18. Hazard and Risk

18.1 Overview

This section examines the hazard and risk issues associated with the Project during the construction and operational phases for both the dam and associated water pipelines for the urban and irrigation option. The hazard identification and risk assessment has been undertaken in accordance with Australian Standard AS/NZS 4360:2004 Risk Management and the Australian National Committee on Large Dams (ANCOLD) Guidelines.

The assessment outlines the implications for, and the impact on, the surrounding land uses. The risk assessment incorporates:

- Reasonably anticipated relevant hazards associated with construction and operational activities (minor and major);
- The likelihood of potential hazards, accidents, spillages and abnormal events occurring;
- An indication of cumulative risk levels to surrounding land uses; and
- An envisaged list of the hazardous substances to be used, stored, processed or produced contained requiring licensing.

The risks to existing environmental values are addressed in detail throughout **Sections 4** to **12** of the EIS. This section details the specific risks that have a potential to affect the environment and the community, including the Project workforce.

The preliminary risk assessment undertaken for the Project as part of the preliminary design has used the relevant ANCOLD Guidelines on Assessment of the Consequences of Dam Failure (ANCOLD, 2000b) and Guidelines on Selection of Acceptable Flood Capacity for Dams (ANCOLD, 2000a) in estimating the Population At Risk (PAR) and the extent and severity of damages and loss caused by dam failure.

The Guidelines on Risk Assessment (ANCOLD, 2003b) has also been consulted, as well as Emergency Services. Also included are assessment of the health and safety of Project employees and the public.

Where risks are identified, appropriate mitigation strategies are outlined and a subsequent analysis has been undertaken to identify any significant residual risks.

18.1.1 Legislative Compliance

Table 18-1 identifies the relevant legislation and the regulatory requirements related to hazard and risk and describe how the Project will achieve compliance.

Table 18-1 Legislative Compliance

Relevant Legislation	Legislative Requirements	Compliance
Explosives Act 1999 and AS 2187 'Explosives—Storage, transport and use'.	The Act sets out the requirements for the handling, storage, transport and manufacture of explosives.	The use and handling of explosive materials/ substances will be in compliance with the requirements of the Explosives Act.
Workplace Health and Safety Act 1995	The objective of this Act is to prevent a person's death, injury or illness being caused by a workplace, by a relevant workplace area, by work activities, or by plant or substances for use at a workplace.	Work practices will be in compliance with the requirements of the Act.
Dangerous Goods Safety Management Act 2001	Permit required for the storage of flammable and combustible liquids.	A Permit to store flammable and combustible liquids will be obtained.
Transport Operations (Road Use Management) Act 1995	Sets standards for the transport and storage of substances and the systems to adopted based on these substances.	The storage and use of substances will be in accordance with the requirements of relevant Australian Standards.

18.1.2 Project Health and Safety Standards

The Proponent will implement Safety Standards and Occupational Health Standards that will provide the basis for effective management of employee and public health and safety. The dam constructor, including all subsidiary parties, will also be required to comply with these Standards via an integrated safety system including a clear structure and framework of responsibility and review.

18.2 ANCOLD Risk Assessment

18.2.1 ANCOLD Risk Assessment Methodology

The Water Act 2000 provides the regulatory framework for dam safety of water dams in Queensland and requires that the owners of referable dams must operate and maintain dams in accordance with the Guidelines on Acceptable Flood Capacity for Dams (DNRW 2007).

These guidelines require, unless specified otherwise, that the dam safety risk assessment procedure be carried out in accordance with the following guidelines:

- ANCOLD Guidelines on Selection of Acceptable Flood Capacity for Dams (ANCOLD, 2000a);
- ANCOLD Guidelines on Assessment of the Consequences of Dam Failure (ANCOLD, 2000b);
- NRW Guidelines for Failure Impact Assessment of Water Dams (DNRW, 2002) (for the dam breach sizes and timings and the estimation of Population at Risk);
- ANCOLD Guidelines on Dam Safety Management (ANCOLD, 2003a); and
- ANCOLD Guidelines on Risk Assessment (ANCOLD, 2003b).

ANCOLD determines Dam Hazard Categories on the basis of the consequences of failure of a particular dam. These are shown in **Table 18-2**. These will be applied to the Project. Categories of environmental effects have been included **Table 18-2**.

▪ Table 18-2 ANCOLD Dam Hazard Impacts (Consequences)

High	Medium	Low
Loss of life expected because of community or other significant developments downstream	No loss of life expected, but the possibility recognised. No urban development and no more than a small number of habitable structures downstream	No loss of life expected.
Excessive economic loss such as serious damage to communities, industrial or commercial or agricultural land or facilities, important utilities, the dam itself or other storages downstream	Appreciable economic loss, such as damage to limited land areas, secondary roads, minor railways, relatively important public utilities, the dam itself or other storages downstream	Minimal economic loss, such as farm buildings, limited damage to agricultural land, minor roads. Etc
Repairs to dam not practicable. Dam essential for services	Repairs to dam practicable or alternative sources of water/power supply available.	Repairs to dam practicable. Indirect losses not significant
Substantial to irreversible reduction of a species/habitat or National or State significance with little prospect of recovery to pre-impact conditions.	Reduction of a species/habitat with regional significance	Impacts to abundance of flora and fauna in the affected environment limited to a localised effect as species and habitat abundant in the region.

Source: Adaptation from ANCOLD 2003 (a)

The Project as described in **Section 3** of the EIS meets the definition for a large dam under the ANCOLD Glossary of Definitions, Terms and Abbreviations as noted below. This is based on the largest of the two dam options - the Combined Urban and Irrigation Dam.

A large dam is defined as one which is:

a) more than 15 m in height measured from the lowest point of the general foundations to the 'crest' of the dam (the urban/irrigation dam meets this criterion); and

b) more than 10 m in height measured as in (a) provided they comply with at least one of the following conditions (the urban/irrigation dam meets this criterion):

   – the crest is not less than 500 m in length (the urban/irrigation dam meets this criterion).
   – the capacity of the reservoir formed by the dam is not less than 1,000,000 m3 (the urban/irrigation dam meets this criterion).
   – the maximum flood discharge dealt with by the dam is not less than 2000 cubic metres per second (the urban/irrigation dam meets this criterion).
   – the dam is of unusual design (does not meet this criterion).

Emu Swamp Dam is expected to be categorized as a "High C" Incremental Flood Hazard Category (IFHC) Dam. Hence an initial assessment of the consequences was undertaken in line with the ANCOLD Guidelines on Assessment of the Consequences of Dam Failure.

The EIS addresses the required inputs for an initial consequence assessment as defined in the ANCOLD Guideline. This information includes:

- dam and reservoir data (refer **Section 3** of the EIS)
- topographical data (refer **Section 4** of the EIS)
- flood characteristics (refer **Section 7** of the EIS)
- downstream community information (refer **Section 3** of the EIS) and
- natural environment (refer **Section 9** and **Section 10** of the EIS).

Examination of this information supports the following deliberations (**Table 18-3**):

- **Table 18-3 Emu Swamp Dam – ANCOLD Consequence Assessment**

Consequence	Assessment
Flood affected zone	The zone downstream of the Project is mainly westward from the site in populated locations.
Potential damages and losses	The affected areas are limited to the following: the land required to construct and operate the dam, including quarry sites; value of the water in storage and environmental impact to the nearby environment.
Population at risk	Populations downstream of the dam have an exposure.
Other considerations	The ANCOLD Guidelines on Design and Safety Management are required to be complied with to mitigate this risk.

The main hazardous events involved with constructing and operating the Project are a sudden dam failure and public safety around the dam wall and inundation area.

