CHAPTER 20

Hazard and risk

HELIDON TO CALVERT ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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20. Hazard and risk

20.1 Summary

The Project has incorporated risk identification and assessment practices throughout the design development phase; ARTC will implement and maintain appropriate safety practices throughout operations.

A preliminary risk assessment was undertaken in accordance with the requirements of AS ISO 31000:2018 *Risk Management: Principles and Guidelines* (Standards Australia, 2018).

Hazards were identified for each of the Project phases and evaluated qualitatively to determine residual risks following the implementation of risk management strategies and mitigation measures. Residual risks include potential events related to dangerous goods freight transport, potential use of explosives for the construction of the Little Liverpool Range Tunnel, pedestrian and community safety, interface with live trains and derailment, or private access routes, overbridges and emergency access.

The design of the Little Liverpool Range tunnel will incorporate fire and life safety mitigation measures, including:

- limiting the amount of combustible materials used in construction
- providing fire detection systems, preventing derailed trains from entering the tunnel
- preventing trains that are on fire from stopping in the tunnel.

Risk assessment is an ongoing process and, as the Project design evolves, the impact on risks will be regularly reviewed to ensure they are reduced as far as is reasonably practical. This risk reduction can be demonstrated by ensuring all mitigation proposed and any other mitigation identified in detailed design are implemented for both residual medium and low risks.

The ARTC *Safety Policy* (ARTC, 2020a) and the ARTC *Fatal and Severe Risk Program* (ARTC, 2017) will be fully implemented.

ARTC's existing Emergency Management Procedure (ARTC, 2019), which provides a systematic approach to incident response and recovery or incident investigation on the ARTC network, will also be applied to Inland Rail and the Project. The Emergency Management Procedure will be used for emergency management including emergency response and emergency planning.

An Incident Management Plan will be developed for the Inland Rail Program to detail the procedures and resources for responding to and managing emergencies.

20.2 Scope of the chapter

This chapter assesses the risk of adverse impacts from both natural hazards and hazards associated with the Helidon to Calvert (H2C) Project (the Project) Section of Inland Rail by:

- Evaluating the risks and hazards in the existing environment
- Identifying and assessing the potential risks to people, property and the environment that might be associated with the construction and operation of the Project
- Proposing appropriate mitigation measures to be implemented during the Project's lifecycle.

20.2.1 Purpose

Natural, Project-related, and dangerous goods risks and hazards have been assessed, in accordance with the final Terms of Reference (ToR) for the Project phases of:

- Design and pre-construction
- Construction and commissioning
- Operation and maintenance.

The health and safety of employees and communities, along with risks to the environment and property, have been considered in accordance with the final ToR outlined in Section 20.3.

This Chapter describes a preliminary risk assessment for the Project including:

- Natural hazards (e.g. flooding, wildlife, sudden subsidence or movement of soil or rocks, cyclone, bushfire, landslide, implication related to climatic conditions)
- Construction and commissioning hazards and risk (e.g. existing infrastructure, use of explosive for construction, land contamination, implication related to climate change)
- Operational hazards and risks (e.g. respirable silica and other airborne contaminants such as naturally occurring asbestos, fatigue and heat management, concurrent or simultaneous operations with existing railway infrastructure)
- Other health, safety and security hazards and risks (e.g. other potential hazards including abandoned mines, underground collieries, accidents including derailments and pedestrian safety, spillages, fire and abnormal events that may occur during all Project stages).

20.2.2 Approach

The hazard and risk assessment have considered potential impacts to people, property and the environment either initiated or exacerbated by the Project. The hazard and risk assessment assessed risks on the Project from external factors such as climate conditions, subsidence or biosecurity hazards. Findings and outcomes of environmental investigations completed during the development of the Environmental Impact Statement (EIS) have been incorporated into the assessment.

Throughout the Project life cycle, mitigation measures will be applied to manage the hazards and reduce the risk level. The risk assessment forms part of the larger risk management process that will be continued throughout the Project lifecycle and adopted into the Australian Rail Track Corporations (ARTC) risk management process.

