey of the RTOs offering training in the National Water Training Package in Queensland. Appendix F includes the results of that survey relevant to the dam operator training and provides information on the proposed modes of delivery and approximate costs.

### 3.3 Water Training Australia (WTA)

Water Training Australia has been contacted directly in September 2016 as the only known registered training provider delivering ‘source’ units in Queensland at that time. Information received from the Managing Director of WTA has been included in this report as it provides insight into the training specifics from the provider’s point of view.

WTA has been delivering Dam Operator training in Queensland, New South Wales, Victoria, South Australia, Australian Capital Territory, Tasmania and Northern Territory for 10 years. The company trained 760 operators in the groups limited to 12 people. The following six Queensland companies utilised this training: Origin Energy, Arrow Energy, Townsville City Council, Seqwater, BHP Billington and Rio Tinto.

The length of the dam operator training through WTA depends on the specific requirements, i.e. a single unit takes around 2-3 days, while a study towards Certificate III requires around 12-14 months with 2-3 days spent
on the workshops and field trips/inspections for each of the 11 units that make up the qualification. Each operator receives an extensive training manual for each of the 11 units and is asked to write reports on their dam performance and undertake specific projects relating to their dam. Assessments are via responses to written questions, observing on the job activities such as adjusting regulating valves/gates, dewatering conduits, conducting inspections and interrogating instruments.

The average cost for a non-subsidised qualification at Certificate II level is around $4,000 per person, Certificate III - $5,000 per person and Certificate IV - $6,000 per person.

The Managing Director of WTA advised that the new NWP Water Industry Training Package (December 2015) re-introduced ‘Flood Routing’ (NWPSOU027) training as one of its electives. In the last five years, the company has seen a notable increase in the training requests from small dam owners including coal seam gas, mining and small water authorities and shires, operating smaller storages and wastewater lagoons. More recently, there has been also an increased demand for dam safety refresher training covering the dams with earthen embankments.

4. Australian Water Industry Associations

4.1 The Australian National Committee on Large Dams Inc

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 develops and publishes guidelines which represent the best engineering practice and provide a basis for consistency across the dam’s industry in Australia. In most cases, the state regulations require compliance with the ANCOLD guidelines.

Facilitating the ongoing education of professionals working in the dam’s industry is a key ANCOLD objective. Minimum training requirements for the dam operators have been outlined in the 2003 ANCOLD Dam Safety Management Guidelines and include training courses and seminars, meetings, using up to date guidelines and training materials. Principal areas of knowledge for dam inspectors and other field personnel should cover:

- Dam failure modes
- Awareness of visual signs of dam safety deficiencies
- Operation and maintenance procedures
- Emergency response
- Surveillance principles including monitoring.

ANCOLD offers regular face-to-face and on-line courses covering dam operation and management. One of such courses delivered in Brisbane, Sydney and Melbourne in 2014 (at a fee of $675 per person for ANCOLD members) covered the following topics:

- Dam types and issues (new and existing)
- Risk assessment
- Foundation types, investigation and design
- Construction of embankment and concrete dams
- Foundations -preparation and treatment

In the past, ANCOLD has been delivering approximately between two to four Continued Professional Development (CPD) approved training courses/seminars in the Australian state capitals (Brisbane, Melbourne etc.) every year. Some of these courses were:

- ‘Dam Types, Foundations and Construction’
- ‘Spillway and Outlets’
- ‘Hydrology, Dambreak and Consequences’
- ‘Retarding Basin Fundamentals’
- ‘Internal Erosion and Piping of Dams’

Since 2012 the ANCOLD’s Professional Development Working Group has been developing a series of dam related short courses, workshops, seminars and webinars to be brought out progressively across Australia.
Sixty video presentations given by the world class experts in a variety of dam safety topics are now available for purchase from the ANCOLD website with prices ranging from $25-$80 per module to $240 for the full course/seminar (4 modules).

Every year ANCOLD's organizes a Conference for the dam owners and operators, engineers, geoscientists, regulators where they can share ideas and knowledge on management, maintenance and design of water dams.

ANCOLD's annual Dam Operators Forum is another event providing an opportunity for dam operators to meet colleagues from the dam community, share knowledge, expertise and new developments. The two days Forum organised in Wodonga in 2016 ($1800 per person) included a full day tour of Hume and Dartmouth Dams and covered the following topics:

- Managing Water Resources
- Maintenance of Dams Assets
- Optimising Dam Operations
- Planning and Preparing Dams for Unusual Conditions
- Innovation in Dam Operations and Maintenance

Over three hundred technical papers are available for download from the ANCOLD website and the links to the overseas organizations, such as International Committee on Large Dams (ICOLD), Canadian Dams Association (CDA), U.S. Bureau of Reclamation (USBR) and British Dams Society (BDS). These resources provide the opportunity to follow new developments in other countries and utilize available knowledge/training resources.

4.2 Australian Water Association (AWA)

The Australian Water Association is the national peak water organisation, delivering information, expertise and collaboration for sustainable water management. The AWA membership includes professionals and practitioners working in utilities, science and research, energy and resources, manufacturing and agriculture across all Australian States and Territories.

The AWA has not traditionally been involved with dams. The activities by the AWA include:

- A comprehensive program of conferences including Ozwater - Australia’s largest water industry event.
- Workshops, forums, summits and technical seminars
- A wealth of online and print technical and industry information and news
- Industry programs and projects offering significant opportunities
- Training courses (including online training and webinar series)
- Professional networking
- B2B, business matching and mentoring opportunities

AWA is running a specialist network LinkedIn group. This network aims to raise the profile and importance of Operations in the water industry, create meaningful networking and knowledge sharing opportunities for all members and run from a Committee with strong national representation.

This Network includes people working in all areas of water industry operations, from the catchments and dams, through to treatment processes - water, wastewater, recycled water, desalination, industrial water - and their associated transport systems, in both public and privately run businesses.

4.3 Water Industry Operators Association (WIOA)

WIOA is a national non-for-profit association with a primary role of facilitating the collection, development and exchange of quality information between people undertaking operational roles in the water, wastewater and recycled water industries. WIOA holds Annual Water Industry Operations Conference and Exhibition in Queensland and other states.
The Association organises and funds Member seminars to meet the objectives of continually upgrading knowledge. These seminars are informative and topical given the ongoing changes to the structure of, and technologies employed in, the water industry.

The WIOA website include a page ‘Operator Resources Home’ with links to the information that could be used by operational people in the water industry to improve their efficiency, knowledge or skills. WIOA regularly produces two publications: a journal entitled ‘WaterWorks’ and a quarterly newsletter entitled ‘Operator’.

The 42nd Queensland Water Industry Operations Conference and Exhibition will be held in the Logan Metro Sports Centre on 7 and 8 June 2017. The Admission fee for the full conference is $550 per person.

4.4 Water Services Association of Australia (WSAA)

The Water Services Association of Australia (WSAA) is the peak industry body representing the urban water industry and focusing on the following areas:

1. influencing national and state policies on the provision of urban water services and sustainable water resource management
2. promoting debate on environmentally sustainable development and management of water resources and the community health requirements of public water supplies
3. improving industry performance and establishing benchmarks and industry leading practices for water service processes and
4. fostering the exchange of information on education, training, research, water and wastewater management and treatment and other matters of common interest.

A significant number of the local Councils has WSAA membership and publications produced by these associations could be utilised as one of the methods to distribute information relevant to the Dam Safety operators.

Recently WSAA has formed a group specifically for dam owners and published four water Information Packs. The Dam Information Pack (www.wsaa.asn.au/publication/dams-information-pack) was the first report covering key topics relating to water supply and security in Australia.
5. United States dam safety regulation and dam operator training requirements

In the United States, there are both federal and state laws that deal with dam safety. While most states have established dam safety regulations to cover private dam owners and owners with small portfolios of dams, the United States Bureau of Reclamation and United States Corp of Army Engineers, both of which are federally owned agencies with large portfolios of dams, are self-regulated.

Although most infrastructure facilities, such as roads, bridges and sewer systems are owned by public entities, the majority of dams in the United States are privately owned. In general, very large dams are owned and regulated by the federal government.

5.1 Federal law on dam safety

The tragic failure of the Buffalo Creek Dam in 1972 was a prelude to a number of federal actions, which prompted President Jimmy Carter to create the Federal Emergency Management Agency (FEMA) in 1979 and Congress to pass Public Law 104-303 to provide the country with a legislatively mandated National Dam Safety Program (NDSP) in 1996).

The mission of FEMA is to support citizens and first responders as to prepare for, protect against, respond to, recover from, and mitigate all hazards, whether natural or manmade. Dam safety stewardship, led by FEMA, is a coalition of federal, state, local, tribal and territorial partners united in a common purpose to encourage individual and community responsibility for dam safety. One of the FEMA’s primary goals is to promote research and training for state dam safety and other professionals with the following objectives:

- Establish and implement a national course of study for state dam safety professionals.
- Improve the awareness and understanding of dam risks for other professionals with roles in dam risk management.
- Promote understanding of the knowledge and techniques needed to safely evaluate, operate, maintain, design, and construct dams.

Federal agencies involved with dam safety, either as owners and/or regulators, include the following:

- U.S. Department of Agriculture
  - Natural Resources Conservation Service
  - Agriculture Research Service
- Department of Defense
  - Army Corps of Engineers
    - Engineer Research and Development Center
    - Hydrologic Engineering Center (HEC)
- Department of the Interior
  - Bureau of Indian Affairs
  - Bureau of Land Management
  - Bureau of Reclamation
  - Fish and Wildlife Service
  - National Park Service
  - Office of Surface Mining
- Federal Energy Regulatory Commission
- Mine Safety and Health Administration
- International Boundary and Water Commission (U.S. Section)
- Nuclear Regulatory Commission
- Tennessee Valley Authority
Together the agencies listed above make up the Interagency Committee on Dam Safety (ICODS), overseen by FEMA as head of the National Dam Safety Program (NDSP). The Federal Guidelines on Dam Safety prepared by ICODS outline the internal, academic and professional dam safety training requirements with the training in the following areas required to be provided to the operation and maintenance personnel:

- dam operation and inspection
- observations and instrumentation monitoring
- problem detection and evaluation, and application of appropriate remedial (emergency and non-emergency) measures.

A sufficient number of personnel is required to be trained to ensure adequate coverage of all tasks at all times. If a dam is operated remotely training must include procedures for dispatching trained personnel to the site at any reported indication of distress. The training must cover the types of information needed to prepare for the inspections, critical features that should be observed, inspection techniques, and preparation of inspection reports.

FEMA website contains an extensive list of documentation on Dam Safety, including publications, technical manuals, guides, videos and software, federal guidelines and information on the National Dam Safety Program. The ‘Pocket Safety Guide for Dams and Impoundments’ (Appendix G, www.fema.gov/media-library-data/1478633654726-9b1587e1cbbe6898d38baa92c95d1f6f16/FEMAP-911.pdf) is one of the recently developed pamphlets providing dam owners with a quick reference when assessing low hazard dams and impoundments.

FEMA NDSP and its federal, state, local, tribal and territorial partners all offer a wide range of training to people who work in the dam sector through traditional and digital means. Whether through online or classroom training, the knowledge that is necessary to improve the Nation’s infrastructure is readily available at little or no cost.

Training activities conducted under the NDSP fall under one of three components:

- **National training opportunities**, most of which are conducted at the FEMA Emergency Management Institute
- **Regional training** conducted by the Association of State Dam Safety Officials (ASDSO) and other private vendors
- **Local training** through direct assistance to the states and self-paced training.

### 5.2 The Association of Dam Safety Officials (ASDSO)

The Association of State Dam Safety Officials is a national non-profit organization dedicated to improving dam safety in the U.S. ASDSO was created in 1983 in response to an urgent need for establishing and strengthening state dam safety programs and improving interstate communication about dam safety.

The ASDSO has made significant achievements through pursuing a cohesive national approach to dam safety, raising awareness, providing technical training, establishing forums for information exchange, facilitating financing for dam safety activities, and supporting its members.

The Association of State Dam Safety Officials notes in its brochure ‘Dam Failure and Owner Liability’ that there are approximately 10 to 20 dam failures each year in the United States. Many of these results in catastrophic impact on communities, private property, and public works downstream, including loss of life. Owner liability varies from state to state depending on statutes, regulations and case law. However, the concept of strict liability falls heavily on the dam owner for damages regardless of the cause of the failure. ASDSO notes that to manage risks and control potential loss an owner will need to provide employee training, regular maintenance, emergency preparedness, and liability insurance.

ASDSO’s training program includes national and regional conferences, classroom courses, and webinars on technical topics. More than 5,000 people have been trained in 2014-2015 through ASDSO’s Dam Safety Resource Center. The Resource Center is a one-stop-shop for information on dam safety engineering and related topics. The bibliography holds more than 14,000 records and is searchable on the ASDSO website.
Recently, ASDSO has taken on administration of the new, FEMA-funded website on dam failures lessons learned, www.damfailures.org. This website is now a part of the Resource Centre. ASDSO houses survey data on state technical criteria and topics of interest to state dam safety programs.