18.2.2 Consequences of Dam Failure

Flood hazard categories are determined using the ANCOLD "Guidelines on Assessment of the Consequences of Dam Failure" (ANCOLD, 2000b) and "Guidelines on Selection of Acceptable Flood Capacity for Dams" (ANCOLD, 2000a) by estimating the Population at Risk (PAR) and the extent and severity of damages and loss caused by dam failure.

The Population at Risk (PAR) for each of the flood cases was assessed using available aerial photography supported by ground truthing. There are two existing 'farm buildings' downstream of the dam site that have been considered PAR sites (PAR1 and PAR2 – see **Section 7** of the EIS for locations).

In determining the resultant risk levels, mitigation and control measures were taken into account, where these will be applied at the time of design, construction or operation. It is expected that the approval to construct and operate the Project would be dependent on these conditions being met.

The ANCOLD approach has been taken in relation to acceptability of risks, as follows:

- HIGH: This level of risk is not tolerable. Additional or alternative mitigation strategies to be implemented to reduce risk to lower level;
- MEDIUM: This level of risk is acceptable provided all possible efforts have been made to reduce risk where those efforts have a positive cost benefit ratio (apply the principles of ALARP – As Low As Reasonably Practical); and
- LOW: This level of risk acceptable with normal management procedures.

18.2.3 Flood Capacity

The design flood capacity for the Emu Swamp Dam needs to comply with the Guidelines on Selection of Acceptable Flood Capacity for Dams (ANCOLD, 2000a). The selection of the design flood capacity uses a risk procedure that considers the PAR and the severity of damage and loss (to the services and business relating to the dam, to the society and to the environment) arising from a dam failure.

The Acceptable Flood Capacity for a dam failure was assessed after consideration of the Severity of Damages and Loss arising from loss of life, political consequences, loss of services, dislocation of business and environmental impacts (ANCOLD 2000a). The Acceptable Flood Capacity was assessed as the 100 000 year ARI event but the PMF event was also examined. For Emu Swamp Dam, a conservative approach has been taken and the full reservoir level has been adopted for all flood events.

The Guidelines for Assessment of The Consequences of Dam Failure (ANCOLD, 2000a) provide a simple methodology for assessing severity of damages and loss. Using this approach the severity of a dam failure at Emu Swamp Dam would be “Major” – the “Major” severity rating is considered possible for issues such as political implications, loss of services, dislocation of businesses and environmental impact.

Two potential PAR sites were identified in the downstream area of influence for a dam failure. The total population at risk is less than 10 but greater than 1.

For the 100 000 year ARI flood, one site was unaffected and the other had an inundation depth increase of 1m which is acceptable. For the Probable Maximum Flood (PMF) event one site was again unaffected and the other had an inundation depth increase of 0.8m which is also acceptable (SKM 2007).

For a Population at Risk of 1 to 10 and a “Major” Severity of Damage and Loss rating the Hazard Category is “High C”.

For a “High C” Incremental Flood Hazard Category (IFHC) rating the Fallback Alternative process assigns an upper limit Flood AEP within the range of:

- 10,000 year ARI to Probable Maximum Precipitation Design Flood (PMPDF); or
- 100,000 year ARI (with the lesser value to apply).

For the Emu Swamp site the PMF is 7,900m^3/s, the PMPDF is 7,140m3/s and the 100,000 year ARI is 3,460m^3/s.

For the 100,000 year ARI event, ANCOLD 2000 allows a joint probability assessment to be made for the reservoir level (prior to the flood event).

A comparison of the downstream effects of PMF and 100,000 year ARI Acceptable Flood Capacities for the Urban plus Irrigation dam option i.e. crest level 740.5 m AHD is presented below.

The potential inundation depths at the PAR sites compared below in **Table 18-4**. The estimated building floor levels are 712 m ADH at PAR1 and 702 m AHD at PAR2.

Table 18-4 Comparison of inundation at PAR sites

Flood Event	WSL at PAR1	Potential Inundation	WSL at PAR2	Potential Inundation
100,000 ARI – existing	704.8 m AHD	Nil	700.2 m AHD	Nil
100,000 ARI – developed (no breach)	704.8 m AHD	Nil	700.2 m AHD	Nil
100,000 ARI – developed (breach)	708.2 m AHD	Nil	703.0 m AHD	1.0m
PMF – existing	708.1 m AHD	Nil	703.1 m AHD	1.1m
PMF – developed (no breach)	708.0 m AHD	Nil	703.1 m AHD	1.1m
PMF – developed (breach)	709.0 m AHD	Nil	703.9 m AHD	1.9m

Note : WSL is water surface level

Clearly there is little or no inundation potential at PAR1 – it can also be concluded that the population at risk at PAR1 is nil for both 100,000 year ARI and PMF events.

There is a risk of inundation at PAR2 for a dam breach during the 100 000 year ARI flood event.

For the PMF – existing (no dam) event the PAR2 site is inundated to a depth of 1.1 m. For the PMF – developed (no dam breach) event there is no incremental increase in inundation depth. So, provided there is no dam failure the construction of the Emu Swamp Dam does not change the risk situation at PAR2.

Where there is a PMF event with a dam failure the inundation depth at PAR2 increases from 1.1 m to 1.9 m. This does increase the risk at PAR2 but no other PAR sites are impacted so the population at risk does not increase.

It is considered that 100,000 year ARI should be adopted as the Acceptable Flood Capacity for Emu Swamp Dam.

18.2.4 Potential Dam Failures

The following operational dam failures have been identified:

- piping or overtopping;
- Sunny Day Failure – due to poor maintenance, design or construction faults, geotechnical slope stability;
- incremental flood hazard - the associated extent and severity of damages and loss from an increase in an existing flood caused by dam failure;
- seismic "uncontrollable" failure – earthquake;
- hydrological – erosion of dam material, abutments/ foundations, destabilising the dam by hydraulic loads; and
- miscellaneous – sabotage/terrorism.

The main causes of dam failure are discussed further in the following Sections.

The root cause of a sudden dam failure is usually poor design or construction leading to a breach. To ensure the potential frequency of sudden dam failure is kept to a minimum the following measures will be implemented:

- design according to category of installation determined by failure impact assessment according to ANCOLD standards;
- use of fail safe devices;
- regular maintenance;
- develop emergency action plan; and
- remote monitoring by maintenance crew.

It should also be noted that there has never been a dam wall failure in Australia.

18.2.4.1 Piping or Overtopping

The process of a piping failure can be divided into the four phases: 1) erosion initiation of the embankment, 2) erosion continuation 3) progression to form a pipe, and 4) formation of a breach. These phases were incorporated in the analysis along with the likelihood that the development of a piping hole is detected and if intervention is attempted, if it is successful in preventing the breach of the embankment.

Overtopping could occur either by wave action for reservoir levels at or below the dam crest or by sheet flow over the embankment for reservoir levels above the dam crest.

18.2.4.2 Sunny Day Failure

The consequence of sudden dam failure would be the sudden release of a 17 m wall of water downstream (for the Combined Urban and Irrigation Dam). It is expected that this wall would cause significant damage to land downstream of the Project, especially if the dam was full.

In the Preliminary Design Report, the Sunny Day Hazard Category was determined from the PAR and also the extent and severity of damages and loss resulting from dam failure under a Sunny Day event.

The PAR for the Sunny Day Failure is significant and the severity of damage and loss assessed as "Major" using the ANCOLD "Guidelines on Assessment of the Consequences of Dam Failure" (2000b).

18.2.4.3 Incremental Flood Hazard

The Incremental Flood Hazard Category (IFHC) is determined using the highest incremental PAR and the associated extent and severity of damages and loss from an increase in an existing flood caused by dam failure. As the dam will be designed to pass the Probable Maximum Flood (PMF), the highest incremental effect would be adopted as the difference between the PMF - No Dam Failure, and PMF Failure cases.