The hazard and risk chapter:

- Identifies the relevant legislative framework associated with the risk assessment
- Identifies and describes the natural and environmental values
- Documents the Project construction (and commissioning) and operational activities with the potential to cause health, safety and risk impacts
- Describes how the Project may potentially affect hazards within and surrounding the hazard and risk study area and implications of climate conditions
- Demonstrates how the risk assessment process has been applied throughout the lifecycle of the Project in accordance with AS/NZS ISO 31000:2009 (Standards Australia, 2009a) (compliant with AS ISO 31000:2018) (Standards Australia, 2018))
- Discusses mitigation measures to be implemented during construction (and commissioning) and operational and mitigation measures incorporated in the design
- Outlines the relevant emergency management plan, including consultation undertaken or required to be undertaken during detailed design, with relevant emergency management authorities such as Local Disaster Management Groups.

20.2.3 Assumptions and limitations

The Project will continually monitor identified risks and conduct future risk assessments to identify and assess emergent risks throughout the Project life cycle in accordance with the process of continuous improvement described in ARTC's environmental management system. Additional mitigation measures will be developed and documented throughout the Project in accordance with the draft Outline Environmental Management Plan (draft Outline EMP) (refer Chapter 23: Draft Outline Environmental Management Plan).

A Construction Environmental Management Plan (CEMP) including relevant sub-plans, will also be prepared as the Project progresses towards construction. The CEMP will address all measures and requirements of the Draft Outline EMP, together with primary and secondary approval conditions and other legislative requirements from permits, licences and other Project commitments, in advance of relevant Project works commencing. Additional mitigation measures will be continually reviewed, developed and documented throughout the construction program, as required.

The impacts of natural hazards on the Project, as discussed in this chapter, are based on existing and historical natural events. Detailed assessments of these events are referenced to the appropriate EIS chapter, where applicable.

Emergency management plans are described based on the ARTC's existing *Emergency Management Procedure* (RLS-PR-044) (ARTC, 2019) considering the possible emergency events that could occur throughout the Project phases of construction, commissioning and operation.

20.3 Terms of Reference

The ToR describe the matters ARTC must address in the EIS for the Project. The matters relating to hazard and risk are contained in the ToR are detailed in Table 20.1. Compliance of the EIS against the full ToR is documented in Appendix B: Terms of Reference Compliance Table.

TABLE 20.1: TERMS OF REFERENCE—HAZARD AND RISK

Terms of Reference requirements		Where addressed
Information requirements		
11.77	Provide evidence of consultation with the relevant owners/licensees of gas/petroleum pipelines in the vicinity of the rail corridors. Provide detail of agreed risk management strategies for project construction and operation with regard to the gas/petroleum pipelines. Demonstrate that the construction and operation of the project will not inhibit the safe and efficient operation of the pipelines.	Table 20.9 summarises the initial design measures, and proposed mitigation measures for future design and construction activity in the vicinity of these assets
11.154.	Describe the potential risks to people and property that may be associated with the Project in the form of a preliminary risk assessment for all components of the Project and in accordance with relevant standards. The assessment should include: a) Specific consideration of: i) Respirable silica and other airborne contaminants (e.g. naturally occurring asbestos) ii) Sudden subsidence or movement of soil or rock iii) Flash flooding iv) Fatigue and heat management v) Concurrent or simultaneous operations with existing railway infrastructure b) Other potential hazards (including abandoned mines), accidents (including derailments), spillages, fire and abnormal events that may occur during all stages of the Project, including estimated probabilities of occurrence c) Identifying all dangerous and hazardous substances (including likely volumes) to be used, stored, processed, transported or produced and the rate of usage d) Potential wildlife hazards, natural events (for example, cyclone, flooding, bushfire and landslide) e) How the Project may potentially affect hazards away from the preferred alignment (for example, changing flooding characteristics)	Specific risks are discussed below. Preliminary risk assessment is provided in Table 20.12 a) Sections 20.7, 20.8.1.3, 20.8.1.5, 20.9.2, 20.10.2.1, 20.10.2.2 and 20.10.2.3 b) Estimated probabilities are inherently incorporated into likelihood assessments as part of the risk assessment in Table 20.12 Accidents including derailments discussed in Sections 20.7.1 and 20.10.2.2, spillages in Sections 20.10.2.3 and 20.10.3, fire in Sections 20.8.1.2 and 20.10.1.1 c) Sections 20.9.3 and 20.10.3 d) Sections 20.8.1, 20.9.1 and 20.10.1 e) Sections 20.8.1.3 and 20.10.1
11.155.	Describe those measures required to ensure that the proposed Project avoids the release of hazardous materials to the environment, including as a result of a natural hazard event	Section 20.11.3
11.156.	Provide details on the safeguards that would reduce the likelihood and severity of hazards, consequences and risks to persons, within and adjacent to the Project area(s). Identifying the residual risk following application of mitigation measures including any actual or potential impacts to existing fire trails and evacuation routes. Present an assessment of the overall acceptability of the impacts of the Project in light of the residual uncertainties and risk profile	Sections 20.11 and 20.12
11.157.	Provide an outline of the proposed integrated emergency management planning procedures (including evacuation plans, if required) for the range of situations identified in the risk assessment developed in this section	Section 20.12.3
11.158.	Outline any consultation undertaken with the relevant emergency management authorities, including the Local Disaster Management Group	Section 20.12.3 Chapter 5: Stakeholder engagement, Section 5.9.1 Chapter 16: Social, Section 16.9.4 Appendix C: Consultation Report, Sections 4.4 and 6.12 Appendix Q: Social Impact Assessment Technical Report, Section 7.4.3