The ASDSO is also trying to educate dam owners, especially those owning small, non-federal or non-federally regulated dams. In 2014, ASDSO delivered four training workshop to the dam owners in the U.S. Information on all future training is available on the ASDSO website. For example, a 3 days ‘Inspection and Assessment of dams’ course in February 2017 was offered at a cost of US$850 for ASDSO members and US$950 for non-members.

The training covered the following:

- Historical perspective of dam construction methods for various dam types
- Common failure modes associated with various dam types
- Understanding of standards for maintaining dams
- Techniques for performing a comprehensive dam inspection
- Awareness of emerging issues related to inspection and assessment of dams

The Workshop DVD includes copies of the presentation slides, plus several helpful references including FEMA Technical Manuals with:

- Impacts of Animals on Earthen Dams
- Impacts of Plants on Earthen Dams
- Conduits Through Embankment Dams
- Best Practices
- Filters for Embankment Dams
- FEMA P-919 – Summary of Existing Guidelines for Hydrologic Safety of Dams; plus
- a number of internet URLs for sites where additional information can be found.

ASDSO also hosts on-line and distance training webinars. All previously held ASDSO webinars are available in digital archived format for on-demand viewing.

In 2001, ASDSO’s Technical Training Committee developed the list of technical topics that should be included in a complete dam safety Program of Study (Appendix 8). Many of these topics are currently addressed through courses offered by ASDSO and other organizations. ASDSO encourages the distribution and use of the Program of Study as a reference for all dam safety professionals pursuing professional development opportunities.

ASDSO publishes a list of Technical Resources which allows to search for specific information within the 17 topics. One of them, ‘Inspections’ provides overview for the topic, including the details on proficiencies, classroom and web-based training, relevant guidelines and references

The links to the FEMA and USBR training resources and Federal Guidelines also published on the ASDSO website.

5.3 The Bureau of Reclamation (USBR)

Established in 1902, the Bureau of Reclamation is best known for the dams, power plants and canals it constructed in the 17 western states. The Bureau of Reclamation oversees the operation of more than 70 dams in the Pacific Northwest. The Safety of Dams program was created in response to the failure of Teton Dam in 1976.

In the 1970’s, the Bureau of Reclamation developed the Safety Evaluation of Existing Dams (SEED) procedure. A five-day SEED training course delivered by USACE every year provides information and instruction in dam safety surveillance, visual examination, and monitoring of instrumentation. Hydrologic considerations, concrete repair, remedial measures for dams, and emergency action planning are also
discussed. The seminar is suitable for engineers, technicians, maintenance personnel, and administrators responsible for dams.

The seminar includes a visit to a local dam to practice inspection techniques during a simulated dam examination. As part of the seminar, three concurrent workshops are presented to provide more information on the following subject areas:

- Engineering Geology and Dam Safety Workshop presents an introduction to geologic investigation and evaluation relative to dam safety static and seismic issues.
- Evaluation and Response to Seepage and Internal Erosion Concerns presents seepage process and failure modes, types of sinkhole formations, and approaches for investigating and responding to seepage and internal erosion conditions.
- Emergency Management presents key elements of a dam owner’s responsibilities regarding facility operations in response to emergencies, namely detection, decision making, and notification and how to exercise those responsibilities through simulated events.

Reclamation’s Dam Safety Office is providing this seminar at no cost to attendees. However, due to agency restrictions, the audience is limited to Federal agency, Tribal and Reclamation Water District personnel.

The Reclamation’s Directives and Standards for the Operating Practices and Procedures for High-and Significant-Hazard Dams Temporary Release FAC TRMR-66 mandates that all primary and alternate dam operators responsible for the operations and maintenance of high-and significant-hazard dams within Reclamation’s jurisdiction attend Classroom Dam Operator Training every 4 years. This is a recent change from the 3 year training rotation. The Pacific Northwest Regional Office is maintaining the same schedule and travel cycle between Idaho, Oregon and Washington every three years and the Annual 2-days Classroom Dam Operator Training is normally conducted during the off-water season in late November or early December each year. The schedule for the next 4 years is published on the reclamation website. The government training rate is US $89 per person (for Reclamation and Non-Reclamation agencies) with an additional US$20 registration fee.

The Directives and Standards further mandate that the primary dam operator and at least one alternate dam operator must participate in on-site dam operator review (on-site review) for the dam(s) which they are assigned every 8 years. As part of the on-site review, completion of a proficiency review form is required and is based on Classroom Dam Operator Training attendance and a demonstration of knowledge of operations and maintenance regarding the dam(s) during the on-site review.

The Directives and Standards indicate that at a minimum classroom training will cover:

- Purposes of Reclamation Projects (how dams interrelate)
- Design and Construction of Safe Dams
- Awareness of dam failures, incidents, and risks from natural or man-made hazards
- Instrumentation (purposes, types, locations, readings and maintenance requirements)
- Dam tender/operator duties and responsibilities, including general safety and security awareness and procedures
- Emergency Management / Emergency Action Plans / Incident Command System
- Documentation (operating and reference)
- Standing Operating Procedures
- Reference material and supporting documentation
- Hydrology and reservoir operations

Onsite training is conducted for dam operators (and their designated alternates) at their respective facility and consist of a minimum of 4 hours of onsite instruction and discussion. For a facility, which is small and associated operations are considered simple, the area manager must approve training sessions less than the minimum of 4 hours. The goal of onsite training is to provide participants with site-specific information that is pertinent to all facets of their unique facility. As a minimum, the onsite training will cover the following topics specific to each facility:

- Standing Operating Procedures (SOP) and other site-specific operating and reference documents
• reservoir operating procedures for both normal and emergency events
• Emergency Action Plan (EAP) and emergency management responsibilities
• operations related to major control gates/valves and other associated mechanical, electrical, and electronic equipment used for local or remote operations, security, etc.
• instrumentation purposes, locations, reading requirements and gathering, and maintenance
• operating log
• performance parameters and potential natural failure modes, as well as general information and awareness regarding potential man-made/security-related failure modes
• general understanding of the use of a maintenance management system and related documentation needs
• personnel safety and operational security procedures (access/key control, identification badges, alarm assessment and response, etc.)
• communication, attendance, and access factors related to operations
• other specific duties and responsibilities related to the dam.

In 2014 and 2015 USBR organized a mixture of eight conferences, workshops, classrooms, and web based/virtual sessions. These events hosted 1,260 people.

5.4 US Army Corps of Engineers (USACE)
The USACE is a self-regulated dam owner with a diverse inventory of 709 dams in 44 states. The dams provide a variety of project purposes including navigation, flood risk management, water supply, irrigation, hydropower, recreation, environmental, and a combination of these purposes.

Dam operators within the USACE are usually skilled trade people with general or specific backgrounds of electricity, plumbing, carpentry, equipment operation and repair, water and sewage plant operation, as well as labourers. All new Lock and Dam Operator personnel are required to participate as a trainee in a formalized training and development program involving on-the-job training, classroom instruction, and related correspondence courses. Work performed and observed includes operation and maintenance of electrically or hydraulically controlled lock gates, control valves, and related equipment such as dam gates, inclusive of manually operated wicket gates at sites where they exist, maintenance and repair of other site structures and facilities such as lock buildings and lighting systems, and grounds maintenance.

For example, the U.S. Army Corps of Engineers Savannah District provides a rigorous, four-year apprenticeship program that trains college students to work high-demand jobs at hydroelectric dams in the region. Trainees are funded by the Federal Student Pathways program, a national effort that offers students and recent graduate internships and other career paths to federal employment. The trainees work up to 40 hours a week at their assigned dam and must pass a laborious four hours of oral evaluation every six months.

The USACE website contains information on the Technical Guidance and Standards covering dam design, stability analysis, dam instrumentation; Engineer Manuals, Regulations, technical letters, bulletins and pamphlets.

5.5 State law on dam safety
Today, every US state but Alabama has its own laws on dam safety. State governments have regulatory responsibility for 70% of the 90,580 dams within the National Inventory of Dams. These programs vary in authority but, typically, the program activities include
• safety evaluations of existing dams
• review of plans and specifications for dam construction and major repair work
• periodic inspections of construction work on new and existing dams
• review and approval of emergency action plans.
State dam safety inspection programs typically follow one of two models, State Inspection or Owner-Responsible Inspection (22 states). The dam owners are required to train their personnel in the basics of visual inspection techniques. Any person employed by the owner who regularly visits or works at the dam should be trained to inspect part or all of the dam and to report any observed problems.

5.6 Dam Safety in Kansas

Kansas dam safety laws are found in Kansas State Legislation 82a-301 through 305a, last amended in 2002. Regulations are found in Kansas Division of Water Resources Regulations KAR 5-40-1 through 5-40-94, effective May 1983, and last amended May 18, 2007.

The goal of the Dam Safety Program in the Division of Water Resources (DWR) is to reduce risks to life and property from dam failure. This goal is addressed through review and approval of plans for constructing new dams and for modifying existing dams, ensuring quality control during construction, and monitoring dams that, if they failed, could cause loss of life, or interrupt public utilities or services.

The Kansas Dam Safety Program works to increase and promote public awareness of the benefits and risks related to dams through educational conferences, symposia, workshops, publications (Dam News, the Water Structures YouTube Channel, Flickr photographs and Pinterest), event presentation and on-line resources, such as:

- ‘Dam Safety Tool Box’ (fact sheets)
- Special publications
- Guidelines and checklists
- Federal and other state resources (FEMA, ASDSO, USACE, Indiana DS, etc.)

From 2003, the Kansas Water Structures Program at the Division of Water Resources has hosted annual conferences to increase stakeholder knowledge of dam safety and state regulations. These conferences cover a wide spectrum of information including research, case studies, state regulations, environmental impacts, emergency response, yearly legislative updates and DWR program news. Summaries of previous conference presentations are available on the divisional website www.agriculture.ks.gov/divisions-programs/dwr/dam-safety/dam-safety-resources.

To increase owner and public awareness, state dam safety personnel from the Kansas Department of Agriculture, Division of Water Resources, is offering a free, 2-hour Dam Safety Seminar to small dam owners. This seminar can be tailored to meet the needs of individual dam owners, facility managers, maintenance personnel, emergency planning and response agencies, neighbourhood associations and others. It provides information on the liability and responsibilities, operation and maintenance, failure problems, solutions, and related information. In the last decade, for example, the dam safety staff offered 25 on-site workshops, in addition to conference sessions and on-site consultation. (For more information on the Operations and Maintenance workshops please follow the following link www.agriculture.ks.gov/docs/default-source/dwr-ws-fact-sheets/o-m.pdf?sfvrsn=2).

Another free non-technical seminar is available for the owners of Significant and High Hazard Category Dams. This training covers aspects of the relevant regulation and provides basic information needed for an emergency action.

6. Dam Safety regulation and Dam Operator training in United Kingdom

The most important statute with regard to dam safety in the United Kingdom is chapter 23 of the 1975 Reservoirs Act (RA75), which entered into force on December 1, 1991. This only applies to raised reservoirs for water. Within the meaning of the Act, this refers to dams that have a holding capacity greater than 25,000 cubic meters (25 ML) and do not fall within the scope of the Mines and Quarries (Tip) Act of 1969.

Approximately 2,500 reservoirs are covered by the Act: some 80 percent of these are formed by embankment dams with the remainder being concrete or masonry dams or service reservoirs. The Act is applicable in
England, Wales and Scotland: it does not apply to Northern Ireland, although some reservoir owners and operators there comply with the spirit of the Act. England has an excellent reservoir safety record, and there have been no dam breaches resulting in the loss of life since reservoir safety legislation was first introduced in 1930.

The Department for Environment, Food and Rural Affairs (Defra) is responsible for managing and implementing reservoir safety regulations in England, and for enforcing safety requirements if needed. RA75 does not apply to smaller reservoirs (holding less than 25 ML). However, owners/operators would be liable if their reservoir dams failed and caused harm to people or property, and the Environment Agency provides good practice guidance to help owners take adequate safety precautions. Defra initiates and provide funding for the research and preparation of guidelines on dam management, some of which are available online from the Construction Industry Research and Information Association (CIRIA). One of the recent CIRIA publications is the Guide on ‘Dam and reservoir conduits Inspection, monitoring, investigation, maintenance and repair’ (CIRIA C743, 2015)

In July 2013, Defra introduced new regulations to make the safety rules more risk-based, using powers under the Flood and Water Management Act 2010.

Pursuant to Article 10 of the RA75, the undertakers of a dam must have an independent qualified engineer conducting periodic inspections on the dam and obtaining from him or her a report on the results of the inspection. In the case of large reservoirs, if they are not under the supervision of a construction engineer, they must be under the supervision of a qualified civil engineer who is employed to supervise the reservoir and advise the undertakers on safety-related issues.