For a Population at Risk of 1 to 10 and a "Major" Severity of Damage and Loss rating the Hazard Category is "High C". This is discussed further in **Section 18.2.1**.

18.2.4.4 Seismic

Dams are designed to withstand seismic activity (earthquake). Dams have been subjected to strong seismic loads resulting in damage but very few dams worldwide have failed due to seismic activity. The main risks to roller compacted concrete dams similar to those proposed for Emu Swamp Dam from earthquake are:

- cracking with loss of section strength;
- sliding of foundation; and
- cracking or collapse of ancillary structures such as outlet towers, bridges.

The result can be failure or severe damage. There have been only a few failures recorded worldwide and these were caused by factors that are not applicable to the siting of the proposed Emu Swamp Dam.

The risk of dam failure due to seismic activity is increased with the presence of potential permeable strata below the river surface. These strata can liquefy during seismic activity thus reducing the support that the earth provides to the dam wall. Reducing the support to the dam wall will place extra loads on the wall structure.

To ensure failure due to seismic activity is minimised the following measures will be taken:

- the structure is designed to incorporate features to cater for the permeable strata; and/or
- remove permeable strata.

The frequency of seismic activity is increased with the additional weight of the water on the earth surface. To ensure this event is adequately taken into account with the dam design, the expected seismic loads will be based on a seismologist's assessment.

18.2.4.5 Hydrologic

Hydrologic overload risks for roller compacted concrete dams can be classified into two main groups as follows:

- destabilising of the dam by hydraulic loads that exceed the structural capacity of the dam; or
- erosion of the abutments or foundations by overtopping flows to the extent that support for the dam is removed.

The result can be severe damage or failure. Embankment erosion and destabilisation tend to be progressive and irreversible once initiated, and failure of the dam can be the outcome. Erosion is a problem for embankment dams while destabilisation and foundation/abutment erosion is typically associated with concrete dams.

The essential cause of dam failure is due to hydrological and static reasons. The frequencies of these failures for roller compacted concrete dams (all of which are very low) based on historic data are provided in **Table 18-5**.

Table 18-5 Prior Frequencies of Dam Failure Based on Historic Data

Dam Type - Concrete	Frequency per dam-year
Foundation/abutment	5.1×10^{-4}
Structure distress	1.7×10^{-4}
Miscellaneous failure modes	8.4×10^{-5}

Source: ANCOLD 2000 (b)

The residual risk to the public of dam failure depends primarily on the rating of exposure. The duration of exposure of an individual living near the dam, and downstream areas to a consequent water wall caused by a dam failure would be rare to occasional due to the possibility of being able to evacuate. The rare to occasional categories result in the residual risk being medium.

Because of the preliminary nature of this preliminary hazard and risk assessment, it is considered essential that a quantitative risk assessment be undertaken as part of the design process to confirm the risks are in fact acceptable and that all efforts have been applied to reduce the risks to ALARP.

The Dam will be designed to handle the PMF – the recognised methods for determining the PMF are summarised in **Section 7** of the EIS.

The spillway will be designed to the FSL. The dam will be designed to a PMF of a '1 in a 100,000 flood', meaning any error in the data or hydrological modelling will result in an insignificant probability of overtopping due to flood. This is a standard approach.

18.2.4.6 Static

Approximately two thirds of all dam failures are caused by piping or slope instability which are referred to as static causes. All other failures, such as those due to outlet conduit leaks, overturning or sliding that are not associated with floods or earthquakes, are included in this category.

The cause of these types of failures is primarily due to poor design and/ or construction. To ensure "sunny-day failure" is minimised the following measures will be taken:

- vertical drainage through the dam;
- backup drainage devices;
- regular monitoring of drain function;
- manual inspection of drains;
- rigorous construction supervision provided by experienced engineers;
- core testing to determine concrete strengths by a NATA accredited laboratory;
- rigorous quality control of supplied material; and
- design according to category of installation determined by failure impact assessment according to ANCOLD standards.

A land slump within the reservoir area could result in a wall of water overtopping the dam wall. However, the soils present on the site generally would not pose such a problem. However, a quality assured geotechnical survey will be conducted and taken into account for any excavation. Slopes that are at risk of eroding will be appropriately stabilised and maintained.

Also, levels within the storage will not change rapidly. Therefore, erosion around the edge of the inundation area is not considered to be a significant problem. Wave action from recreation or wind action is not considered to be significant.

18.2.4.7 Electrical Systems

The electrical and control systems that may be used on the site were reviewed. The control system does not in itself constitute a significant risk and so is not discussed here. It is primarily used to control risks and its failure may then become a significant cause for another hazard.

The major hazards are restricted to the site and involve the potential for fire from short circuiting and electrical faults. Uncontrolled water release would also be possible from power grid supply failures, however, there are backups built into the system and diesel generators for electricity supply will be available. These hazards are assessed as insignificant.

Specific details of these systems are still to be developed once the detailed design stage proceeds.

18.2.5 Flooding

Flooding within the reservoir area may result in adjacent properties being inundated. The probability of this happening is not significantly changed by the dam. However, the consequence changes because different lands will be subject to flooding, although flood levels will rise at a slower rate, providing more warning.

Following construction of the proposed dam, the risk of minor flooding downstream of the dam will be reduced. In the event of a major flood, there will be greater warning of floods and a time delay to flood peaks. The dam will assist in mitigating the down stream effects of flood rather than exacerbating the problem. Hence, the impact of flooding following dam construction is deemed to be not significant.

18.2.6 Water Environmental Flows

The schedule of downstream flows, if significantly different to current environmental flows, can impact on ecology. The consequence could be a reduction in current aquatic populations that are significant to the area.

The outcome of these changes is assessed in detail in **Section 10** of this EIS.

18.2.7 Public Safety

Access to the reservoir is able to be restricted because surrounding land will be leased back to existing landholders.

It is possible that primary contact recreation such as kayaking, boating or other similar recreational activities will occur within the reservoir. Fishing from the banks of the reservoir may also be allowed. This will only occur from a proposed recreation area.

Visitor access to the dam wall will be restricted. The wall will be fenced to prevent access and vehicle access restrictions will apply to the entire site. Access to the reservoir outside of the dedicated access area for recreation use outlined above, will be restricted due to existing and potential new fencing on surrounding properties.

18.2.8 ANCOLD Risk Summary

The ANCOLD analysis of the hazards indicates that off-site risks to the public are low. In terms of this preliminary risk assessment, it is considered that the risk levels are tolerable, but every effort must be made to both reduce and confirm the risk levels.

18.2.9 Commitments

The major potential hazards from the dam operations were identified to be due to sudden dam failure.

The Project is deemed to be a referable dam and as such will require a Failure Impact Assessment Study prior to undertaking detailed design.

The following general recommendations are made, based on the preliminary hazard review:

- undertake a failure impact assessment study according to ANCOLD guidelines;
- safety management systems for all of the operations to be established in line with current guidelines as published by ANCOLD (2000b);
- emergency planning to be implemented in line with Queensland and Australian emergency planning guidelines codes of practice; and
- an emergency plan detailing each potential hazardous scenario on the site, including evacuation plans and emergency response to be documented and consulted with Department of Emergency Services (DES), Queensland Fire and Rescue Service (QFRS) and Queensland Ambulance Service (QAS) and finalised and distributed to all relevant parties (including PAR, SSC, and site personnel) prior to dam commissioning.

18.2.9.1 Dam Safety

The recommendations specific to ensuring that the Project is constructed and operated safely, are summarised in this Section.

The dam is being designed by experienced engineers to meet both the Queensland Dam Safety Management guidelines and ANCOLD guidelines. The dam design and construction will be subject to independent peer review to ensure that these guidelines and objectives are met. This peer review process will continue throughout the life of the Project.