Terms of Reference requirements		Where addressed
11.159.	Identify the need for appropriate explosive licences and requirements to notify of proposed blasting prior to explosives use under the Explosives Act 1999 and relevant codes and standards including the Australian Standard AS2187—Explosives—Storage, transport and use. Any risk associated with explosives use, manufacture or storage is within an acceptable level in accordance with the Explosives Act 1999 and codes and standards including Australian Standard AS2187— Explosives—storage, transport and use	Section 20.9.3.3
11.160.	Detail the risk of the use of explosives in connection to the rail alignment, associated infrastructure and any proposed mitigation measures to limit this risk	Sections 20.10.3.3, 20.11.3.3 and 20.12.4
Climate		
11.166.	Describe the climate patterns with particular regard to discharges to water and air and the propagation of noise related to the Project	Sections 20.8.1.1 and 20.10.1.3 Chapter 12: Air quality, Sections 12.6.1 and 12.6.2.5 Chapter 13: Surface water and hydrology, Section 13.6.2.1 Chapter 15: Noise and vibration, Section 15.8.8 Appendix K: Air Quality Technical Report, Sections 4.4.2.8, 5.2 and 5.3.7 Appendix L: Surface Water Quality Technical Report, Section 5.3
11.167.	Climate information should be presented in a statistical form including long-term averages and extreme values, as necessary	Section 20.8.1
11.168.	Describe the climatic conditions that may affect management of the Project. This includes a description of the vulnerability of the Project area to seasonal conditions, extremes of climate (for example, cyclones and prolonged rain events) and natural or induced hazards (including bushfire)	Sections 20.8.1 and 20.10.1

20.4 Legislation, policies, standards and guidelines

20.4.1 Legislation and Standards

The assessment of hazards and risks to health, safety and the environment has been conducted against legislative and policy level objectives for the management of risk.

The following legislation is relevant to the assessment of hazards and risks for the Project:

- *Rail Safety National Law (Queensland) Act 2017* (Qld)
- *Work Health and Safety Act 2011* (Cth)
- *Public Health Act 2005* (Qld)
- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* (Cth)
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth)
- *Explosives Act 1999* (Qld) (Explosives Act)
- *Disaster Management Act 2003* (Qld)
- *Biosecurity Act 2014* (Qld)
- *Fisheries Act 1994* (Qld)
- *Aboriginal Cultural Heritage Act 2003* (Qld)
- *Fire and Rescue Services Act 1990* (Qld)
- *Land Act 1994* (Qld)
- *Queensland Heritage Act 1992* (Qld).

Further discussion about the listed legislation, its relevance to the Project and how the Project complies is provided in Chapter 3: Project approvals. Policies and guidelines of relevance to this assessment and their respective requirements are described in Table 20.2.