6.1 The British Dam Society (BDS)

The British Dam Society is an Associated Society of the Institution of Civil Engineers. It consists of individual and corporate members. It is open to anyone wanting to share experience or knowledge of all aspects of dams and reservoirs.

BDS exists to advance the education of the public and the profession in technical subjects relating to planning, design, construction, maintenance, operation, safety, environmental and social issues.

A BDS conference has been held once every two years since 1982. The conferences have formed some of the most successful events of BDS with more than 150 participants at recent conferences. They are normally held at a University campus and have generally taken place over two and half days with one afternoon being used for a visit to dams. Conference proceedings has been published by Thomas Telford since 1990 and are available from the ICE Bookshop.

No information on the Dam Operator training requirements or courses provided on the BDS website, however relevant aspects appear to be covered in some of the technical papers presented at the 2016 BDS conference:

- Mechanical and electrical components of dams.
- Incidents affecting the safety of dams.
- Efficiency in monitoring and surveillance.
- Cost-effective maintenance and repairs
- Operating procedures for ensuring reservoir safety.

A search of the UK dam owners (Southern Water and Northumrian Water) websites did not produce any information on the dam operators or dam safety training requirements.

6.2 HR Wallingford

HR Wallingford is an independent civil engineering and environmental hydraulics organisation based in the UK.

The company is offering a one-day classroom training course on dams and reservoir safety at the fee of £350.00 per person. This course aims to explain the importance of reservoir safety, the legal framework that
exists, and basic dam engineering principles in non-technical language to assist those involved in the 
operation, maintenance, monitoring and regulation of dams in the UK. It is aimed primarily at non-technical 
people who need a basic understanding of dam engineering, UK legislation and reservoir safety issues. It 
would suit new enforcement agency staff, reservoir operation, maintenance and monitoring staff, and reservoir 
owners who may not have an engineering background.

Course content:

- An introduction to the different types of reservoir and dam.
- Why do dams fail?
- What happens if they fail?
- An introduction to the legal framework in the UK.
- Why is maintenance important?
- Why is monitoring important?
- Where to find more information?
- When to ask for professional advice?
- An introduction to the uncertainties in breach modelling and how to deal with them.

7. Dam safety regulation and dam operator training in Canada

There are over 10,000 dams in Canada of which 933 are categorised as ‘large’ dams under the ICOLD 
definition. These dams are owned by the federal and provincial governments, electric utilities, industrial and 
mining companies, irrigation districts, municipalities and private individuals.

In Canada water resources management is a provincial responsibility. In the absence of specific provincial 
legislation on dam safety, the Dam Safety Guidelines, issued by the Canadian Dam Association (CDA) are 
treated as evidence of best practice. The regulatory schemes exist in Alberta, British Columbia, Ontario and 
Quebec.

7.1 Canadian Dam Association (CDA)

The Canadian Dam Association (CDA) is a group of dam owners, operators, regulators, engineers and others 
who share the goal of advancing knowledge and practices related to dams. The mission of the organisation is 
to encourage cooperation, advance technical knowledge, and build competency related to dams in Canada.

The CDA has an extensive list of resources available on-line, which include Guides, Guidelines, manuals, 
videos, fact sheets and flyers, set of US training Modules for Dams (TADS) and sample inspection forms.

Dam Safety Guidelines, issued by CDA in 2007 and revised in 2013, has become an important reference 
document for dam safety in Canada and internationally. The Guidelines consist of principles that are 
applicable to all dams, and outline processes and criteria for management of dam safety in accordance with 
these principles. Guidelines outline the requirements for employee training and accountability for this process.

In addition to the Dam Safety Guidelines, nine Technical Bulletins were published by CDA in 2007. The 
Technical Bulletins provide additional information and provide suggested methodologies and procedures for 
dam analyses and assessments. A list of the Technical Bulletins is provided below:

- CDA-TB01 Inundation, Consequences, and Classification for Dam Safety
- CDA-TB02 Surveillance of Dam Facilities
- CDA-TB03 Flow Control Equipment for Dam Safety
- CDA-TB04 Public Safety and Security Around Dams (DRAFT)
- CDA-TB05 Dam Safety Analysis and Assessment
- CDA-TB06 Hydrotechnical Considerations for Dam Safety
- CDA-TB07 Seismic Hazard Considerations for Dam Safety
- CDA-TB08 Geotechnical Considerations for Dam Safety

CDA launched a portal for on-line learning (www.cda.sclivelearningcenter.com/) which contains live recording 
of sessions that were originally held in person, such as conference sessions or workshops, on-line webinars, 
or pre-recorded presentations.
7.2 Damsafety in British Columbia

The Dam Safety Regulation sets requirements and best practices for all aspects of dam design, construction, operation, maintenance, removal and decommissioning of dams in British Columbia. The Dam Safety Regulation came into effect on February 29, 2016, replacing the former B.C. Dam Safety Regulation (2000).

More than 1,500 active dams in British Columbia (the westernmost province of Canada) are regulated under the Water Sustainability Act and Dam Safety Regulation. Regulated dams require a water licence issued under the Act and must meet the requirements specified in the Dam Safety Regulation. Government seeks to ensure that the provincial Dam Safety Program is consistent across British Columbia, and functions smoothly, efficiently and transparently for dam owners. Records of dam owner’s staff training are required to be regularly provided to the provincial Dam Safety Office.

Dam Inspection and Maintenance training courses are conducted periodically by the BC Water and Waste Association (BCWWA) and the Water Supply Association of B.C. (WSABC). BCWWA offers a range of certified and custom training options for dam operators; however, they mainly cover the water and wastewater treatment operations.

A full day ‘Inspection and Maintenance course’ was offered to the dam owners and operators for a fee of CD$100 per person during the 22nd WSABC Annual Conference and included topics such as dam components and terminology, legislation, operation and inspection of dams, emergency management and dam maintenance.

The cost of the one-day training in September 2016 was CD$199 for BCWWA members and CD$299 for non-members with the following topics covered:

- Organize and prepare for a dam safety inspection
- Conduct an evaluation of a dam, including its stability
- Inspect for visual deficiencies, seepage conditions, spillways and outlets, and hydraulic and hydrology adequacy
- Test the gates, valves and other mechanical systems.

On average, four of these courses are offered each year at various locations across the province. Over one thousand people have attended the course since 2001. Additionally, dam safety staff inform stakeholders about the program through dam safety presentations at public meetings including association conferences, local government meetings and other interest group gatherings. Dam Safety Officers also conduct informal training when conducting the regularly scheduled dam audits with dam owners.

Information on all aspects of the BC Dam Safety Program is posted on the BC Government website for the information of dam owners and the public. Each year the Dam Safety Annual Report is published on this site, which also provides access to significant Dam Safety Technical Resources, including design aids, inspections and surveillance templates, BC Dam Safety Guidelines, video and historical information on the dam failures and Dam Safety related links to the following organizations:

- Canadian Dam Association
- Association of State Dam Safety Officials
- Federal (USA) Emergency Management Agency – Dam Safety Publications and Resources
- Federal (USA) Energy Regulatory Commission – Dam Safety and Inspection
- State of Washington – Dam Safety
- US Army Corps of Engineers – Dam Safety Program
- US Department of the Interior – Bureau of Reclamation
- Canadian Water Resources Association
7.3 CEATI International

The Centre for Energy Advancement through Technological Innovation (CEATI) is a user-driven organization committed to providing technology solutions to its electrical utility participants, who are brought together to collaborate and act jointly to advance the industry through the sharing and developing of practical and applicable knowledge.

CEATI International’s roots date back to the late 19th Century, with the founding of the Canadian Electricity Association in 1891. During the 1970s, in order to better serve and meet the needs of the Canadian marketplace and the provincially owned electric utilities, the Association established a Research and Development program, which was at that time limited exclusively to Canadian utilities. Now CEATI’s efforts are driven by over 120 participating organizations (electric and gas utilities, governmental agencies, provincial and state research bodies), represented within 18 focused Interest Groups and specialized Task Forces. Continuously expanding its international reach, CEATI’s participants represent 17 countries on 6 continents. In addition to facilitating information exchange through topic-driven interest groups and industry conferences, CEATI International brings partners to collaborate on technical projects with a strong practical focus, and develops customized software and training solutions to fit the participants’ needs.

CEATI hosts the Dam Safety Interest Group (DSIG) composed of dam owners who jointly sponsor research and development projects designed to help assess and improve the safety of dams. Today, the DSIG is represented internationally by participants from Canada, the United States, Australia, New Zealand, Sweden, France, the United Kingdom and Germany. The DSIG serves as a portal for networking and information sharing (meetings, workshops and weekly information exchange), industry benchmarking and collaborative technical projects.

In 2014, CEATI published the ‘Dam Safety Inspection Procedures, Guidance and Training for Plant Operators’. This Guide is intended to serve as a manual for Hydroelectric Plant Operators to help them recognize, understand, and respond to potential dam safety hazards. Recognizing that no two hydroelectric projects are exactly alike and that the most effective dam safety surveillance practices are those that are tailored to a specific site, this document has been designed so that readers can focus on content that is directly relevant to the types of structures they encounter and for which they are responsible.

Some of the other projects completed by DSIG include:
- Seismic Hazard and Risk Workshop for Dams
- Dam Safety Risk Management Training
- Development of Standardised Inundation Maps Produced using Geographic Information Systems (GIS)
8. Dam safety regulation and dam operator training in New Zealand

Dam safety in New Zealand is governed by the Resource Management Act (RMA, 2015) and Building (Dam Safety) Regulations 2008.

The RMA requires consideration of event of low probability, but high potential impacts (assessment of the effects the activity may have on the environment). The RMA is premised on the principle of subsidiarity, according to which decision-making is best left to those who are directly affected by the results of the decision. Therefore, it devolves authority to the most appropriate level, and as a result, local authorities are responsible for the day-to-day implementation of the RMA. International methods and codes and the Dam Safety Guidelines prepared by the New Zealand Society of Large Dams are often used in the absence of a specific New Zealand standard.

- Building (Dam Safety) Regulations 2008:
  - Require large dams to comply with the Dam Safety Scheme (in force from July 2015)
  - Dams with Medium or High Potential Impact Classifications must have a formal system of dam monitoring, inspection and maintenance
  - The Dam Safety Assurance Programme (DSAP) must follow the NZSOLD guidelines

Based on the 2015 New Zealand Dam Safety Management Guidelines (s 3.2.3), the dam owner is directly responsible for the safety of a dam. This is both a moral and legal obligation. At a minimum, the responsibility includes establishing and maintaining the necessary competencies for ongoing dam safety management including the training of surveillance and operational personnel.

8.1 Waikato Regional Council

The Waikato Regional Council publishes ‘Dambuilders’, a series of brochures providing information to all those who own a dam or canal, or are planning to construct, modify or remove a dam, canal or a structure associated with a dam. No information on the dam safety training available on this website.

8.2 Auckland Regional Council

The role of Auckland Regional Council (ARC) is to ensure compliance with the consents issued for the development and the construction phase. An engineering resource consent (approval) is required in NZ for work involving public drainage, public water, roads and common access way.

Section 35 of the RM Act lists four types of monitoring required to be carried out by the ARC: state of the environment; suitability and effectiveness of the RPS and regional plans; transferred or delegated powers; and resource consents. Compliance monitoring of resource consents is important both as a mechanism for monitoring changes in the availability or condition of a particular resource (e.g., aquifers) and anticipating cumulative effects on the environment.

On the job staff training for monitoring systems, safety, and incident response is the only training requirement under the ARC Dam Safety Guidelines (TP-109, Guidelines for Construction, maintenance and monitoring).

8.3 New Zealand Society of Large Dams (NZSOLD)

The New Zealand Society on Large Dams is a technical society of the Institution of Professional Engineers New Zealand (IPENZ). The NZSOLD was founded to advance the technology of dam engineering and support socially and environmentally responsible development and management of water resources.

The objectives of the society are to:

- promote best practice in the development, operation, maintenance and refurbishment of dams and their associated impoundments throughout New Zealand
- integrate best practice into the regulatory process associated with the dam and impoundment management industry in New Zealand
be recognised as a credible and respected professional body, and the national focus for all matters relating to dams and their associated impoundments in New Zealand.

Module 5 of the 2015 NZ Dam Safety Management Guidelines outlines the requirements for appropriate training and education programs for all personnel with responsibilities for dam safety. This training is required to be geared towards developing and maintaining appropriate awareness and competencies, and should take into account:

- organisational structure and governance arrangements
- characteristics of the dam, reservoir and appurtenant structures
- potential failure modes for the dam and appurtenant structures
- gate and valve systems that fulfil dam and reservoir safety functions
- site-specific issues including any potential or confirmed dam safety deficiencies
- changes in the facilities or operating procedures.

Training requirements depend on the nature and the Potential Impact Classification (PIC) of the dam, and may range from the Designer or Technical Adviser training the Owner/Operator of a small Low PIC dam to Operators of High PIC dams completing structured training courses, seminars, audits and refresher courses. Potential Impact is related to the consequences (effects) of the dam failing, if it should release its stored contents:

If a dam is assessed as having a High Potential Impact, it does not mean that the dam is unsafe. However, High Potential Impact dam is required to have a higher level of safety than other dams.