18.2.9.2 Design

The following recommendations are made with respect to design of the proposed Emu Swamp Dam:

- outlet works should allow rapid drawdown of the dam in the event of loss of integrity of the dam wall;
- suitable materials for dam construction must be identified;
- design must take into consideration the load and strengths of construction materials to ensure that the dam wall integrity is maintained in the long term;
- a quantitative risk assessment is carried out according to ANCOLD 2000 (b); and
- design safety studies must be undertaken including a HAZOP analysis of the operating elements associated with the release mechanisms.

18.2.9.3 Construction

The following recommendations are made with respect to construction of the Project:

- actual conditions must be checked against design assumptions and specifications and amendment of the design made as appropriate;
- detailed records including as built drawings of all stages of construction must be maintained;
- detailed records must be kept during the initial filling stage; and
- design report with associated data must be prepared.

18.2.9.4 Operations and Maintenance

An Operations and Maintenance manual will be prepared for the dam. This should include procedures for the following, in accordance with the ANCOLD guidelines:

- operating the dam under normal conditions;
- maintaining environmental flows;
- coordinating with emergency response and counter disaster agencies;
- flood warning;
- maintaining the dam, associated structures and associated equipment in accordance with the designer's operating criteria;

- a program for surveillance and monitoring of the dam and all associated structures and equipment to allow for early detection of faults and deficiencies;
- recording and reporting of routine and non-routine surveillance;
- remedial action in the event of faults or deficiencies being identified by surveillance; and
- periodic review, at regular intervals or when changes or other circumstances dictate.

The manual must be written such that persons unfamiliar with the dam can operate it properly. This is particularly important in an emergency situation.

18.3 Health and Safety Hazard and Risk Assessment

18.3.1 Project Risk Assessment

Note that this assessment deals with occupational health and safety hazards and those that affect the public and the workforce. Occupational hazards at the proposed Project are similar to those of any construction or workplace site and need to be managed through sound workplace health and safety procedures.

A preliminary hazard analysis was undertaken for the EIS. A quantitative failure impact (risk) assessment will be conducted before the detailed design following ANCOLD guidelines.

The preliminary hazard and risk assessment involved:

- intended operations and the proposed design of the facilities (described in **Section 3** of the EIS);
- identification of hazards and potential operational challenges for the construction process was undertaken using a qualitative risk assessment study referred to as a preliminary hazard analysis (PHA);
- risk scenarios in the form of hazard review tables;
- possible causes and consequences from the hazards and their detection and protection mechanisms;
- preliminary qualitative assessment of the risk level associated with each hazardous scenario;
- preliminary qualitative assessment of the major risks from natural hazards and external risks to the public and major infrastructure;
- recommendations for the most appropriate environmental and quality management systems needed, in regard to key scenarios and potential impacts; and
- key input for development of an emergency response plan.

The preliminary hazard analysis identified the key events that may have an impact on the public and the workforce from the associated construction, operation and transport.

18.3.1.1 Risk Assessment Methodology

The risk assessment has been undertaken in accordance with the 'Guidelines for Hazard Analysis' and Australian Standard AS/NZS 4360:2004 Risk Management. The assessment outlines the implications for the Project and the impact on the public and workforce.

The risk assessment process includes a preliminary hazard analysis which considers:

- relevant hazards (minor and major);
- frequency of the potential hazards, accidents, spillages and abnormal events occurring;
- cumulative risk levels to the surrounding community;
- duration of any identified hazards;
- effects and rate of usage of the hazardous substances to be used, stored, processed or produced; and
- type of machinery and equipment used.

Potential incident scenarios for the Project were identified through consideration of:

- the range of activities carried out and facilities present during the construction and operation phase. These included construction activities, energy supply, excavation, and materials handling; and
- the range of potentially hazardous incidents that might be associated with each of the activities/ facilities identified at the Project.

The identification of hazards is aided through the application of a prompt list. The list is based upon the possibility of a damaging energy occurring as a result of a loss of control of that energy. Not all energies are relevant to this project as can be seen from the identified potential hazards.

- Animal
- Biological
- Chemical
- Electrical
- Falling objects
- Falls, slips and trips
- Fire & explosion
- Kinetic
- Manual handling
- Mechanical
- Noise
- Proximity
- Pressure
- Radiation
- Temperature
- Vibration
- UV
- Interface
- Sharp
- Vacuum
- Dust, fume, vapour
- Stressors
- Confined spaces

Having identified the range of hazards likely to occur at the site during the construction and operation phases, the following matters were considered for each hazard:

- possible causes of hazards and the probability of these causes occurring and leading to the hazardous incident(s) identified. The probability of each hazardous incident occurring takes into consideration the proposed control measures;
- the consequences of each of the hazardous incidents if they were to occur. Consequences might include direct impacts and the potential for their occurrence and secondary incidents. Assessment of the severity of consequences, considering the proposed mitigation measures;
- appropriate controls and mitigation measures proposed for the management of each hazard. These may include prevention and response measures;
- this information was then tabled to prioritise the risks and evaluate these risk levels against acceptable risk criteria; and
- where an extreme or high risk was identified, additional controls and mitigation measures were identified to further reduce the risk and/or if this were not possible, provide monitoring to identify changes and take mitigation measures.

These potential incident scenarios, including potential consequences and prevention, protection or mitigation measures were then examined.

18.3.1.2 Risk Analysis Criteria

The risk analysis matrix, which is shown in **Table 18-8**, is a tabular portrayal of risk as a combination of the probability of occurrence and level of severity.

Potentially hazardous incidents are identified for the facility or system with each potential incident having identifiable causes and consequences.

The consequence and probability are plotted on the risk assessment matrix in order to determine the risk level.

High risk incidents have priority for consideration of additional risk reduction and mitigation options whilst low risk incidents are subject to normal operational controls and ongoing improvement processes.

A likelihood/probability of occurrence was assigned to each identified hazardous incident based on definitions shown in **Table 18-6**. The contribution of the preventative and protective features was taken into account when assessing the likelihood of occurrence and potential consequence from each hazardous incident.

The consequence and likelihood of occurrence also assumes that any mitigation measures and other recommendations are implemented. The risk levels presented denote the residual risk for the most likely scenarios. The consequences assessed are based on definitions shown in **Table 18-7**. Where a hazardous incident may have several outcomes or consequence each potential outcome was assessed in turn.

The risk scales and risk matrix for consequence and likelihood are based on the Australian Standard AS/NZS 4360:2004 Risk Management and HB436: 2004 Risk Management Guidelines.

The shading and numerical coding in the risk matrix in **Table 18-8** refers to the qualitative bands of risk level. Risk ranks from 1 to 8 are considered to be 'extreme', 9 to 16 are 'high', 17 to 20, 'moderate' and 21 to 25 'low'.

- **Table 18-6 Likelihood of Occurrence for Hazardous Incidents**

Probability rank	Descriptor	Description
A	Almost certain	The event is expected to occur in most circumstances
B	Likely	The event will probably occur in most circumstances
C	Possible	The event could possibly occur at some time
D	Unlikely	The event could possibly occur at some time but is unlikely
E	Rare	The event may occur only in exceptional circumstances

- **Table 18-7 Consequence Classes for Health and Safety and Environmental Losses**

Consequence rank	Descriptor	Health and Safety	Environment
1	Catastrophic	Fatalities	Irreversible detrimental effect to off-site natural resource
2	Major	Permanent disability	Prolonged but reversible detrimental effect to off-site natural resource
3	Moderate	Hospital treatment	Short term detrimental effect to off-site natural resource with full recovery
4	Minor	Medical treatment	Minor detrimental effect to on or off-site natural resource and promptly contained/cleaned
5	Insignificant	First aid	On site release with no damage to natural resource

Table 18-8 Risk Assessment Matrix

	Consequence				
Likelihood	5	4	3	2	1
A	15	10	6	3	1
B	19	14	9	5	2
C	22	18	13	8	4
D	24	21	17	12	7
E	25	23	20	16	11

The colours in the risk matrix denote the general bands of risk as defined below.