TABLE 20.2: LEGISLATION, POLICY AND GUIDELINE CONTEXT

Policy or guideline	Relevance to the Project
Queensland State Planning Policy (SPP) (DILGP, 2017b)	Provides guidelines to ensure the risks associated with natural hazards, including the projected impacts of climate change, are avoided or mitigated during planning and development to protect people and property and enhance the community's resilience to natural hazards. Forms the basis of design decisions such as route selection and impact assessment which inform risk assessment for the development.
Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG code) (National Transport Commission, 2018)	Details the technical specifications, requirements and recommendations applicable to the transportation of dangerous goods in Australia by road and rail. Taken as the basis of dangerous goods handling and considered in the development and assessment of mitigation measures.
Rail Safety Principles and Guidance 1996 (Great Britain Railway Inspectorate, 1996)	Provides safety principles and guidelines for the construction of railways. Principles applied to risk assessment considering expected mitigation measures and approach to rail construction.
The National Rail Safety Guideline Accreditation of Rail Transport Operators 2008 (National Transport Commission, 2008)	Provides requirements for being an accredited rail operator in Australia and to attest that a rail transport operator has demonstrated the competence and capacity to manage rail safety risks. Requirements considered in risk assessment.
The National Rail Safety Guideline Preparation of a Rail Safety Management System 2008 (National Transport Commission, 2008)	Provide accredited rail transport operators with guidance about legislative requirements for safety management. The assessment has considered that the system requirements will be applied to the Inland Rail Program (Inland Rail), specifically in the context of ARTC's Safety Management System.
National Standard for Health Assessment of Rail Safety Workers 2017 (National Transport Commission, 2017)	Provides guidance for rail transport operators to manage the risk and protect the safety of public, rail employees and the environment. Specifically, the standard outlines requirements to limit the impact of individual health issues on rail safety.
AS/NZS ISO 31000:(2009 and 2018) *Risk Management—Principles and Guidelines* (Standards Australia, 2009a; Standards Australia, 2018)	Describes the risk management process that can be applied throughout the life of an organisation and to a wide range of activities. Also provides guidance on the identification and assessment of risk, which has been applied in the methodology of this chapter.
AS 4801-2001 *Occupational Health Safety Management Systems* (Standards Australia, 2001a)	Sets requirements for the formation of health and safety policy and objectives.
AS 4084-2001 *Occupational Health and Safety Management Systems—General Guidelines on Principles, Systems and Supporting Techniques* (Standards Australia, 2001b)	Provides guidance on the development and the implementation of occupational health and safety management systems and principles and their integration with other management systems.
AS 4292-2006 *Railway Safety Management* (Standards Australia, 2006b)	Specifies railway safety requirements and management system associated with design, specifications, operating and maintenance procedures. Considered in the assessment of mitigation measures and risk assessment associated with railway incidents.
AS 2187-2006 *Explosives— storage, transport and use* (Standards Australia, 2006a)	Sets requirements for storage, transport and use of explosives associated with their location, design, construction and maintenance. Consideration of separation distances, handling requirements and restrictions on quantities has informed the risk assessment of potential explosives activities.
AS 1678-2004 *Emergency Procedure Guides—Transport* (Standards Australia, 2004)	Provides information on transport requirements for different classes of dangerous goods, specifically with respect to the actions taken and likely response procedures to be in place in the event of an incident.
AS 2931-1999 *Selection of Use of Emergency Procedure Guides for Transport of Dangerous Goods* (Standards Australia, 1999)	Provides lists of Emergency Procedure Guides (EPGs) and Group Text Emergency Procedure Guides (GTEPGs) and guidance on their selection, completion and use. This Standard serves as a reference when selecting the appropriate EPG for particular types of dangerous goods.
AS 1940-2017 *Storage and Handling of Flammable and Combustible Liquids* (Standards Australia, 2017)	Sets requirements for storage and handling of flammable and combustible dangerous goods Class 3. Considered in the development of mitigation measures for storage of construction chemicals.