NZSOLD participate in the annual ANCOLD/NZSOLD Conferences and periodically organizes symposiums, seminars and workshops (i.e. Short course on internal erosion and piping of dams and their foundations in 2014) for people involved in designing, building and managing dams in New Zealand.

8.4 Damwatch

Damwatch is a company of consulting civil engineers, geologists and geophysicists based in Wellington, New Zealand and providing services to hydropower, water and irrigation clients internationally.

On 22nd and 23rd September 2016 a team of Damwatch staff ran its two-day Dam Safety Training Course in Wellington. The course focused on dam safety management and how it fits with the 2015 edition of the NZ Dam Safety Guidelines, and covered everything from Primary Duty of Care to Lessons Learned from Dam Failures. The course was attended by participants from irrigation companies, regional councils, hydropower generators and NZ Government ministries.

Course content:

- NZ Dams Context
- Dams and their important features – geology, foundations, hazards
- Embankment dams – design features and behaviour
- Concrete dams – design features and behaviour
- Dam hazard, risk and PFMs – including PIC dam classification, and learnings from incidents and failures
- Dam Safety Management Systems (DSMS) and Dam Safety Assurance Programmes (DSAPs)
- DSMS and DSAP in practice (including surveillance, instrumentation, quality assurance, evaluation and reporting, intermediate and comprehensive reviews, emergency action plans, appurtenant structures, testing of gates and valves)
- Managing dam safety issues and deficiencies
- Dam safety governance and support

Damwatch is also offering customised courses on client’s sites tailored to specific requirements ranging from a couple of hours to multiple days.
A number of links published on the Damwatch website provide access to the dam societies, dam owners in New Zealand and Australia, Asia, Pacific, Canada, Dam organisations in Australasia and worldwide, NZ Energy and Engineering Resources.

9. Conclusion

Though various dam safety regulatory frameworks exist in the world, research indicates that in most countries, the regulatory authority has the power to develop standards for Dam Safety and enforce them. The Regulator also can require dams, subject to its jurisdiction, to comply with the standards issued by a recognized body such as ANCOLD, ICOLD or CDA. In most jurisdictions, the regulatory framework also explicitly imposes on the dam owner the primary responsibility for dam safety. Most of the Standards/Guidelines on the dam safety management published worldwide, similar to the Guidelines produced by the Queensland Dam Regulator, require dam owners to engage experienced and/ or trained operating personnel for all regular activities undertaken at the dams.

Queensland has a diverse range of dam owners: from organisations with large portfolios of dams and dam specialists on the staff, through to individuals who are managing a single dam with little or no in-house knowledge of safe dam operation. The service life of a well-designed, constructed, maintained and monitored dam can easily reach 100 years. To ensure the ongoing functionality of the dam and to minimise possible adverse impacts of its failure, it is important that all referable dam owners in Queensland have sufficient capability to safely manage their dams and are able to meet the minimum standards set by the Regulator. While when required to provide some technical reporting the smaller dam owners have to rely on the external advice from the specialists with technical expertise, they also need to have knowledgeable and reliable personnel to undertake daily/regular activities at the dam to keep them functional and safe.

Considering that no two dams are exactly the same and they all are built for various purposes, such as water storage for domestic, irrigation or industry use, hydroelectric power generation, flood control etc.; it makes it very difficult to provide one fits all training for the dam operators. A wide range of other activities often required to be undertaken by the operational staff, such as water treatment plant operation or hydroelectric power station management, is another limiting factor as in most instances these activities already require operators to have mandatory qualifications in the relevant field.

New VET qualifications, such as Certificates II and III in Water Operation attract significant subsidies in several Australian states including Queensland; and ‘Source’ units could be utilised in conjunction with other subjects covering Water treatment plant or Irrigation specialisation to achieve the desired outcome. When considering formal qualifications, the complexity of each dam and appurtenant structures should form the basis for determining relevant study units accordingly to the competency and capability levels required of the dam operators. This approach has been utilised by the large dam owners in Queensland (Seqwater and SunWater) and is comparable to the training options adopted overseas.

The analysis of the dam safety training identified another common approach utilised by most jurisdictions where training of the operational personnel is actively supported without being mandated. The aspects of the classroom training provided by the training agencies or engineering consultancies may vary slightly, but as a minimum include:

- dam design and construction,
- regulation requirements
- surveillance, monitoring and instrumentation,
- documentation and operational issues
- dam failures, incidents, risks and
- emergency action planning.

The cost of non-accredited training varies between countries and states, with some of the courses available to the dam owners free of charge or at significantly reduced training rates. For example:

- USBR (US) – The cost for the annual 2-days Classroom Dam Operator Training is US$89 per person plus US$20 registration fee and
- WSABC (Canada) – The cost of the full day ‘Inspection and Maintenance course’ offered to the dam owners and operators at the 2016 WSABC Annual Conference was CD$100 per person
At present, there are no opportunities for dam owners in Queensland to receive free or subsidised dam safety training.

The Training Aids for Dam Safety (TADS) material, that gives examples of inspection procedures, problem conditions and consequences, is now available on-line from FEMA and other agencies including NSW DSC. This program of self-instructional studies provides the opportunity for dam owners to get free access to the dam safety training materials and utilise common dam safety practices. Numerous other dam safety resources, such as fact sheets, standards, guidelines and checklists are also available from Dam Safety Regulators and water industry organisations worldwide. These resources also provide significant assistance to small dam owners, as they tend to simplify/clarify particular aspects of dam safety management required under the relevant Dam Safety Law.

Following the analysis of the Dam Operator training in Australia and overseas, a wide diversity of the training courses and delivery modes has been identified. One of the important findings is that at present Australia appears to be the only country where a dam operator training is available to anyone as a Vocational Educational and Training qualification. Considering the advantages offered by formal qualification system and generous subsidies currently available from the Queensland Government, it seems imperative to raise awareness of the Dam owners and Operators on the availability of this fully certified course and encourage their participation.

The Queensland Dam Safety Regulator should also consider providing additional guidance/assistance to the small dam owners/operators, who may not have sufficient capacity to undertake formal or informal dam safety training, and ensure they attain and maintain adequate expertise in this area.

When compared to other jurisdictions, the DEWS website seems to have limited educational information on dam safety and there is a considerable scope for more material to be made available to the relevant groups, particularly dam operators. This will help to raise their awareness and understanding of the issues involved in dam safety.

10. Recommendations

Based on the results of the 2016 Queensland DO training survey and comparative analysis of the dam operator training arrangements in other countries, the following actions are recommended for further consideration by the Queensland Dam Safety Regulator:

- **Department of Energy and Water Supply website**
  - Investigate the opportunity to create a ‘Dam Safety Information Portal’ similar to the webpages supported by the NSW DSC or Kansas Department of Agriculture. This portal can provide:
    - Up-to date information on the upcoming training for Dam Owners/Operators (i.e. ANCOLD Dam Operators Forum 2017, 2017 Water Industry Operations Conference and Exhibition in Logan, SunWater and NSW DSC training etc)
    - Links to the Dam Safety knowledge database (see 2 below) and
    - Training resources such as TADS (contact the U.S. Bureau of Reclamation and discuss the options for publishing ‘Training Aids for Dam Safety’ (www.usbr.gov/dsis/tads.html)
  - Access to FEMA Technical Manuals and Guides.
- Establish a Dam Safety knowledge database, covering topics such as: the dam safety regulation in Queensland, operation and maintenance requirements, inspection and routine surveillance techniques, remote and on-site monitoring, requirements for effective emergency action plans, inspection checklists/templates etc.
- Record and publish a presentation/video on the dam safety regulation in Queensland (similar to www.qldwater.com.au/Skills_Legislative_Training)
- Publish this report on the DEWS website and/or distribute it to the interested dam owners.
- **Newsletter**
  - Prepare and distribute 3-monthly/6-monthly electronic newsletters to the dam owners/operators covering specific items for attention (prior to the wet season, changes to the regulation, new guidelines, training opportunities, reporting requirements etc.)
- Promote awareness of the new Water Industry qualifications and funding available for undertaking Certificate II and Certificate III.

- **Training**
  - Investigate the opportunity to develop short (2-3 hours) Dam Safety/Surveillance courses (each relevant to a specific dam type) and present them either at the regional meetings with dam owners or at the annual conferences/forums held by the Australian Water Industry Associations:
    - Australian Water Association (AWA)
    - Water Industry Operators Association (WIOA)
    - Water Services Association of Australia (WSAA).
  
  This training could be delivered by the Dam Safety staff from DEWS or external dam specialists. Exposure of the dam operators to a wider range of experiences would be beneficial in enhancing their skills and knowledge.

  - Establish a panel of training providers and regular annual (2-3 days) dam operator training course to be delivered at least every 2 years.
  - Consider establishing a specialist training advice panel incorporating dam safety staff from DEWS, engineering consultants, RTOs and dam owner representatives with well-established training system such as Seqwater and SunWater.

- **Queensland Dam Safety Management Guidelines**
  - Include a recommendation for the Category 2 Dam owners to incorporate ‘Source units’ in the formal training undertaken by their dam operators.
  - Include a requirement for all personnel involved in the operation and maintenance of referable dam to undertake regular refresher training in dam surveillance and inspection techniques at least every 4 years.

- **External groups**
  - Investigate the option of distributing/publishing Dam safety information through the AWA’s Operations network (LinkedIn).
  - Discuss with FEMA the opportunity to utilise the ‘Pocket Safety Guide for Dams and Impoundments’ (either ‘as is’ or a slightly revised version with Australian terminology and references to the local infrastructure) for distribution to Category 1 dam owners in Queensland.
11. Appendices

11.1 Appendix A

The 2016 Dam Safety survey questionnaire Dam operator training in Queensland

<table>
<thead>
<tr>
<th>Questions</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) How many referable dams your organisation has?</td>
<td>a) Total number of dams</td>
</tr>
<tr>
<td>Categories:</td>
<td></td>
</tr>
<tr>
<td>✔- Gated/ungated:</td>
<td>✔- No. of Gated dams:</td>
</tr>
<tr>
<td>✔- Failure Impact Rating category:</td>
<td>✔- No. of Ungated dams:</td>
</tr>
<tr>
<td>1 =&lt; 100 PAR; 2 =&lt; 100 PAR; 3 =&lt; 100 PAR;</td>
<td></td>
</tr>
<tr>
<td>✔- How many Dam Operators (DOs) your organisation employs (including contractors):</td>
<td></td>
</tr>
<tr>
<td>✔- Number of DOs:</td>
<td></td>
</tr>
<tr>
<td>Full-time:</td>
<td></td>
</tr>
<tr>
<td>Part-time:</td>
<td></td>
</tr>
<tr>
<td>Backup:</td>
<td></td>
</tr>
<tr>
<td>✔- DOs with qualifications:</td>
<td>✔- DOs containing qualifications:</td>
</tr>
<tr>
<td>✔- Qualification requirements:</td>
<td></td>
</tr>
<tr>
<td>Cart III, Cart IV, Cart V, Others (please specify):</td>
<td></td>
</tr>
</tbody>
</table>

2# Please provide details on the training undertaken by your DOs in the last 1-2 years:

<table>
<thead>
<tr>
<th>Training</th>
<th>Date/Year</th>
<th>No. of DOs attended</th>
<th>Complete days/total</th>
<th>Approx. cost/post</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

3# Training Provider (TP) details:

<table>
<thead>
<tr>
<th>TP Name</th>
<th>TP Contact Details</th>
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</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

4# a) Training delivery (may be a combination of options):
   b) Training frequency & timeframe (days, over...)
   c) Training methods, materials and resources:

5# Competence skills covered (please tick):

<table>
<thead>
<tr>
<th>Workplace Health &amp; Safety</th>
<th>Dam Operations and Maintenance</th>
<th>Flood Rating</th>
<th>Emergency Action Plan</th>
<th>Other, please specify below</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

6# a) Training satisfaction with current arrangement:
   b) Please add comment on the adequacy of the training:

<table>
<thead>
<tr>
<th>(please tick) 0 - not satisfied, 5 - very satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5</td>
</tr>
</tbody>
</table>

7# a) Do you expect in the next 2 years to utilise more formal training options (such as Certificate III in Water Operations) in the future?
   b) If a more formal qualification system is considered, please specify the system and where is this likely to take place:

<table>
<thead>
<tr>
<th>✔ Yes</th>
<th>No. Please list the reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
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</tr>
</tbody>
</table>

8# Other training providers utilised and/or to be utilised:

<table>
<thead>
<tr>
<th>TP Name</th>
<th>TP Contact Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>was booked/online course kurs</td>
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<td></td>
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</tbody>
</table>

9# Any other comments/concerns:

|                               |                                                                 |
|                               |                                                                 |
|                               |                                                                 |
|                               |                                                                 |
|                               |                                                                 |