Low	Moderate	High	Extreme

18.3.2 Inventory of Dangerous Goods

Some of the key hazards for the Project are associated with the substances being stored and used in construction and operations for the Project. The Project will use few hazardous substances which are regulated by the Australian Dangerous Goods Code.

Table 18-9 lists the principal dangerous goods, by name, classification, raw and storage concentration, UN number, and packaging group.

Table 18-9 Indicative List of Dangerous Goods and Hazardous Substances

Chemical Name/ Shipping Name	DG Class	Raw conc. (wt%)	Storage conc. (wt%)	UN Number	Packaging group	Purpose/ Use
Diesel Fuel Oil	3 (Class C1)*	N/A	N/A	1202	III	Fuel for mobile equipment
Unleaded petrol	3	N/A	N/A	1203	II	Fuel for mobile equipment
Ammonium Nitrate	5.1	100%	-	1942	III	Blasting on site
Lubrication oils (hydraulic oil)	3 (Class C2)**	N/A	N/A	N/A	N/A	Lubricate plant and equipment and replenish hydraulic systems.
Solvents (eg. acetone)	3	99.5%	99.5%	1090	II	Plant maintenance
Paints	3	N/A	N/A	1263	III	Paint – small amounts

*Class C1 – a combustible liquid that has a flashpoint of 150°C or less

**Class C2 – a combustible liquid that has a flashpoint exceeding 150°C

18.3.2.1 Construction

During the dam construction, some hazards are associated with substances being stored and used for motor vehicle operation and quarry operation. **Table 18-10** provides an indicative list of dangerous goods and hazardous substances and materials, which may be used during construction. The table details the relevant rate of use and maximum amount of the substance/material stored at the site during construction.

Refer to **Table 18-9** for the physical properties of these materials. Material Safety Data Sheet (MSDS) information will be obtained and communicated to all site personnel involved in the storage, handling, use and disposal of dangerous and hazardous substances and materials.

- **Table 18-10 Indicative List of Dangerous Goods and Hazardous Substances – Construction**

Chemical Name/ Shipping Name	Rate of Use	Indicative maximum inventory
Diesel Fuel Oil	2,500 L/day	50,000 L
Unleaded Petrol	200 L/day	1,000 L
Lubrication Oils (hydraulic oil)	200 L/day	10,000 L
Solvents	As required	<200 L
Paints	As required	<200 L

18.3.2.2 Operational Phase

The key hazards during the operational phase are associated with the substances being stored and used for maintenance activities. However, the use of these will be minimal when compared to the construction phase.

Table 18-11 lists the rate of use and the maximum amount stored on-site during operations. Refer to **Table 18-9** for the physical properties of these materials.

MSDS information will be obtained and communicated to all site personnel involved in the storage, handling use and disposal of hazardous substances and material.

- **Table 18-11 Indicative List of Dangerous Goods and Hazardous Substances - Operations Phase**

Chemical Name/ Shipping Name	Rate of Use	Indicative maximum inventory
Diesel Fuel Oil	As required	1,000 L
Lubrication Oils (hydraulic oil)	As required	1,000 L

The major dangerous/hazardous substances shown in **Table 18-11** are diesel fuel and lubricating and hydraulic oils. It is important that approved separation distances and containment measures are maintained during the storage of these materials/substances as defined in Australian Standard AS 1940-2004: The storage and handling of flammable and combustible liquids.

Also, the storage, handling and use of these materials/substances will be in accordance with current Australian Standards (AS), industry codes of practice and best environmental management practices (BEMP). Given the implementation of appropriate controls for these materials there is negligible risk to employees, adjacent land users, general public and the environment.

18.3.3 Construction Hazard Identification

Flooding caused by high rainfall events during construction could potentially result in damage to the construction works, possibly causing a serious failure that may increase the risk to downstream populations. Construction personnel will be able to monitor river flows likely to impact on the project construction.

During construction, upstream and downstream coffer dams will be constructed to divert flood events. Coffer dams will be designed to minimise a potential failure impact, and will have a failure impact assessment undertaken.

Explosives will be needed to provide earth and rock fill for the dam wall from a quarry within the inundation area. If required, explosives may also be used in the river bed to remove potential permeable strata if it is deemed to provide a significant risk to the dam safety. Explosive accidents are caused by inadequate planning, supervision and/or inexperienced personnel leading to incorrect placement and detonation of explosives. Further, poor signage and inadequate security measures could increase the exposure of the public to a possible accident. Some of the inundated land may need to be burnt off. If the fire is not controlled adequately, then the fire could go out of control and pose a risk to the public.

18.3.3.1 Transport Accidents Remote From Site

Off-site transportation of materials to and from the site could result in accidental release or exposure to hazardous materials. The hazards of transporting chemicals by road and handling chemicals off-site are described in **Table 18-12**.

- **Table 18-12 Chemical Handling Off site**

Item - Hazard or Event	Possible Causes	Possible Consequences	Detection/ Protection Measures
Road tanker spill	Run off road	Accident with no spillage through to tanker failure.	All vehicles carry Hazchem Identification and responses for use by emergency personnel attending accident.
	Collision with other vehicle/ obstacle	Accident is serious and tank fails.	Local roadways to the construction site will be adequate for bulk transport vehicles.
		Dangerous goods escape tanker and contaminate environment.	Company emergency response plan will be developed to handle such incidents.
			All tankers conform to the Australian Code for the Transport of Dangerous Goods by Road and Rail, and Australian Standard AS 2809.4-2001 road tank vehicles for dangerous goods (eg. explosives).

If a tanker shell became damaged in an incident, the full contents of one tank compartment (5 000-8 500 litres) or greater (up to 20 000 litres) could spill onto an off-site roadway, and escape into the soil profile or nearby waterway. The environmental damage caused by such a spill is dependent on the area in which the accident occurs.

The expected frequency of deliveries of hazardous materials that have the potential to spill is detailed in **Table 18-13**. The largest requirement for delivery of chemicals to the site during construction is for diesel fuel oil.

- **Table 18-13 Delivery Frequency of Hazardous Goods During Construction Phase**

Product	Annual Deliveries	Delivery Frequency
Diesel	800,000 L	Every 2 Weeks

18.3.4 Construction Risks

The hazard and risk assessment during construction is shown in **Table 18-14**.

The assessment takes into account the various aspects of the Project, such as spillway construction, dam construction, rock quarries, and other infrastructure construction such as road upgrades and pipelines.

Table 18-14 Risk Assessment Table – Construction Phase

Hazards	Proposed controls	Environment			Health and Safety		
		C	L	R	C	L	R
1. Dust from road and earthworks.	1. Water trucks. 2. Speed limits.	5	C	22	5	C	22
2. Traffic incidents on site	1. Traffic management plan 2. Safety inductions for workers. 3. Speed controls 4. Radio communications in vehicles.	4	D	21	3	D	17
3. Construction activity hazards	1. Fall from heights controls. 2. Experienced supervision. 3. Safety management systems. 4. Equipment inspection and selection. 5. Formal design safety practices. 6. Welding safety practices. 7. Contractor and supplier selection. 8. Personal Protective Equipment (PPE).				3	D	17
4. Slump of sloped ground	1. Rollover Protective Structures (ROPS) fitted to equipment. 2. Geotechnical investigation and design. 3. Drainage Controls.	5	D	24	3	D	17
5. Leaks of oil, fuel, chemicals or concrete from vehicles onto construction earthworks, or within reservoir	1. Refuelling in designated areas fitted with spill containment. 2. Storage and handling in accordance with AS1940. 3. Material used in construction will be stored and used in an appropriate fashion to ensure containment.	4	C	18			
6. Pests brought to site by earthmoving equipment	1. All vehicles must be washed down and inspected prior to arrival on site.	4	D	21			
7. Blasting	1. Explosive materials handled and used incompliance with current Australian Standards (AS2187)/best environmental management practice 2. Explosive materials will only be made by licensed contract personnel as and when required. 3. Explosives will only be handled and used by competent Contractor personnel. 4. Sources of ignition will be strictly controlled. 5. Blasting procedures including separation from the blast zone Storage of detonators shall be in accordance with the *Explosives Act 1999*, Part 4 Division 6.	4	D	21	1	E	11
8. Bushfire	1. Facilities and equipment will be inspected and tested for fire safety on a regular basis. 2. Relevant site staff will complete fire safety training during induction.	3	D	17	4	D	21
9. Working near Roads	1. Erect barriers along roadside to protect workers 2. Limit speed along the highway				3	C	13
10. Contact with	1. Secured access				1	E	11