Policy or guideline	Relevance to the Project
AS 3780-2008 *The Storage and Handling of Corrosive Substances* (Standards Australia, 2008)	Sets requirements for storage and handling of corrosive dangerous goods Class 8. Considered in the development of mitigation measures for storage of construction chemicals.
AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites* (Standards Australia, 2010)	Details the requirements in assessing noise and vibration control measures of construction, demolition and maintenance sites. Mitigation measures are expected to be in accordance with requirements of this guide and are considered in the assessment.
AS 4825-2011 *Tunnel Fire Safety* (Standards Australia, 2011)	Provides the guidelines for fire safety in new road, rail and bus tunnels. Mitigation measures are expected to be in accordance with requirements of this standard and are considered in the assessment.
AS 5100-Set 2007 *Series Bridge Design* (Standards Australia, 2007)	Details the acceptable requirements for the design of bridges and related structures intended to support railway and pedestrian traffic loads. Mitigation measures are expected to be in accordance with requirements of this standard and are considered in the assessment.
AS 7636-2013 *Railway Structures* (Standards Australia, 2013b)	Details the requirements that encourage rail organisations to use a whole-of-life approach to rail structures, and cover the general management requirements, material composition, manufacturing, construction, maintenance, decommissioning and disposal of rail structures used in Australian rail operations. Mitigation measures are expected to be in accordance with requirements of this standard and are considered in the assessment.
HB203-2012 *Managing Environmental-Related Risk* (Standards Australia, 2012)	Provides guidelines to help organisations manage environment-related risk.

20.4.2 ARTC management plans and procedures

20.4.2.1 Safety management system

The ARTC *Safety Management System* is accredited under the *Rail Safety Act 2006* (Victoria) and is based on the promotion of continuous safety improvement. ARTC is undertaking action to obtain accreditation for this system under the *Rail Safety National Law (Queensland) Act 2017* (Qld). ARTC will use this system to manage safety risks associated with construction and commissioning, and operation as relevant. The types of documents that form part of the ARTC *Safety Management System* are as shown in Figure 20.1.

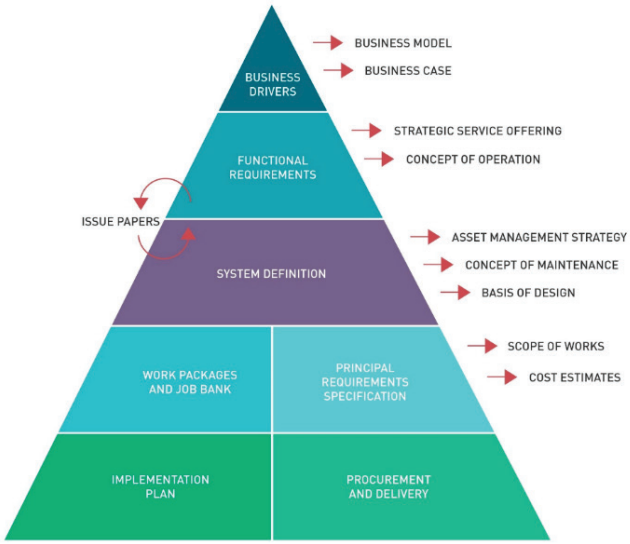

FIGURE 20.1: INLAND RAIL SAFETY MANAGEMENT SYSTEM

'No harm' is an ARTC value, with the objective that no one is harmed at work or at the ARTC rail network. Demonstrating integration of ARTC's value of 'No harm' into the management system, ARTC participates in voluntary audits with the Work Health and Safety Regulators and engages with Comcare and Office of the National Rail Safety Regulator (ONRSR), who regulate the national rail networks, to ensure ARTC systems meet the legal requirements and effectively prevent accidents and injury.

The ARTC *Safety Management System* documents interactive process flows for:

- Governance framework:
  - Development of strategic priorities, consultation and governance requirements and review process
- Governance committees:
  - Safety governance structures outline the escalation processes from the Operational Safety, Environmental and Risk Committee, through to the Chief Executive Officer and includes the Boards Safety and Environment Sub-committee.

20.4.2.2 Safety policy

ARTC will provide the basis for effective management of employee, contractor and public health throughout the life of the Project. The *Safety Policy* (ARTC, 2020a) includes:

- 'No harm' is an ARTC value, with the objective that no one is harmed at work or at the ARTC rail network
- The Project is committed to achieving a strategy to reach 'No harm', appreciating the following protocols:
  - Providing tools to support the identification of risk as appropriate to work activity
  - Establishing and maintaining communication, consultation and coordination with and between employees, contractors and relevant stakeholders
  - Providing information, instruction, and training to develop worker capabilities and competence
  - Providing plant, equipment and personnel protective equipment as suitable to undertake work
  - Establishing and maintaining measurable and achievable objectives and targets
  - Promoting safe behaviours and a positive safety culture
  - Monitoring performance and implementation of requirements to ensure continuous improvements
  - Maintaining a Safety Management System that is accessible and user-friendly
  - Ensuring the processes and work practices are in line with the requirements of applicable laws.
- The policy will apply to Inland Rail and the Project, including to contract workers throughout all phases of the Project.