Survey completed by ___________________________ (ph: ______________) on ___________ 2017

(Please forward the completed questionnaire to damsafety@dews.qld.gov.au. Thank you!)
11.2 Appendix B
Summary of the 2016 Dam operator training in Queensland
Survey results
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Failure Impact Category</th>
<th>No. of Gated</th>
<th>No. of DO</th>
<th>Cost of the latest training (total travel, accommodation, etc.)</th>
<th>No. of attendees</th>
<th>Current Training Provider</th>
<th>Delivery</th>
<th>Skills covered</th>
<th>Frequency</th>
<th>Satisfied ee(Yes or No, satisfied, 3—very satisfied)</th>
<th>Used since</th>
<th>Future outlook</th>
<th>Previous Costs</th>
<th>Costs</th>
<th>Other comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam Owner 1</td>
<td>&quot;CA1&quot;</td>
<td>0</td>
<td>1</td>
<td>$2,000 (plus $65 for each, in First Aid, Combined space, working at heights, etc.)</td>
<td>10 (2015)</td>
<td>External</td>
<td>DS</td>
<td>Survater + others</td>
<td>4</td>
<td>2000 Cent HR in VO</td>
<td>2016 ($500)</td>
<td>2016 ($1,800)</td>
<td>Dam Safety Surveillance source is unclear; needs to be resampled however it is satisfactory for a 3-day course and gives sufficient information required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 2</td>
<td>&quot;CA1&quot; + &quot;CA2&quot;</td>
<td>0</td>
<td>1</td>
<td>$1,500/yr (less $8,000 in 2018)</td>
<td>2 (2018)</td>
<td>WSP Parson Inc.</td>
<td>onsite</td>
<td>DS, EAP, O&amp;M</td>
<td>3 yearly</td>
<td>2014 will continue</td>
<td>WSP PB (2014-2015), Cardeo (2016), PB (2014-2015), $7,000 (2015), $10,000 (2016)</td>
<td>2014 ($8,000)</td>
<td>Dam Owner 2 will continue, with this approach unless formal training is required. Dam Owner 2 approach to training to date has been driven by the types of dams we are responsible for. Two of Dam Owner 2 's largest dam are rehabilitated; these do not normally hold water. None of Dam Owner 2's dams are 'operated' as such, as they have no mechanism to control the release of water (e.g., a water event affecting the dam). Dam Owner 2 's dam operators monitor and report on the dam's condition (state of embankment, performance of uncontrolled flow pipes at the two rehabilitation bays) and water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 3</td>
<td>&quot;CA2&quot;</td>
<td>0</td>
<td>2</td>
<td>$2,000</td>
<td>2 (2014)</td>
<td>Survater</td>
<td>External</td>
<td>DS</td>
<td>5 yearly</td>
<td>na will continue</td>
<td></td>
<td>2014 ($8,000)</td>
<td>Dam Owner 2 's operators monitor and report on the dam's condition (state of embankment, performance of uncontrolled flow pipes at the two rehabilitation bays) and water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 4</td>
<td>&quot;CA1&quot;</td>
<td>0</td>
<td>5</td>
<td>? TAFE</td>
<td>na</td>
<td>TAFE</td>
<td>External</td>
<td>Cert HR in VO (VTP?)</td>
<td>4</td>
<td>all DO are fully qualified in VTP operations. Dam is a fully isolated storage system situated near the... Q4, all dam operators are fully qualified VTP operators operating out of... Waste, Water and Waste VTPs. These members of staff would be competent in all aspects of water movement, gate valve operations and drainage. Outlet valves for which dam operators are responsible for are normally operated at maximum of 5 times each year.</td>
<td></td>
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<tr>
<td>Dam Owner 5</td>
<td>&quot;CA1&quot;</td>
<td>1</td>
<td>3</td>
<td>Internal</td>
<td></td>
<td>DS, EAP, O&amp;M</td>
<td>actually</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>2015 ($500)</td>
<td>Dam Owner 2 's operators monitor and report on the dam's condition (state of embankment, performance of uncontrolled flow pipes at the two rehabilitation bays) and water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Company Name</td>
<td>Failure Impact Category</td>
<td>No of Gated</td>
<td>No of DII</td>
<td>Cost of latest training (incl. travel, accomm. and et.al)</td>
<td>No of attendees</td>
<td>Current TP</td>
<td>Delivery</td>
<td>Skills covered</td>
<td>Frequency</td>
<td>Satisfactorily (60% satisfied, 5 very satisfied)</td>
<td>Used since</td>
<td>Future outlook</td>
<td>Previous</td>
<td>Costs</td>
<td>Other comments</td>
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<tr>
<td>Dam Owner 6</td>
<td>&quot;Cat1&quot;</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>no DS training</td>
<td>Matinence skill</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>2006</td>
<td>will continue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 7</td>
<td>&quot;Cat1&quot;</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>no DS training</td>
<td>Matinence skill</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 9</td>
<td>&quot;Cat1 &amp; Cat2&quot;</td>
<td>0</td>
<td>0</td>
<td>$2200/pp (2016)</td>
<td>Sunwater + Intec</td>
<td>External</td>
<td>DS &amp; EAP</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Dam Owner 10</td>
<td>&quot;Cat1 &amp; Cat2&quot;</td>
<td>1</td>
<td>4</td>
<td>$2700 (w/7A), $2250 (StnWtr)</td>
<td>Water Training Au, SunWater</td>
<td>External</td>
<td>Cedi III in WO, US</td>
<td>Cedi III in WO, US</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dam Owner 11</td>
<td>&quot;Cat1 &amp; Cat2&quot;</td>
<td>1</td>
<td>1</td>
<td>$600 pp</td>
<td>GHD, Engineers Au.</td>
<td>on site</td>
<td>Cedi III in WO, US</td>
<td></td>
<td>2-yearly</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 12</td>
<td>&quot;Cat1 &amp; Cat2&quot;</td>
<td>5</td>
<td>4</td>
<td>$1500 (2015)</td>
<td>DS Internal training</td>
<td>Internal</td>
<td>DS, EAP, O&amp;M</td>
<td></td>
<td>annually</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 13</td>
<td>&quot;Cat1&quot;</td>
<td>0</td>
<td>1</td>
<td>$1500 (2015)</td>
<td>DEVS</td>
<td>otsernal</td>
<td>DS, EAP, O&amp;M</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Company Name</td>
<td>Failure Impact Category</td>
<td>No of Gated</td>
<td>No of DO</td>
<td>Cost of latest training (excl. travel, accommodation and toll)</td>
<td>No of attendees</td>
<td>Current TP</td>
<td>Delivery</td>
<td>Skills covered</td>
<td>Frequency</td>
<td>Satisfied with training?</td>
<td>Very</td>
<td>Used since</td>
<td>Future outlook</td>
<td>Previous</td>
<td>Costs</td>
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</tr>
<tr>
<td>Dam Owner 14</td>
<td>Cat1</td>
<td>0</td>
<td>4-1, 1, 1</td>
<td>$2300 (2016), $2000 (2018)</td>
<td>2 (2016), 2 (DEWS 2015)</td>
<td>Survator</td>
<td>External</td>
<td>US</td>
<td>3 yearly</td>
<td>4</td>
<td>Very</td>
<td>2000</td>
<td>DEWS 2016 - 2018</td>
<td>24/1800</td>
<td></td>
</tr>
<tr>
<td>Dam Owner 15</td>
<td>Cat1</td>
<td>0</td>
<td>2 FT, 1, 1</td>
<td>$1500 (2015)</td>
<td>2</td>
<td>DEWS</td>
<td>External</td>
<td>DE, EAP, C&amp;I M</td>
<td>4</td>
<td>will continue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 16</td>
<td>Cat1, Cat2</td>
<td>0</td>
<td>1 FT, 1, 1</td>
<td>$1500 (2015)</td>
<td>DEWS - 2015</td>
<td>DEWS</td>
<td>External</td>
<td>DE, EAP, C&amp;I</td>
<td>5</td>
<td>SunWater in 2017, formal training in 2-3 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 17</td>
<td>Cat2</td>
<td>0</td>
<td>2 FT</td>
<td>$1500 (2015)</td>
<td>1 (2015), 1 (2013)</td>
<td>DEWS - 2015, IF - 2013</td>
<td>External</td>
<td>DE, EAP, C&amp;I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Company Name</td>
<td>Failure Category</td>
<td>No of Gated</td>
<td>No of DO</td>
<td>Cost of the Latest training (Fuel, travel, accomod. etc)</td>
<td>No of attendees</td>
<td>Current TP</td>
<td>Delivery</td>
<td>Skills covered</td>
<td>Frequency</td>
<td>Duration expected (if not satisfied)</td>
<td>Used since</td>
<td>Future outlook</td>
<td>Previous</td>
<td>Costs</td>
<td>Other comments</td>
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</tr>
<tr>
<td>Dam Owner 10</td>
<td>&quot;Cat1 &amp; Cat2&quot;</td>
<td>3</td>
<td>25 FT, 50 PT</td>
<td>From $2000.00 incl. WO1 to $10,000.00 incl. WO2 for DO w/o qualifications; S trained once per year. 12 DOs attended ANCOLD DOs Forum - $1300.00. 7 DOs attended ANCOLD surveillance course, annual internal EP &amp; surveillance training for all DO, 2nd line of training (4 groups at 12 week intervals) and</td>
<td>various depending on the training received</td>
<td>Internal - 2010</td>
<td>Internal &amp; external</td>
<td>WHS, EHS, OSH, FR, FM, WT</td>
<td>ongoing, one-off and annual depending on the type of training</td>
<td>5</td>
<td>CII since 2013</td>
<td>will continue</td>
<td>ANCOLD</td>
<td>DOs with qualifications. It is part of the Position Description that all Full Time Dam Operators have at least a Cert III in Water Operations. The majority of Part Time and Back-up Dam Operators would either have a full or a Cert II in Water Operations or be studying for a Cert II in Water Operations or a higher qualification. Dam Owner 10 offers Cert III in Water Operations, Cert II in Water Operations and a Diploma in Water Operations to all Operational staff working across the areas of Dam Operation, Catchment Management and Water Treatment Plant Operations. The numbers of Dam Owner 10 staff undertaking or completing this training in recent years would be in the hundreds. Dam Owner 10 provides additional training to operational staff in the areas of WHS, Project Management, Supervision and other related areas. Some of this training is mandatory. Dam Owner 10’s Water Operations Certificate and Diploma Level training is currently provided by the South West Institute of TAFE. Various other training providers are involved in the other operational training described above including In-house training providers. Annual retraining is normally provided across Dam Operations and V&amp;O.</td>
<td></td>
</tr>
<tr>
<td>Dam Owner 15</td>
<td>&quot;Cat1 &amp; Cat2&quot;</td>
<td>0</td>
<td>4PT</td>
<td>$1400.00 (2016)</td>
<td>1</td>
<td>ANCOLD conference</td>
<td>WHS, EHS, OSH, FR</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 20</td>
<td>&quot;Cat2&quot;</td>
<td>0</td>
<td>4 PT</td>
<td>$7200.00</td>
<td>4</td>
<td>SunWater</td>
<td>WHS, EHS, OSH, FR</td>
<td>3</td>
<td>2005</td>
<td>SunWater</td>
<td>2005-4th</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 21</td>
<td>&quot;Cat1&quot;</td>
<td>0</td>
<td>0</td>
<td>n/a upto date</td>
<td>0</td>
<td>none</td>
<td>WHS, EHS, OSH, FR</td>
<td>3</td>
<td>2005</td>
<td>SunWater</td>
<td>2005-4th</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dam operator training, Department of Energy and Water Supply, 2017
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Failure Impact Category</th>
<th>No of Gated</th>
<th>No of DO</th>
<th>Cost of the latest training (excl. travel, accommodation, etc)</th>
<th>No of attendees</th>
<th>Current IP</th>
<th>Definitive</th>
<th>Skills covered</th>
<th>Frequency</th>
<th>Satisfaction</th>
<th>Used since</th>
<th>Future outlook</th>
<th>Previous</th>
<th>Costs</th>
<th>Other comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam Owner 22</td>
<td>&quot;Cat 1&quot;</td>
<td>0</td>
<td>IPT</td>
<td>nil to date</td>
<td>0</td>
<td>none</td>
<td>Internal</td>
<td>training guides and EAP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>the EAP and the engineering report are utilized for training purposes.</td>
</tr>
<tr>
<td>Dam Owner 23</td>
<td>&quot;Cat 1&quot;</td>
<td>0</td>
<td>IPT, 3EU</td>
<td>nil to date</td>
<td>0</td>
<td>none</td>
<td>Internal</td>
<td>training guides and EAP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Four of the DOs have had Dam Safety training provided by SunWater. Two backup DOs have onsite training provided by their supervisors. The last formal training provided to our operators occurred late 2013. All MSC staff have regular WHS/Take5 training and workplace (notions safer) training. The dedicated part-time staff test the safety procedures weekly during the wet season.</td>
</tr>
</tbody>
</table>