Hazards	Proposed controls	Environment			Health and Safety		
		C	L	R	C	L	R
high voltage electricity	2. Qualified electricians.						
	3. Control of Energy (isolations) procedure						
11. Excessive noise	1. Design and operate all equipment to comply with the *Environmental Protection (Noise) Policy 1997*	5	C	22	5	C	22
	2. Noise emission requirements included in vendor information for the evaluation process						
	3. Personal Protective Equipment provided.						

C = Consequence, L = Likelihood, R = Risk

18.3.5 Operations Phase Hazard Identification

The hazards due to operating the dam have been identified already in the ANCOLD Risk assessment in **Table 18-2** and discussed in **Section 18.2**. The hazards involve dam failure, flooding and public safety.

An assessment of the main hazardous elements during operations (regarding individual health and safety) is provided in **Section 18.3.6**. Due to the limited number of activities occurring during operations, the number of hazards are significantly less when compared to the construction phase.

18.3.6 Operations Phase Risk Assessment

The hazard and risk assessment during operations is shown in **Table 18-15**.

- **Table 18-15 Risk Assessment Table – Operations Phase**

Hazards	Proposed controls	Environment			Health and Safety		
		C	L	R	C	L	R
1. Traffic incidents on site	1. Traffic management plan.	4	D	21	3	D	17
	2. Safety inductions for workers.						
	3. Speed controls.						
	4. Radio communications in vehicles.						
2. Leaks of oil, fuel or chemicals from vehicles during site operations	1. Major equipment maintenance to be conducted in dedicated facilities	4	C	18			
	2. Refuelling in designated areas fitted with spill containment.						
	3. Storage and handling in accordance with AS1940.						
	4. Material used in operation will be stored and used in an appropriate fashion to ensure containment.						
3. Fires	1. Facilities and equipment will be inspected and tested for fire safety on a regular basis.	3	D	17	4	D	21
	2. Relevant site staff will complete fire safety training during induction and thereafter on an annual basis						
	3. The site will have an approved fire alarm, detection, suppression and fighting system designed and installed in consultation with the relevant fire control authorities.						

C = Consequence, L = Likelihood, R = Risk

18.3.7 Risk Assessment - Conclusion

The information contained in **Table 18-14** and **Table 18-15** shows that the risk profile for the proposed facility is generally Low or Moderate with the exception of safety risks from blasting, and contact with electricity which have been assessed as High risk.

It should be noted that these are assessed as high since there is significant energy involved and the controls can only address the probability of the event. These risks are common to most construction projects.

There are no other Extreme risk scenarios identified. There are no identified extreme or high risks to off site facilities, persons or the environment.

18.4 Construction and Operations Risks Impacts and Controls

Emergency Response

Designated first aid and emergency rescue facilities and equipment will be available during the construction and operation phases. Appropriately trained personnel will be available on site throughout the life of the Project to provide first aid and emergency response to on site emergencies. First aid response and provision will be included in site induction training that will be provided to all staff members.

Stores, workshops and offices will be fitted with approved and certified fire detection (smoke detectors). First aid and fire fighting equipment (hand held extinguishers and fire hoses) will be installed at strategic points within each building. Fire fighting equipment and exit locations will be suitably signed. All work areas will be within safe distances as required by Australian Standards wherever applicable to reach emergency exits.

Induction training will include fire response techniques. The site will have a fire truck or suitably equipped water truck or trailer that can support fire response requirements. Site fire fighting capabilities also will be addressed in the Emergency Response Plan.

Fire drills will be undertaken on a regular basis during construction and operation of the Project. Permanent facilities, such as fuel storage areas, will have a dedicated fire alarm, suppression and fire fighting systems.

The dam constructor and operator will liaise with local State Emergency Services and local ambulance and hospital services with respect to planning for Emergency Response.

Dust

The Project will implement particulate and gas/vapour exposure standards and procedures that will apply to dust, fibres, mist and fume (i.e. particulates), and gas and vapour exposures in the workplace (with emphasis on inhalation as the primary route of exposure).

The standards and procedures will cover, amongst other things, evaluation of particulate and gas/vapour hazards, and development of a control program to ensure that employees, contractors and the community will not suffer adverse health effects from particulates or gas/vapours, either used or generated by the Project.

Where required, the dust control program will include engineering controls and use of respiratory protection devices.

The health risks are expected to be low. Dust from earthmoving machinery will be controlled by water trucks. The nearest residences are within a kilometre from the site, and there is the potential for these to be affected by dust during construction or operation (see **Section 11** of the EIS).

Noise

All equipment (both fixed and mobile) will comply with the relevant Australian Standard in regard to design and operating noise levels.

The Project will implement hearing conservation standards and procedures during construction and operation to ensure that employees and contractors will not suffer adverse health effects from noise generated in the workplace.

These standards and procedures cover, amongst other things, the identification and evaluation of occupational noise hazards and development of noise control programs to minimise noise levels and protect employees and contractors from adverse exposure. Where required, the noise control programs will include use of hearing protection devices.

There is the potential for the nearest residences to be affected by noise during construction or operation (see **Section 12** of the EIS).

Land Stability

During the construction of the Urban and Irrigation Pipelines, there is a possibility of trench collapse and worker safety in regards to traffic (e.g. when working in road reserves). Standard working widths for safety will be adopted to ensure the risk of this occurring is minimised. Distances between construction traffic and the pipeline trench will be maximised as much as possible.

Pests

The Project is not expected to lead to an increase in the number of pests during construction. During operation there may be increased visitation to the dam by fauna species that prefer dam and lagoon conditions. or as a result of site operations. SSC will develop and implement an Animal Pest Species Management Plan. Waste will be managed and removed from site periodically so that the potential for pests is minimised.

Waste

Waste will be managed to avoid adverse impacts on the health of the construction workforce and minimise risk of impact on land, air and water.

There will be small amounts of wastes generated during construction. This waste will consist of scrap steel, timber, concrete, general waste, recyclable waste and some hazardous waste from the operation and service of equipment.

During the construction phase, food wastes, paper and recyclables will be generated in communal areas. Colour-coded, signed bins will be used to segregate and collect these wastes. The bins will be located throughout offices and canteen areas to achieve maximum economic waste recovery.

Waste materials that are known to attract vermin will be stored and handled in a hygienic manner. General wastes will be transported for disposal to the nearest landfill.

Standard procedures will be in place during construction to contain and limit damage from the accidental release of waste materials, such as oil spillages. Standard procedures for the storage, containment, disposal and spill response for potentially hazardous waste materials will minimise potential impacts associated with these materials/substances.

Operational activities are not expected to generate significant amounts of waste. The health risks presented by operational wastes are low.

Chemicals

The chemicals used during the construction and operation phases will be relatively benign. Fuel (predominantly diesel), lubricants, oils, minor quantities of solvents, degreasers and domestic cleaning agents will form the majority of chemicals on site.