20.4.2.3 Fatal and severe risk program

The *Fatal and Severe Risk Program* (ARTC, 2017d), with accompanying lifesaving behaviours, is a fundamental element of ARTC's 'No harm' value, which aims to implement ten control protocols to manage risk areas with potentially fatal consequences. The risk management protocol will provide safe work practices and establish minimum performance and expectations to manage risk and eliminate incidents, including:

1. Vehicle accidents (including road–rail vehicles)
2. Manual handling
3. Struck by rail traffic
4. Rail traffic collision
5. Struck by mobile plant
6. Contact with electricity
7. Hazardous chemicals, hot materials and confined spaces
8. Crushed by a crane or lifted load
9. Fall from height
10. Contractor management.

The program will apply to Inland Rail and the Project, including to contract workers throughout each phase.

20.5 Methodology

20.5.1 Hazard and risk study area

The hazard and risk study area incorporates all Project permanent and temporary infrastructure with the potential to impact people, environment and property. The extent of the impacts varies according to the nature and requirement of each hazard identified during the preliminary risk assessment, including existing environmental conditions and natural events. Refer to Chapter 6: Project description for further detail.

The hazard and risk study area as defined for the hazard and risk assessment is described as:

- Natural environment directly and potentially indirectly impacted by the Project
- Extent of the proposed temporary construction and permanent operational disturbance footprint, including road–rail interfaces, water crossings, maintenance and construction access sites, construction laydown areas and services locations.

The disturbance footprint includes:

- **Permanent operational disturbance footprint**: the rail corridor, which includes the rail tracks and associated infrastructure as well as other permanent works associated with the Project (e.g. where changes to the road network may be required)
- **Temporary construction disturbance footprint**: the permanent disturbance footprint and any temporary storage, laydown areas and access tracks to be used on a temporary basis during the construction phase.

20.5.2 Risk assessment methodology

The risk assessment presented in Section 20.12.3 has been prepared to describe the potential risks to people and property associated with the Project. The assessment considered sensitive receptors of the Project including population centres, environmental assets, and activities conducted within and around the Project footprint. This assessment provides a basis for assessment of potential impacts and preparation of safeguards to manage and mitigate impacts that might arise from the Project.

The basic methodology for risk assessment is based on AS/NZS ISO 31000:2009 (Standards Australia, 2009a) (compliant with AS ISO 31000:2018 *Risk Management: Principles and Guidelines* (Standards Australia, 2018) and HB203-2012 *Managing Environmental-related risk* (Standards Australia, 2012). Section 6.4.1 of AS ISO 31000:2018 (Standards Australia, 2018) describes the risk assessment is the overall process of risk identification, risk analysis and risk evaluation.

The risk management process as shown in Figure 20.2 will be applied throughout the lifecycle of the Project. For the purpose of the risk assessment, the lifecycle of the Project is defined in the following phases:

- Design
- Construction and commissioning
- Operation.

The application of the AS/NZS ISO 31000:2009 (Standards Australia, 2009a) (compliant with AS ISO 31000:2018 (Standards Australia, 2018)) provides a framework that enables ongoing identification and documentation of hazards and risk associated with the Project. The risk assessment presented in Section 20.12.3 will form part of the risk management process under the ARTC *Risk Management Procedure (RSK-PR-001)* (ARTC, 2020b) and work instructions and the broader ARTC Safety Management System.