### Attendance at 2015 DEWS organised training

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Failure Impact Category</th>
<th>Cost of the latest training (excl. travel, accommodation, etc)</th>
<th>No of attendees</th>
<th>Current IP</th>
<th>Skills covered</th>
<th>Frequency</th>
<th>Satisfaction</th>
<th>Used since</th>
<th>Future outlook</th>
<th>Previous</th>
<th>Costs</th>
<th>Other comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam Owner 24</td>
<td>&quot;Cat 2&quot;</td>
<td>$2000pp(2016)</td>
<td>2,756</td>
<td>Sunwater</td>
<td>External</td>
<td>5 yearly</td>
<td>US</td>
<td>DEWS</td>
<td>$500pp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Owner 25</td>
<td>&quot;Cat 1&quot;</td>
<td>$600 (2015)</td>
<td>2,215</td>
<td>DEWS-2015</td>
<td>external</td>
<td></td>
<td>US, EAP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Abbreviations

- **BU**: Back-up Operator
- **CM**: Catchment Management
- **CS**: Confined Space
- **DO**: Dam Operator
- **DS**: Dam Surveillance
- **EAP**: Emergency Action Planning
- **FT**: Full time Operator
- **FO**: Flood Operations
- **FR**: Flood Routing
- **O & M**: Operation and Maintenance
- **PT**: Part time Operator
- **TP**: Training Provider
- **WT**: Water Treatment
- **WHS**: Workplace Health and Safety
- **na**: Details not available
11.3 Appendix C

NSW DSC ‘Requirements for Type 3 Surveillance Reports (D5 Form)’

<table>
<thead>
<tr>
<th>DAM DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Name of dam: ____________________________</td>
</tr>
<tr>
<td>2. Location of dam: (a) River, Stream: ____________________________</td>
</tr>
<tr>
<td>(b) Nearest town: ____________________________</td>
</tr>
<tr>
<td>3. Dam owner: ____________________________ Phone No: _______</td>
</tr>
<tr>
<td>Address: ____________________________</td>
</tr>
</tbody>
</table>

Attach a completed D8 Dam Owners Address Form

4. Type of dam (Please Tick)

- Embankment - Zoned Earthfill  
  - Homogenous Earthfill  
  - Earth & Rockfill  
  - Rockfill with impervious face (e.g. concrete)
- Concrete (or Masonry) - Gravity  
  - Arch  
  - Buttress  
  - RCC
- Tailings Dams - Upstream  
  - Centreline  
  - Downstream

Combination of these or other types (tick all that apply and describe briefly):

---

This document: [Link](http://www.damsafety.nsw.gov.au/DSC/Download/Forms/D5.pdf)  
Page 1 of 8  
February 2012
5. Height of dam (m):
6. Storage Volume (ML):
7. Year construction completed:
8. Catchment Area (km² or hectares):
9. Consequence Categories (Refer DSC3A) - (a) Sunny Day: 
   (b) Flood: 
10. Spillway capacity - (a) Inflow Flood Peak (m³/s): 
    (b) Annual Exceedance Probability (AEP): 
    (c) Method & date of calculation:

**INSPECTION REPORT**

Please provide a comment in each section to confirm all features are inspected (including not applicable, nil, etc. if appropriate). Include explanatory notes where space provided is insufficient.

**Conditions at time of inspection**

a) Date of inspection: 

b) Weather: 

c) Storage Level: m below full supply level 

d) Date of most recent rain: 

**Embankment dam**

11. General condition of embankment slopes and crest:

12. Location and extent of any slips, erosion, cracks, sink holes, piping, subsidence or movement in embankment slopes and crest:

13. Location and extent of any cracks or other defects in concrete/bitumen or other impervious upstream face:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

14. Condition of embankment with regard to vegetation (e.g., grass cover, presence of trees and bushes, impairment of rock protection, etc.):
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

15. Describe any leakage/seepage through dam, foundations or abutments (give location, quantity, clear or coloured):
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Concrete or masonry dam

16. Location and extent of any defects such as cracks, surface deterioration, movement, etc.:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

17. Describe any leakage/seepage through dam, foundation or abutments (give location, quantity, clear or coloured):
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

18. Give details of any drains in the dam and state whether they are open or blocked. Are they flowing?
________________________________________________________________________
________________________________________________________________________
19. Type of spillway and nature of discharge channel (e.g. grassed, rock, concrete lined, etc.):

________________________________________________________________________

20. Location and extent of any erosion:

________________________________________________________________________

21. Location and extent of any obstructions to flow (logs etc.):

________________________________________________________________________

22. Location and extent of any defects in concrete or masonry:

________________________________________________________________________

23. Give number, size, type and condition of any spillway gates or stoplogs (including operating facility):

________________________________________________________________________

24. Provide information on the highest flood (and date of occurrence) passed by the spillway including height relative to crest of dam. Is the spillway capacity considered adequate and basis of assessment?

________________________________________________________________________
Outlet works

25. General description:

________________________________________________________________________

________________________________________________________________________

26. State whether outlet works are in good working order. If not, give details:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

INSTRUMENTATION, ROUTINE INSPECTIONS & TRAINING

27. Provide a brief description of instrumentation in dam (eg. seepage measurement wells, piezometers, survey points, etc.) and frequency of measurement:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

28. Do instruments indicate normal behaviour of dam? If not, give details:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

29. At what frequency are routine visual inspections conducted (eg. weekly)?

30. Have all inspection personnel, who conduct routine inspections of the dam, completed a Dams Surveillance Training Course within the last 5 years?
CONSEQUENCE CATEGORIES

(Please refer to Guidance Sheet DSC3A for explanation).

31. State the adverse consequences which justify the Sunny Day Consequence Category:

32. State the adverse consequences which justify the Flood Consequence Category:

CONCLUSIONS & RECOMMENDATIONS

33. Is the dam considered to be in a safe condition? Are there any other matters within the owner's knowledge which could affect the safety of the dam?

34. State any Recommendations necessary to make the dam safe or address maintenance issues raised in the Report, & provide a program for implementation:
DOCUMENTATION

Advise on availability of the following:

a) Design Report: ________________________________

b) Construction Report: __________________________

c) Dam Safety Emergency Plan: ____________________

PHOTOGRAPHS & DRAWINGS

Please attach a minimum of 6 labelled photographs taken during the inspection, particularly areas commented on in the Report. Also include copies of any Design or Work-As-Executed Drawings available.
CERTIFICATION

This is to certify that the information submitted in this Report is true and is based on a recent inspection of the dam and is, to the best of my knowledge, true and correct.

Report prepared by:

Signature:

Name of person making inspection

(Occupation, e.g. civil engineer, manager, etc.)

Phone:

Mobile:

Email address:

Date:

Owner/Owner's Authorised Representative:

This is to certify that I have read the above Report and accept the findings.

Signature:

(Name of Owner/Owner's authorised representative)

Phone:

Mobile:

Email address:

Date:
11.4 Appendix D

Australian NWP, Units of competency
Certificate II and Certificate III in Water Industry Operations

NWP20115 Certificate II in Water Industry Operations

Packaging rules

11 units of competency are required for this qualification:

- 2 core units
- 9 elective units

Specialisation

The candidate may either complete the general qualification or specialise in networks, source, irrigation or treatment by selecting elective units as specified in the table below.

Elective units selected must not duplicate content already covered by other units in this qualification.
### Core units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPGEN001</td>
<td>Apply the risk management principles of the water industry standards, guidelines and legislation</td>
</tr>
<tr>
<td>NWPGEN003</td>
<td>Apply the environmental and licensing procedures of the water industry</td>
</tr>
</tbody>
</table>

### Group A: Work health safety

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSBWHS201</td>
<td>Contribute to health and safety of self and others</td>
</tr>
<tr>
<td>BSBWHS301</td>
<td>Maintain workplace safety</td>
</tr>
</tbody>
</table>

### Group B: Sampling and testing

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPGEN007</td>
<td>Sample and test drinking water</td>
</tr>
<tr>
<td>NWPGEN008</td>
<td>Sample and test wastewater</td>
</tr>
<tr>
<td>NWPSOU001</td>
<td>Respond to blue-green algae outbreaks</td>
</tr>
</tbody>
</table>

### Group C: Networks

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPNET002</td>
<td>Prepare and restore work site</td>
</tr>
<tr>
<td>NWPNET003</td>
<td>Control electrical risk on metallic pipes</td>
</tr>
<tr>
<td>NWPNET004</td>
<td>Monitor and operate network systems</td>
</tr>
<tr>
<td>NWPNET011</td>
<td>Locate, identify and protect utilities</td>
</tr>
<tr>
<td>NWPNET021</td>
<td>Install metering equipment</td>
</tr>
<tr>
<td>NWPNET022</td>
<td>Maintain and repair networks assets for drinking water</td>
</tr>
<tr>
<td>NWPNET023</td>
<td>Maintain and repair networks assets for wastewater</td>
</tr>
<tr>
<td>NWPNET024</td>
<td>Maintain and repair network assets for bulk water</td>
</tr>
<tr>
<td>NWPNET031</td>
<td>Construct and install water distribution assets</td>
</tr>
<tr>
<td>NWPNET032</td>
<td>Construct and install wastewater assets</td>
</tr>
<tr>
<td>NWPNET043</td>
<td>Monitor and operate bulk water transfer systems</td>
</tr>
<tr>
<td>NWPIRR001</td>
<td>Monitor and operate irrigation and domestic delivery systems</td>
</tr>
<tr>
<td>NWPIRR002</td>
<td>Operate basic flow control and regulating devices in irrigation systems</td>
</tr>
<tr>
<td>NWPIRR011</td>
<td>Install devices for irrigation systems</td>
</tr>
<tr>
<td>NWPIRR012</td>
<td>Construct open earthen channels and drains</td>
</tr>
<tr>
<td>NWPIRR013</td>
<td>Construct and install irrigation delivery and stormwater drainage assets</td>
</tr>
<tr>
<td>NWPIRR021</td>
<td>Maintain and repair irrigation channels and drains</td>
</tr>
<tr>
<td>RIICCM205D</td>
<td>Carry out manual excavation</td>
</tr>
<tr>
<td>RIIWHS202D</td>
<td>Enter and work in confined spaces</td>
</tr>
<tr>
<td>Group D: Source</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>NWPSOU002</td>
<td>Control vegetation on a site</td>
</tr>
<tr>
<td>NWPSOU011</td>
<td>Maintain catchment and surrounding areas</td>
</tr>
<tr>
<td>NWPSOU012</td>
<td>Monitor, inspect and report catchment operations</td>
</tr>
<tr>
<td>NWPSOU021</td>
<td>Inspect and maintain basic dams and water storages</td>
</tr>
<tr>
<td>NWPSOU051</td>
<td>Monitor and operate groundwater extraction</td>
</tr>
<tr>
<td>NWPSOU054</td>
<td>Monitor and operate pump stations</td>
</tr>
<tr>
<td>NWPNET022</td>
<td>Maintain and repair networks assets for drinking water</td>
</tr>
<tr>
<td>NWPNET023</td>
<td>Maintain and repair networks assets for wastewater</td>
</tr>
<tr>
<td>Group E: Irrigation</td>
<td></td>
</tr>
<tr>
<td>NWPIRR002</td>
<td>Operate basic flow control and regulating devices in irrigation systems</td>
</tr>
<tr>
<td>NWPIRR012</td>
<td>Construct open earthen channels and drains</td>
</tr>
<tr>
<td>NWPIRR013</td>
<td>Construct and install irrigation delivery and stormwater drainage assets</td>
</tr>
<tr>
<td>NWPIRR021</td>
<td>Maintain and repair irrigation channels and drains</td>
</tr>
<tr>
<td>NWPIRR041</td>
<td>Identify and apply water entitlements and delivery processes</td>
</tr>
<tr>
<td>NWPNET004</td>
<td>Monitor and operate network systems</td>
</tr>
<tr>
<td>NWPNET022</td>
<td>Maintain and repair networks assets for water</td>
</tr>
<tr>
<td>NWPNET023</td>
<td>Maintain and repair networks assets for wastewater</td>
</tr>
<tr>
<td>Group F: Treatment</td>
<td></td>
</tr>
<tr>
<td>NWPTRT001</td>
<td>Operate and control water treatment processes</td>
</tr>
<tr>
<td>NWPTRT012</td>
<td>Operate and control fluoride addition processes</td>
</tr>
<tr>
<td>NWPTRT013</td>
<td>Operate and control liquefied chlorine gas disinfection processes</td>
</tr>
<tr>
<td>NWPTRT052</td>
<td>Operate and control hypochlorite disinfection processes</td>
</tr>
<tr>
<td>NWPTRT053</td>
<td>Operate and control UV processes</td>
</tr>
<tr>
<td>NWPTRT055</td>
<td>Operate chlorine dioxide processes</td>
</tr>
<tr>
<td>NWPTRT056</td>
<td>Operate and control ozone processes</td>
</tr>
<tr>
<td>NWPTRT061</td>
<td>Operate and control wastewater processes</td>
</tr>
<tr>
<td>NWPTRT071</td>
<td>Operate and control pre-treatment processes</td>
</tr>
<tr>
<td>NWPTRT073</td>
<td>Operate and control wastewater sedimentation processes</td>
</tr>
<tr>
<td>NWPTRT101</td>
<td>Operate and control lagoon processes</td>
</tr>
<tr>
<td>NWPGEN012</td>
<td>Support the role and functions of the water industry</td>
</tr>
<tr>
<td>NWPSOU051</td>
<td>Monitor and operate groundwater extraction</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NWPSOU054</td>
<td>Monitor and operate pump stations</td>
</tr>
<tr>
<td><strong>Group G: General elective units</strong></td>
<td></td>
</tr>
<tr>
<td>NWPGEN011</td>
<td>Use maps, plans, drawings and specifications</td>
</tr>
<tr>
<td>NWPGEN012</td>
<td>Support the role and functions of the water industry</td>
</tr>
<tr>
<td>NWPNET002</td>
<td>Prepare and restore work site</td>
</tr>
<tr>
<td>CPCCCM1015A</td>
<td>Carry out measurements and calculations</td>
</tr>
<tr>
<td>RIISAM204D</td>
<td>Operate small plant and equipment</td>
</tr>
<tr>
<td>BSBCM201</td>
<td>Communicate in the workplace</td>
</tr>
<tr>
<td>BSBCUS201</td>
<td>Deliver a service to customers</td>
</tr>
<tr>
<td>BSBWOR202</td>
<td>Organise and complete daily work activities</td>
</tr>
<tr>
<td>FSKDIG03</td>
<td>Use digital technology for routine workplace tasks</td>
</tr>
<tr>
<td>MSAPMOHS216A</td>
<td>Operate breathing apparatus</td>
</tr>
<tr>
<td>MSS404061A</td>
<td>Facilitate the use of SCADA systems in a team or work area</td>
</tr>
<tr>
<td>RIWHS202D</td>
<td>Enter and work in confined spaces</td>
</tr>
<tr>
<td>RIWHS302D</td>
<td>Implement traffic management plan</td>
</tr>
<tr>
<td>UEEENEK101A</td>
<td>Maintain safety and tidiness of remote area power supply systems</td>
</tr>
<tr>
<td>UEEENE101A</td>
<td>Apply Occupational Health and Safety regulations, codes and practices in the workplace</td>
</tr>
<tr>
<td>UEEENEK102A</td>
<td>Work safely with remote area power supply systems</td>
</tr>
<tr>
<td>UEEENE101A</td>
<td>Apply Occupational Health and Safety regulations, codes and practices in the workplace</td>
</tr>
<tr>
<td>UEEENE102A</td>
<td>Work safely with remote area power supply systems</td>
</tr>
<tr>
<td>UEEENE101A</td>
<td>Apply Occupational Health and Safety regulations, codes and practices in the workplace</td>
</tr>
</tbody>
</table>
NWP30115 Certificate III in Water Industry Operations