All hydrocarbons will be stored and handled in accordance with Australian Standard 1940:2004 *The storage and handling of combustible and flammable liquids*.

In the event of leaks or spills, chemical storage areas will be suitably bunded and constructed to minimise the potential for leaks to cause environmental harm. All chemicals will be stored, handled and used according to provisions in their Material Safety Data Sheet (MSDS). The health risk presented by these chemicals is relatively low.

Bushfire

The land use of the Project area is a mix of native bushland and agriculture. Hence, bushfires are not considered a significant risk, and any fires that do start are likely to be easily contained. Under State Planning Policy 1/03 for flood, bushfire and landslip the Project area is not identified as a high risk area for bushfires.

There are no planned activities that will significantly increase bushfire risk. Wherever possible, timber will be removed and sold as commercial, millable timber whilst non-commercial timber will be re-used as mulch. Otherwise, as a last resort option, it will be burnt, depending on the quantities, location and practical alternatives, under a strict fire management plan.

Equipment

Construction vehicles and equipment will be operated within the manufacturer's specifications. All vehicles and equipment will be maintained and serviced on a regular basis. Records of maintenance and servicing will be retained on-site for the duration of the construction phase.

Machinery and equipment operators will be trained and carry their current licences, where necessary. The health risk presented by equipment/machinery operation is considered low. The key hazards identified with the Project are also shown below, along with appropriate prevention, detection and protection measures.

Vehicle Collision and Driving Conditions

Vehicles on the construction site are likely to include front-end loaders, graders, rollers, water trucks, dump trucks and light vehicles (four-wheel drives) that operate on roads and access roads around the Project. Collisions have the potential to cause serious injury to operators and passengers.

Construction workers operating vehicles on-site will be trained and licensed, so that these vehicles are driven in a safe and appropriate manner. Speed control (signage), driving to conditions, and prescribed driving etiquette on the site will be used to control the risk. All vehicles will be fitted with radios for two-way communication.

Watering of roads and access areas will be undertaken regularly to suppress dust and improve visibility. Adequate night lighting through the provision of lighting towers and vehicle headlights will be provided to ensure night operating and driving conditions are safe.

The potential for injury from vehicles on the construction site is confined to construction personnel and animals, and the risk is considered moderate.

Personnel Interaction with Machinery

Personnel may be at risk of interacting with construction machinery, parts from vehicles and earth moving equipment, resulting in the potential for serious injury. The hazards from interaction with machinery may occur during construction and the movement of heavy equipment. There may also be pipeline failure during commissioning or operation that may result in a large volume of high velocity water which can result in injury or drowning to persons in the vicinity.

Although the potential for injury is moderate, strict adherence to the Project's work place health and safety rules and established safety systems and emergency response procedures will reduce the likelihood of occurrence.

Fuel Storage (Mobile and Static)

Fuel storage on-site will be predominantly diesel, which presents a relatively low combustion risk and a moderate environmental risk. Ignition sources will be controlled to avoid fire involving bulk fuel oil. Fire fighting facilities will be provided at fuel storage facilities.

All hydrocarbons will be stored and handled in accordance with Australian Standard 1940:2004 *The Storage and handling of flammable and combustible liquids*. Chemical storage areas will be suitably bunded and constructed to minimise the potential for leaks to cause environmental harm.

Standard operating procedures for the storage, containment, disposal and spill response for potentially hazardous materials will be developed. The use of AS 1940 for the management of fuel storage (bunding and containment) will reduce this risk to a low level.

The hazard associated with the storage of fuel oil arises from leaks/failures in the system. To minimise the hazards associated with fuel oil leaking during tanker unloading, the following measures will be in place:

- a program of regular equipment inspection and testing will be continued to ensure reliable performance;
- operators will continue to be trained in the safe operation of the system and emergency procedures in the event of fuel oil leakage;
- spill containment equipment will be available at the unloading pad for use in the event of spillage;
- a sump will be provided to collect any spillage and allow recovery;
- ignition sources will be strictly controlled and limited to avoid a fire;
- appropriate fire fighting materials and equipment will be available to suppress fires; and
- an approved fire protection system will be installed around new hydrocarbon storage areas.

The following measures will be taken to minimise the potential for the leakage of fuel oil from storage tanks:

- adequate bunding will be constructed to contain spills, in accordance with as AS1940:2004;
- tank level indicators will be installed on fuel oil tanks for monitoring of fuel oil levels;
- maintenance of fuel oil tanks will be undertaken, to ensure safe and effective operation of all components; and
- tanks will be designed in accordance with as AS1692: 2006 Steel tanks for flammable and combustible liquids to minimise the potential for failure of the diesel storage vessel.

Explosives

A specialist explosives company will provide the ammonium nitrate, emulsion, detonators and boosters to be used during blasting operations. The Contractor's personnel will be licensed and trained in the transport, handling, mixing and use of explosive materials. ANFO will be mixed on-site by the explosives company in a dedicated area. Blasting operations will comply with the *Explosive Act 1999*.

The location of the explosives will take into consideration:

- public risk;
- enhancing physical protection to the public by the use of natural ground features;
- vehicular access routes and junctions with public roads;
- security;
- other activities within the proximity of the site; and
- protection from flood, fire, landslide, lightning or other natural incidents.

Blasting and Misfires

Blasting creates a number of potential risks such as dust, noise, vibration and fly-rock and air-blast effects. Fly-rock and air-blast effects can cause serious personal injury if not properly controlled and therefore create a high risk to the workers.

Mitigation measures include the use of blasting experts to undertake safe blast design, control of access (including temporary mine site road closure) and evacuation warnings before blasting. Personnel in the vicinity of a blast will continue to wear Personal Protective Equipment (PPE) and all personnel will observe safe distances during blasting activities.

Proper stemming will be used in the preparation of charges and appropriate charge ratios will be used to limit the amount of fly rock produced by a blast. Blasting operations will continue to be carried out by an explosive contractor, which has an established record of operation in the industry and adherence to the Australian Explosives Manufacturer Safety Committee (AEMSC) Code of Practice.

Blasting misfires include incomplete detonation of the blast. This may reduce or confine the blast impact, and may pose safety issues to personnel re-entering the area of blast misfires. The training and management of the blast crew will be required to ensure appropriate knowledge and skill by personnel involved in blasting activities.

Safety procedures will be strictly adhered to on site to limit the probability of the hazard occurring.

High Voltage Exposure

Powerlines affected by the Project will require relocation. Specialist electrical engineers will undertake this using approved codes of practice and procedures.

Relocating electricity infrastructure and electricity use from lighting and the electrical operation of infrastructure will require the use of potentially lethal levels of voltage and amperage.

There will be specific and detailed standard operating procedures implemented that deal with high voltage. The residual high risk can be managed by ensuring the preventative controls are well implemented and monitored.

Working at Height and Falling Objects

There will be instances where workers are required to work at height during the construction phase although these will be minimised. However, where working at heights is unavoidable, Safe Operating Procedures for working at height will be used to control this risk.

Mandatory PPE on a construction site that protects against objects falling from height includes steel capped boots and hard hats (both are worn at all times). Falls will be controlled through appropriate elevated work platforms and the proper use of harnesses.

The residual risk is moderate with these controls, as safety statistics during construction activities indicate that injuries caused from falls do contribute significantly to work related injuries.

During operations, there will also be instances where operators are required to work at height during maintenance or repair duties. Safe Operating Procedures for working at height will continue to be used to control this risk.

The residual hazard is still high, as safety statistics at construction sites indicate that injuries caused from falling objects and falls do contribute significantly to work related injuries. Hence the preventative controls must be strictly enforced.

Transportation

Licensed transporters operating in compliance with the Australian Dangerous Goods Code will undertake the transport of dangerous goods to the construction site.