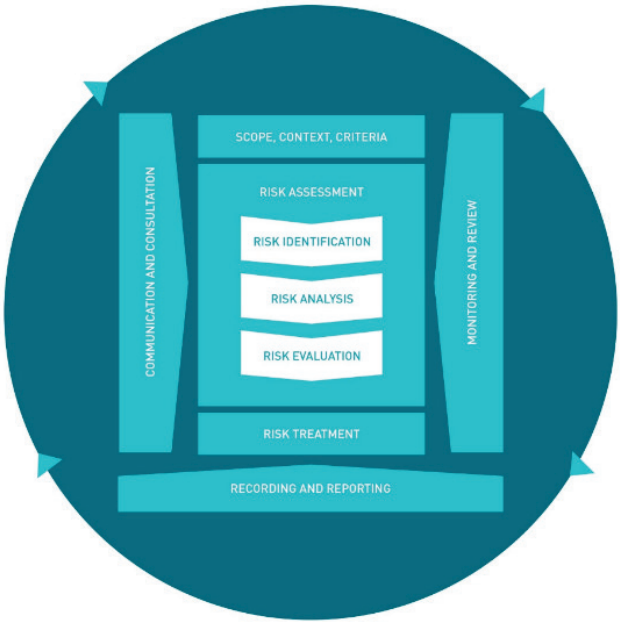

FIGURE 20.2: THE AS ISO 31000:2018 RISK MANAGEMENT PROCESS

Source: Standards Australia, 2018

20.5.2.1 Risk identification

The risk identification involved identification of hazards and their potential receptors over the lifecycle of the Project. The Project phases included design, construction and commissioning, and operation. Receptors were not restricted to individuals or communities, and included sensitive environmental receptors such as land, habitat, flora, and fauna. Potential hazards as identified in other technical studies, Project risk and Project safety in design workshops were included to provide breadth of assessment and to capture hazards identified during the design phase.

20.5.2.2 Risk criteria

The level of risk is determined as a function of potential consequence and likelihood (or probability) considering the presence of any relevant risk mitigation controls in Table 20.3 shows how the ARTC risk matrix determines risk rank as a function of likelihood and consequence. The risk ranking methodology, including criteria applied to likelihood and consequence factors, is discussed in Chapter 4: Assessment methodology. Probabilities of events occurring have been assessed from a qualitative view in the likelihood criteria rather than quantitative.

20.5.2.3 Risk analysis

Identified hazards were analysed in terms of the controls, the range of impacts in the context of those controls, and the likelihood of those impacts arising. Impacts and likelihood were combined to produce an estimated level of risk in accordance with the ARTC risk criteria, as presented in Table 20.3.

TABLE 20.3: RISK MATRIX

Likelihood	Consequence				
	Not significant	Minor	Moderate	Major	Extreme
Almost certain	Medium	Medium	High	Very high	Very high
Likely	Low	Medium	High	Very high	Very high
Possible	Low	Low	Medium	High	High
Unlikely	Low	Low	Low	Medium	Medium
Rare	Low	Low	Low	Low	Medium

20.5.2.4 Risk evaluation

Each risk identified and assessed as part of the risk analysis was evaluated in the context of the Project in accordance with the ARTC risk criteria, as described in Chapter 4: Assessment methodology.

20.5.2.5 Risk treatment and residual risks

Hazards ranked with medium, high and very high-risk ratings require further risk treatment throughout the Project lifecycle. Treatment includes risk management through the ARTC *Safety Management System*. Additional options for risk treatment such as mitigation measures and safeguards have been described in Section 20.11.

The ability of the mitigation and management controls proposed to treat the risks is then evaluated by producing a residual risk evaluation from the same risk matrix used for the original evaluation. If the residual risk rank remains high or very high, the risk will not be deemed tolerable. Intolerable risks will not be accepted by the Project.

As outlined in ARTC's *Risk Management Procedure* (ARTC, 2020b), risks with a residual rank of medium will be considered tolerable if ARTC demonstrates they are reduced so far as reasonably practicable through the ARTC *Safety Management System*. Additional options for risk elimination, inclusion of mitigation measures, and incorporation of safeguards have been described in Section 20.11 and Section 20.12. Consideration of risk controls has considered the full life cycle of the Project including design, construction and commissioning, and operation of the railway. Transfer of residual risk between the Project phases will be managed by ARTC throughout the Project lifecycle.

20.5.2.6 Monitoring and review

The quality and effectiveness of the control measures will be reviewed throughout Project implementation and operations.