Packaging rules

11 units of competency are required for this qualification:

- 2 core units
- 9 elective units

Specialisation

The candidate may either complete the general qualification or specialise in networks, source, irrigation or treatment by selecting elective units as specified in the table below.

<table>
<thead>
<tr>
<th></th>
<th>General</th>
<th>Networks</th>
<th>Source</th>
<th>Hydrography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Group A:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work health safety</td>
<td>Choose 1</td>
<td>Choose 1</td>
<td>Choose 1</td>
<td>Choose 1</td>
</tr>
<tr>
<td>Group B:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling and testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group C:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Choose at least 5 from groups B, C, D, E, F and/or G, with no more than 2 from any one group</td>
<td>Optional – choose no more than 1</td>
<td>Choose at least 4</td>
<td>Choose at least 3</td>
</tr>
<tr>
<td>Group D:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Networks</td>
<td>Choose at least 4</td>
<td>Optional – choose no more than 1</td>
<td>Choose at least 3</td>
<td>Choose at least 4</td>
</tr>
<tr>
<td>Group E:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Group F:</td>
<td></td>
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<td></td>
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<tr>
<td>Hydrography</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Flexible choice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Choose the remaining elective units from the list below or from elsewhere within this training package. Alternatively, up to 2 of the elective units may be selected from another endorsed training package, or from an accredited course.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of units</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
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</tbody>
</table>

Elective units selected must not duplicate content already covered by other units in this qualification.
<table>
<thead>
<tr>
<th>Core units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPGEN001</td>
</tr>
<tr>
<td>NWPGEN004</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group A: Work health safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSBWHS301</td>
</tr>
<tr>
<td>BSBWHS302</td>
</tr>
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<td>BSBWHS303</td>
</tr>
<tr>
<td>BSBWHS304</td>
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</table>

<table>
<thead>
<tr>
<th>Group B: Sampling and testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPGEN007</td>
</tr>
<tr>
<td>NWPGEN008</td>
</tr>
<tr>
<td>NWPGEN009</td>
</tr>
<tr>
<td>NWPSOUU001</td>
</tr>
<tr>
<td>NWPSOUU003</td>
</tr>
<tr>
<td>AHCLPW306A</td>
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<table>
<thead>
<tr>
<th>Group C: Construction</th>
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<tbody>
<tr>
<td>CPCCCM2004A</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>RIICRC202D</td>
</tr>
<tr>
<td>CPCCCM2003B</td>
</tr>
<tr>
<td>PMBWELD301B</td>
</tr>
<tr>
<td>PMBWELD302B</td>
</tr>
<tr>
<td>PMBWELD305B</td>
</tr>
<tr>
<td>PMBWELD308B</td>
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<tr>
<td>RIICBS310D</td>
</tr>
<tr>
<td>RIICCM205D</td>
</tr>
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<td>RIICCM207D</td>
</tr>
<tr>
<td>RIICCM208D</td>
</tr>
<tr>
<td>RIICCM209D</td>
</tr>
<tr>
<td>Code</td>
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<td>RIICCM210D</td>
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<tr>
<td>RIICCM211D</td>
</tr>
<tr>
<td>RIICCM301D</td>
</tr>
<tr>
<td>RIICPL304D</td>
</tr>
<tr>
<td>RIICPL305D</td>
</tr>
<tr>
<td>RIICRC303D</td>
</tr>
<tr>
<td>RIICRC314D</td>
</tr>
<tr>
<td>RIICRC315D</td>
</tr>
<tr>
<td>RIICRC323D</td>
</tr>
<tr>
<td>RIICWM501D</td>
</tr>
<tr>
<td>RIIHAN211D</td>
</tr>
<tr>
<td>RIIMPO327D</td>
</tr>
<tr>
<td>RIISAM203D</td>
</tr>
<tr>
<td>RIISAM204D</td>
</tr>
<tr>
<td>RIIWHS202D</td>
</tr>
<tr>
<td>RIIWHS204D</td>
</tr>
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<td>RIIWMG203D</td>
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**Group D: Networks**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPNET001</td>
<td>Disinfect networks assets</td>
</tr>
<tr>
<td>NWPNET003</td>
<td>Control electrical risk on metallic pipes</td>
</tr>
<tr>
<td>NWPNET012</td>
<td>Use locating devices</td>
</tr>
<tr>
<td>NWPNET013</td>
<td>Identify and respond to water problems</td>
</tr>
<tr>
<td>NWPNET014</td>
<td>Perform odour and infiltration investigations</td>
</tr>
<tr>
<td>NWPNET015</td>
<td>Perform leak detection</td>
</tr>
<tr>
<td>NWPNET016</td>
<td>Inspect sewer or stormwater line</td>
</tr>
<tr>
<td>NWPNET026</td>
<td>Inspect, maintain and repair hydrants</td>
</tr>
<tr>
<td>NWPNET027</td>
<td>Monitor and control vacuum sewer system</td>
</tr>
<tr>
<td>NWPNET041</td>
<td>Monitor and operate water distribution systems</td>
</tr>
<tr>
<td>NWPNET042</td>
<td>Monitor and operate wastewater collection and transfer systems</td>
</tr>
<tr>
<td>NWPNET043</td>
<td>Monitor and operate bulkwater transfer systems</td>
</tr>
<tr>
<td>NWPNET044</td>
<td>Test and commission water distribution systems</td>
</tr>
<tr>
<td>NWPNET045</td>
<td>Test and commission wastewater collection systems</td>
</tr>
<tr>
<td>Code</td>
<td>Task Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>NWPIRR003</td>
<td>Inspect and operate surface water systems</td>
</tr>
<tr>
<td>NWPIRR014</td>
<td>Install meters for rural water supplies</td>
</tr>
<tr>
<td>NWPIRR022</td>
<td>Maintain meters for rural water supplies</td>
</tr>
<tr>
<td>RIISAM203D</td>
<td>Use hand and power tools</td>
</tr>
<tr>
<td>RIICCM205D</td>
<td>Carry out manual excavation</td>
</tr>
<tr>
<td>RIICCM209D</td>
<td>Carry out concrete work</td>
</tr>
<tr>
<td>RIICCM210D</td>
<td>Install trench support</td>
</tr>
<tr>
<td>RIICWM501A</td>
<td>Implement civil construction plan</td>
</tr>
<tr>
<td>RIIMPO327D</td>
<td>Conduct pipe layer operations</td>
</tr>
</tbody>
</table>

**Group E: Source**

<table>
<thead>
<tr>
<th>Code</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPSOU013</td>
<td>Monitor and coordinate catchment operations</td>
</tr>
<tr>
<td>NWPSOU022</td>
<td>Monitor and control dam operations</td>
</tr>
<tr>
<td>NWPSOU023</td>
<td>Monitor and implement dam maintenance</td>
</tr>
<tr>
<td>NWPSOU024</td>
<td>Inspect and report on concrete dam safety</td>
</tr>
<tr>
<td>NWPSOU025</td>
<td>Inspect and report on embankment dam safety</td>
</tr>
<tr>
<td>NWPSOU027</td>
<td>Route floods through storages</td>
</tr>
<tr>
<td>NWPSOU029</td>
<td>Conduct and report dam safety instrumentation monitoring</td>
</tr>
<tr>
<td>NWPSOU030</td>
<td>Inspect and report river performance</td>
</tr>
<tr>
<td>NWPSOU031</td>
<td>Operate and maintain locks and weirs</td>
</tr>
<tr>
<td>NWPSOU032</td>
<td>Operate and maintain fishways</td>
</tr>
<tr>
<td>NWPSOU033</td>
<td>Operate and maintain salt interception works</td>
</tr>
<tr>
<td>NWPSOU052</td>
<td>Inspect and operate groundwater regulation</td>
</tr>
<tr>
<td>NWPNET043</td>
<td>Monitor and operate bulkwater transfer systems</td>
</tr>
</tbody>
</table>

**Group F: Hydrography**

<table>
<thead>
<tr>
<th>Code</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPHYD011</td>
<td>Measure and process low and medium flows using area velocity methods</td>
</tr>
<tr>
<td>NWPHYD012</td>
<td>Establish monitoring sites</td>
</tr>
<tr>
<td>NWPGEN012</td>
<td>Support the role and functions of the water industry</td>
</tr>
<tr>
<td>FSKNUM21</td>
<td>Apply an expanding range of mathematical calculations for work</td>
</tr>
<tr>
<td>MSL904001A</td>
<td>Perform standard calibrations</td>
</tr>
<tr>
<td>MSL922001A</td>
<td>Record and present data</td>
</tr>
</tbody>
</table>
### Group G: General elective units

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPGEN013</td>
<td>Apply principles of chemistry to water systems and processes</td>
</tr>
<tr>
<td>NWPIRR051</td>
<td>Provide and promote customer service</td>
</tr>
<tr>
<td>NWPTRD011</td>
<td>Investigate and report breaches of water industry legislation</td>
</tr>
<tr>
<td>NWPTRT001</td>
<td>Operate and control water treatment processes</td>
</tr>
<tr>
<td>NWPTRT061</td>
<td>Operate and control wastewater processes</td>
</tr>
<tr>
<td>BSBCMM301</td>
<td>Process customer complaints</td>
</tr>
<tr>
<td>BSBCUS301</td>
<td>Deliver and monitor a service to customers</td>
</tr>
<tr>
<td>BSBFLM305</td>
<td>Support operational plan</td>
</tr>
<tr>
<td>BSBFLM312</td>
<td>Contribute to team effectiveness</td>
</tr>
<tr>
<td>BSBINM301</td>
<td>Organise workplace information</td>
</tr>
<tr>
<td>BSBWOR301</td>
<td>Organise personal work priorities and development</td>
</tr>
<tr>
<td>CPCPPS5024A</td>
<td>Conduct a water audit and identify water-saving initiatives</td>
</tr>
<tr>
<td>CPPHSA4003A</td>
<td>Assess household water use</td>
</tr>
<tr>
<td>MSS404061A</td>
<td>Facilitate the use of SCADA systems in a team or work area</td>
</tr>
<tr>
<td>RIIWHS302D</td>
<td>Implement traffic management plan</td>
</tr>
<tr>
<td>TLID2003A</td>
<td>Handle dangerous goods/hazardous substances</td>
</tr>
</tbody>
</table>
11.5 Appendix E

Queensland Government Subsidised training and incentives

Subsidised training and incentives

The Queensland Government invests in training based on industry advice to provide Queenslanders with the skills they need to gain meaningful and sustainable employment through the provider of their choice.