During construction, licensed transporters will undertake the transport of dangerous goods (ammonium nitrate) to the Project site. The transport of ammonium nitrate will be undertaken in compliance with the requirements of AS 1678.5.1.002-1998: *Emergency procedure guide - Transport - Ammonium nitrate*.

Off-site transport accidents have the potential to occur but that is low. Most of the transport occurs along major roadways. The increased exposure of the public to this hazard due to the dam construction is low and the frequency of such an event occurring is low. Therefore, this event is not a likely scenario for the Project.

The potential for a diesel transport accident to occur is low. Most of the road tanker transport occurs along major roads. An accident involving a road tanker would most likely require a second vehicle to collide with the tanker. Tanker drivers are trained to such a level, and are sufficiently experienced that single vehicle accidents do not regularly occur.

The increased exposure of the public to a diesel transport hazard is low and the frequency of such an event occurring is low. Therefore, this event is not a likely scenario for the Project.

To control the damage that may occur, several measures will be put in place prior to commencement of construction for transport operations. These measures include:

- liaise with emergency services to develop an emergency plan to deal with tanker incidents off-site;
- vehicles carry Hazchem identification and response guidelines for use by emergency personnel attending the scene of the accident;
- tankers incorporate internal valves on all outlets to prevent spills, in the event of vehicle damage; and
- tankers to conform with the Australian code for the transport of dangerous goods by road and rail, and Australian Standard AS2809.4.

Biological Hazards

There are potentially dangerous fauna such as snakes and spiders likely to be present in the Project area. However, these species are not likely to cause a high risk because of their behaviours, populations or potential toxicities.

Standard practices under workplace health and safety guidelines should be sufficient to minimise the risk of snakebite and other interactions with biological hazards such as spiders and ticks.

Security

The construction area will be enclosed with suitable fencing. Fencing will protect selected areas with high risk of a security breach or unauthorised public access.

Prior to being given access to the Project site, visitors will complete mandatory registration and an environmental, health and safety induction. The scope of induction will reflect those areas of the Project site that the visitor will be permitted access.

Access to the construction site will be denied to any site staff/visitor not wearing the following mandatory personal protective equipment (PPE):

- safety helmet;
- steel cap boots;
- safety glasses; and
- high visibility vest.

Monitoring

Monitoring will be undertaken to assess whether Project health and safety measures are being implemented and effective. Monitoring will involve the compilation and assessment of data relating to health and safety issues, such as reported near misses, accident reports and any health surveillance data (sickness data). Outcomes from this monitoring may trigger the need for additional safety and health risk control actions.

Accident and near hit data will be monitored to identify where:

- common themes occur;
- PPE is being incorrectly used/abused;
- corrective actions have not been strictly implemented;
- corrective actions are ineffective;
- procedures/practices need to be reviewed;
- retraining may be required; and
- health surveillance data will be monitored to identify common themes.

18.5 Community Safeguards

It is vitally important that the impacts of the Project have minimal impact on local communities. The community safeguards will be implemented through a ‘safety in depth’ or ‘defence in depth’ approach where there exists a multi-layered approach to public and environmental impacts.

These safeguard layers come in two principal forms:

- design of processes to ‘good engineering practice’ standard; and
- implementation of safety management systems and emergency planning appropriate for the hazards involved in the operations.

Many of the design issues related to the Project have been discussed in the hazard review in the previous Sections which outlined the detection and protection mechanisms that should be in place.

Using the “defence in depth” approach the ‘inner layer’ deals with the actual engineering designs and these are usually dictated by Australian Standards and industry codes of practice as specified by ANCOLD.

The outer layers of the approach can include:

- continuous regulation and control;
- alarm systems;
- fire detection and suppression systems;
- local and site emergency procedures; and
- off-site emergency procedures.

All of these items need to be in place where the hazards dictate.

18.5.1 Safety Management Systems

The safety management system adopts an integrated approach to risk management of the dam construction and operations, recognising the hazards at all points in the operations and how these are controlled. AS 4801 and AS4804 should be complied with in developing and operating the safety management system.

The safety management system will comprise many of the ‘defence in depth’ layers but should also include the following:

- strict review of modification and design procedures;
- policies for managing change (new technology, new procedures);
- assessment of human factors in the design and operation;

- training programs for operators;
- internal standards and codes of practice;
- process and equipment integrity including preventative maintenance and procedures;
- documentation and propagation of process knowledge to operators and engineers;
- incident investigation procedures;
- enhancement of safety knowledge and its dissemination to staff;
- risk and compliance auditing; and
- statements of risk management objectives and goals.

These issues will be addressed by the operating company as the Project progresses and these companies would have systems in place.

18.5.2 Emergency Planning

Emergency planning represents the outer layers of the 'defence in depth' approach to community safeguards. Any emergency planning must be based on the following components:

- analysis of the emergency incidents likely to take place for each operational area;
- assessment of the degree of impact likely to occur;
- assessment of what constitutes 'an emergency' for the particular operation;
- on-site plan to handle incidents;
- off-site plan with reference to emergency services needed;
- communication, emergency responsibilities, control centre establishment;
- post emergency procedures, including recovery, debriefing and review of plan; and
- test the plan under emergency-like conditions.

General guidance for preparing emergency plans can be obtained from the Department of Emergency Services. In particular, the recent Australian-New Zealand code of practice for emergency planning will form the basis for the detailed development of the plans covering the individual areas.

Plans will assess the access for emergency services. The inundation area may change the travel routes for response and response times. Discussions will be held with emergency services to identify any route access issues.

The final detailed plans should be developed by the dam operating company as the detailed engineering design takes shape. This will involve local emergency services such as police, fire brigade and State Emergency Services personnel as well as the local emergency response groups.

18.5.3 Emergency Action Plan

An Emergency Action Plan (EAP) or Dam Safety Emergency Plan must be developed and should include the following:

- identification of emergency conditions which could endanger the integrity of the dam;
- dam operation procedures to follow in the event that such emergency conditions are identified;
- warning systems for downstream communities;
- notification listing or flowchart – identifying responsibility for notification, the order of notification and who is to be notified;
- roles and responsibilities – of the dam owner, operator and dam personnel;
- area map – showing the access routes to the storage during fair and adverse weather conditions, including distance and travel times;

- a drawing of the storage catchment area;
- emergency events and actions list;
- description of typical problems, problem characteristics and when/ what to check for during inspections;
- a dam failure inundation map – this should identify: downstream inhabited areas subject to danger, inundated areas, a narrative description of areas affected by dam break; and
- any other charts, rating tables, considered by the dam owners as necessary.

18.6 Decommissioning Phase

A decommissioning date for the Project has not been determined at this stage. The dam will be an integral part of the Stanthorpe area water supply strategy and will be maintained to meet dam safety requirements. A possible decommissioning date is likely to be too far in the future to allow effective planning for decommissioning to occur at this point in time.

When this does occur, consideration to matters such as potential impacts on terrestrial and aquatic ecology and surrounding land use, and the resultant changed hydrology will need to occur. It is not practical to identify the hazards and risks that could be relevant at the decommissioning phase because the decommissioning process and timing has not been determined.

18.7 Public Liability of Infrastructure

For the construction phase, public liability and protection of infrastructure will be managed by the constructor with closure of the area to the public, so there is no public access to the construction site.

Protection of infrastructure will be maintained by ensuring the constructor identifies all assets and undertakes construction in a way that does not damage this infrastructure or cause a reduction in service provided by the dam and associated infrastructure.

A safety risk assessment will be undertaken of the Project to identify areas of high risk to public safety. Exclusion zones will be developed to prevent public access to high risk areas, with fences and signs erected to delineate such areas. For land that surrounds the inundation area, such as that leased back to landholders, public liability for access onto that land will be with the landholder.

The operators of the Project will have adequate public liability insurances.