Government funding is directed to minimise skills shortages, focus on training for jobs that are in demand in our critical industries, and increase the number of Queenslanders with formal post-school qualifications.

The Queensland Skills Gateway (www.skillsgateway.training.qld.gov.au/) includes a tool to help you check if you are eligible for government subsidised training in Queensland.

List of subsidised training and programs


The Certificate 3 Guarantee provides a government subsidy to allow eligible Queenslanders to obtain first post-school certificate III qualification.

User Choice (www.training.qld.gov.au/training/incentives/userchoice) (apprenticeship and traineeship funding)

The User Choice program provides public funding for the delivery of accredited, entry level training to apprentices and trainees.


The Higher Level Skills program provides a government subsidy to help individuals gain the higher level skills and qualifications required to secure employment or career advancement in a priority industry.

Fee-free training for Year 12 graduates (www.training.qld.gov.au/training/incentives/year12-fee-free)

Information about access to fee-free training in priority areas for Year 12 graduates.

Skilling Queenslanders for Work (www.training.qld.gov.au/training/incentives/sqw)

Skilling Queenslanders for Work is an initiative to help eligible Queenslanders to gain the skills, qualifications and experience to enter and stay in the workforce. The programs are targeted at different groups including young people, mature-age job seekers, Aboriginal and Torres Strait Islander people, people with disability, women re-entering the workforce, and people from culturally and linguistically diverse backgrounds.

Back to Work (www.backtowork.initiatives.qld.gov.au)

Back to Work is a two-year $100m package to help give employers the confidence to take on new staff in regions and provide an economic boost to regions that are facing challenging times. Financial support of up to $15,000 is available to businesses to take on jobseekers in regional areas with up to 8000 jobs supported through this assistance package.

VETiS funded from the VET Investment budget focuses on delivering qualifications to provide school students with the skills and knowledge required for employment in specific industries.

VET FEE-HELP (www.training.qld.gov.au/training/incentives/feehelp)

Learn more about how VET FEE-HELP can assist you pay your tuition fees.

Scholarships and financial support (www.training.qld.gov.au/training/incentives/scholarships)

Information about scholarships and financial support available for people undertaking vocational education and training.
### 11.6 Appendix F

Extract from the Qldwater RTO Survey Results ‘National Training Product Reform’ (Release Date 29-Aug-2016)

<table>
<thead>
<tr>
<th>Skills Tech</th>
<th>Chisholm TAFE</th>
<th>East Coast TAFE</th>
<th>Opus/WITI</th>
<th>Water Training Australia</th>
<th>Simmonds and Bristow</th>
<th>Enviro/Check Enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>website</td>
<td>website</td>
<td>website</td>
<td>website</td>
<td>website</td>
<td>website</td>
<td>website</td>
</tr>
</tbody>
</table>

**What qualifications from the National Water Package are offered?**

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Chisholm TAFE</th>
<th>East Coast TAFE</th>
<th>Opus/WITI</th>
<th>Water Training Australia</th>
<th>Simmonds and Bristow</th>
<th>Enviro/Check Enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificate II Water Industry Operations</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>TBA</td>
<td>Yes</td>
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<tr>
<td>Certificate III Water Industry Operations</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>TBA</td>
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<td>Yes</td>
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<tr>
<td>Certificate IV Water Industry Operations</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>TBA</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Diploma Water Industry Operations</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>TBA</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**What specialisations from the Package is training provided in?**

<table>
<thead>
<tr>
<th>Specialisation</th>
<th>Chisholm TAFE</th>
<th>East Coast TAFE</th>
<th>Opus/WITI</th>
<th>Water Training Australia</th>
<th>Simmonds and Bristow</th>
<th>Enviro/Check Enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Treatment</td>
<td>Yes</td>
<td>Yes</td>
<td>TBA</td>
<td>TBA</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bulk Water Management/Source</td>
<td>Yes</td>
<td>Yes</td>
<td>TBA</td>
<td>TBA</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydrography</td>
<td>No</td>
<td>Yes</td>
<td>TBA</td>
<td>TBA</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

**Plans for future qualifications or specialisations?**

| Plan to add Diploma in 2017 |

**Training delivery options**

| How is training delivered? (e.g. online, face to face, blended) | Training is a mix of On site, skills recognition, Blended, Face to Face and online. | Training is delivered face to face in conjunction with support from workplace subject matter experts. We prefer to train on-site so we can utilise the actual plant, equipment and organisational policies and procedures. | Face-to-face in most cases. Correspondence study plus on-site assessment in small number of cases for remote clients. |

**Average prices** **NB - these are approximates based on minimum number, will vary depending on individual needs, and funding source (if funding is available costs will be significantly less)**

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Certificate II</td>
<td>$5500 (min of 8 participants)</td>
</tr>
<tr>
<td>Skills Tech</td>
<td>Chisholm TAFE</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Certificate III</td>
<td>As above</td>
</tr>
<tr>
<td>Certificate IV</td>
<td>As above</td>
</tr>
<tr>
<td>Diploma</td>
<td>As above</td>
</tr>
</tbody>
</table>
11.7 Appendix G

Collection of selected pages from the Pocket Safety Guide for Dams and Impoundments

Pocket Safety Guide for Dams and Impoundments

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This document has been developed from the FEMA P-911 Pocket Safety Guide for Dams and Impoundments developed by the U.S. Forest Service (USFS) and Federal Emergency Management Agency (FEMA).

It was revised in cooperation with 6 agencies of the Department of the Interior (Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation, National Park Service, Office of Surface Mining, Reclamation and Enforcement and US Fish and Wildlife Service) as part of the Department of the Interior’s Enterprise Architecture Project “Reduce Dam Safety Risk”.

Further review was provided by the National Dam Safety Review Board and the Association of State Dam Safety Officials.
Figure 1 – Typical dam diagram showing common terms.

Figure 2.

Figure 3 – Typical gravity dam views showing common terms (www.simsclience.org).

Concrete Gravity Dam Diagram
Seepage Water Exiting From a Point Adjacent to the Outlet Pipe

Probable Causes and Possible Consequences

- A break or hole in the outlet pipe or poor compaction around the pipe allows water to flow and creates a pathway along the outside of the outlet pipe.
- Continued flows can lead to embankment and/or foundation material erosion and dam failure.

Recommended Action

Report the suspected problem to the appropriate Federal or State agency official and have the situation evaluated by a qualified engineer immediately:

- Determine if seepage is carrying soil particles (muddy water).
- Determine quantity of flow, and if flow is increasing with time.
- Have a qualified engineer inspect the condition and recommend further actions.
- If flow increases or is carrying material, the reservoir level should be lowered until seepage flow stops.
- Investigate embankment along alignment of pipe to see if there are any signs of settlement or sinkholes.

Figure 19 – Seepage water exiting from a point adjacent to the outlet pipe.

Figure 20 – Embankment erosion adjacent to an outlet pipe.

Useful Terms

Abutment—That part of the valley side against which the dam is constructed. An artificial abutment is sometimes constructed, as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment. The left and right abutments of dams are defined with the observer viewing the dam looking in the downstream direction, unless otherwise indicated.

Appurtenant structure—Ancillary features of a dam, such as outlets, spillways, powerplants, tunnels, etc.

Arch dam—A dam (typically concrete or masonry) which is curved upstream in plan so as to transmit the major part of the water load to the abutments and to keep the dam in compression.

Axis of dam (concrete)—A vertical reference surface coincident with the upstream face at the top of the dam.

Berm—A nearly horizontal step in the sloping profile of an embankment to break the continuity of the slope, usually constructed to reduce erosion or to increase the thickness of the embankment. A shelf that breaks the continuity of a natural rock or earth cut or artificial ridge of earth. A ledge or shoulder, as along the edge of a road or canal.

Breach—An opening through a dam that allows the uncontrolled draining of a reservoir. A controlled breach is a constructed opening. An uncontrolled breach is an unintentional opening. A breach is generally associated with the partial or total failure of the dam.

Buttress dam—A dam consisting of a watertight upstream part (such as a concrete sloping slab) supported at intervals on the downstream side by a series of buttresses (walls normal to the axis of the dam). Buttress dams can take many forms.

Channel—Natural or artificial watercourse with a definite bed and banks to confine and conduct continuously or periodically flowing water.

Concrete Dam—See arch dam, buttress dam, or gravity dam.
11.8 Appendix H

Extract from the ASDSO Program of study

ASDSO Program of Study (July 2012)

(www.damsafety.org/media/Documents/Conferences-Training/POS%20Outline%20Format%20July%202012.pdf)

1. Dam safety program management

Training topics
Dealing with the Media and Public Relations
Owner's Dam Safety Programs
- Lessons Learned From Dam Failure Case Histories
- Dam Owner Training
- Teaching Owners How to Design and Implement EAPs
Regulatory Dam Safety Programs
- Review of Consultant Dam Safety Inspection Reports and Analysis
- Technical and Regulatory Review of Plans and Specifications for Dams

ASDSO training
Dam Owner Education Workshops*
- The Need-to-Know Basics of Owning a Dam
- Dam Engineering for Non-Engineers
- Dam Operation and Maintenance
*All are available upon request by the state dam safety program managers.

Core Classroom Seminars Plans and Specs Review -Taught by MWH Americas (with Construction Inspections)
Dam Failures and Lessons Learned –Taught by McCook Geotechnical Engineering Consultants

Other Training
FERC Workshop: Case Histories of Dam Failures and Lessons Learned

2. Emergency action planning

Training topics
Emergency Action Planning for Dam Safety
Potential Failure Models Analysis (PFMA)
EAP Exercises
EAPs and Lessons Learned from Case Histories

ASDSO training
Core Classroom Seminars

Webinars*
*Available as live broadcast, in archived (recorded) format on the web, and as a CD.

Other training
FERC Workshop: EAP Exercise Design

3. GEOTECHNICAL training topics

Soil Mechanics (Soils 101)
Stability Analyses for Embankment Dams
Dynamic Analysis for Embankment Dams
Rehabilitation of Embankment Dams
Seepage and Piping for Earthen Dams
  - Application of Geosynthetics for Dams
  - Drainage and Filter Systems for Dams

Engineering Geology for Dam Safety
  - Integrity Analyses for Earth/Rock Cut Spillways

Foundations for Dams
  - Foundation Treatments/Grouting

ASDSO training
Core Classroom Seminars
  - Soil Mechanics for Dam Safety—Taught by Missouri Institute of Science and Technology (MSandT)
  - Slope Stability Analysis of Embankment Dams—Previously an advanced course, to be redeveloped and offered in even years beginning in 2014.
  - Seepage for Earth Dams—Previously an advanced course, to be re-developed and offered in even years beginning in 2014.

Webinars*
  - Guidelines for Assigning Erodibility Parameters to Soil Horizons for SITES Analysis (2010)
  - Pitfalls in Quality Control Testing for Earth Fill (2010)
  - Internal Erosion and Piping (2008)
  - Applying the Pareto (80/20) Principal to Geotechnical Analyses and Review of Embankment Projects (2008)
  - Filter Drain Design for Embankment Dams (2011)
  - Field Investigations for New and Existing Dams (2012)
  - Introduction to Foundation Grouting for New and Existing Dams (2012)
  - Introduction to Internal Drainage Systems for Dams (2012)

*Available as live broadcast, in archived (recorded) format on the web, and as a CD.

Other Courses
FERC Workshop: Engineering Geology for Dam Safety

4. Hydraulics

Training topics
Basic Hydraulics for Dams
Floodplain Hydraulics
  - Hydraulics of Open Channel Flow
  - Computer Modelling of Open Channel Flow
  - GIS-based Methods Applications
Spillway Hydraulics
  - Hydraulic Design of Outlet Works
  - Hydraulics of Stepped Spillways
  - Hydraulics of Labyrinth Spillways
  - Hydraulics, Stability, and Integrity of Earthen and Rock Spillways
Hydraulic Design of Stillwater Basins and Energy Dissipators
Hydraulic Design of Erosion Protection for Channels (Wave Protection, etc.)
Hydraulic Design of Overtopping Systems
Numerical and Physical Modelling of Spillways
Hydraulics for Conduits, Valves and Gates
Reservoir and Channel Routing
- Level-pool Routing Theory
- Dynamic Routing Theory
- Computer Modelling of Routing Through Channels and Reservoirs

Dam Break Modelling
- Methodologies – Steady flow theory and overview of unsteady flow theory
- Incremental Dam Breach Analysis
- Simplified Inundation Mapping for Emergency Action Plans