20.5.2.7 Recording and reporting

All risks associated with the Project are documented in the ARTC Inland Rail risk registers and tracked by ARTC throughout the Project lifecycle.

20.5.2.8 Communication and consultation

ARTC and the Inland Rail team have undertaken community consultation with communities and land users within the hazard and risk study area. Community consultation and engagement forums have included discussion topics such as alignment selection and initial flood modelling and have included consultation with local communities to understand local hazards and risks.

Any residual risks from the design phase of the Project will be communicated to the appropriate stakeholders for construction and operation phases as required.

Refer Chapter 16: Social for details of Project consultation activities.

20.5.3 Dangerous goods and hazardous chemicals

Where hazardous chemicals or dangerous goods including explosives are stored, handled or transported, specific hazards and risks need to be identified and mitigated throughout the Project lifecycle.

The process undertaken when assessing hazards and risks associated with dangerous goods, and explosives included:

- Review of the types and quantity of goods to be stored and handled during construction. This includes fuel, explosives for tunnel blasting and associated items.
- Identification of specific design risks related to freight transport (e.g. dangerous goods fire incident in Little Liverpool Range tunnel). Security Sensitive Explosive Ammonium Nitrate or any Class 1 explosive will not be freighted during the operation of the Project; however, audible track warning devices (Class 1 explosives) will be used. Controlling ignition sources and accumulation of flammable and combustible substances.
- Identifying risk of physical or chemical reaction of dangerous goods, ensuring the stability of goods.
- Incorporating dangerous goods management into the emergency plan if relevant quantities exceed relevant thresholds. The emergency plan must also consider evacuation distances for explosives incidents and lightning exclusion zones (refer Appendix L in AS 2187.2-2006 (Standards Australia, 2006a) and Section 20.1.1) and evaluation of risks associated with explosive vehicle movements in and out of the Helidon Explosives Magazine Reserve.

The risks associated with dangerous goods and explosives have been qualitatively assessed based on the expected types and quantities of dangerous goods associated with the construction and commissioning, and operational Project phases.

20.5.4 Cumulative impact assessment methodology

Cumulative impacts are generally associated with the compounding interactions on the environment arising from a number of development activities occurring in the same area and over similar timeframes.

The assessment focuses on hazards, health and safety arising as a result of the Project, future developments, existing environment or a combination of all. Key hazards identified in the risk assessment have been qualitatively assessed for the relevance and significance of potential cumulative impacts within the temporal and spatial boundaries.

For a detailed description and approach to cumulative impact assessment refer to Chapter 22: Cumulative impacts.

20.5.5 Data sources

Risk assessments and disaster management plans have been developed by local councils within the hazard and risk study area and several technical studies have been undertaken for the Project. The following documents or sections are particularly relevant and are referred to, where applicable, within this chapter:

- District Disaster Management Plan—Ipswich and Toowoomba
- Local Disaster Management Plan—Ipswich and Lockyer Valley
- Local Planning Schemes—Gatton Shire Planning Scheme, Laidley Shire Planning Scheme, Ipswich Planning Scheme
- Climate data—Bureau of Meteorology (BoM)
- EIS Technical Reports—Appendix I: Terrestrial and Aquatic Ecology Technical Report; Appendix K: Air Quality Technical Report; Appendix L: Surface Water Technical Report; Appendix O: Noise and Vibration (construction, fixed infrastructure and operational road noise) Technical Report, and Appendix P: Operational Railway Noise and Vibration Technical Report
- EIS Chapters—Chapter 8: Land use and tenure; Chapter 9: Land resources; Chapter 11: Flora and fauna; Chapter 12: Air quality; Chapter 13: Surface water and hydrology; Chapter 14: Groundwater; Chapter 15: Noise and vibration; Chapter 16: Social; Chapter 19: Traffic, transport and access; and, Chapter 21: Waste and resource management
- Project risk and opportunity, climate change and adaptation strategy and Safety in Design workshops held as part of design development.

20.5.6 Human factors

Human factors were considered in the Safety in Design workshop. Examples addressed in the workshop include:

- A vehicle driver being visually distracted resulting in the driver crashing into the rail bridge
- Confusion of roles/procedures between Queensland Rail (QR) and Inland Rail personnel resulting in rail worker being hit by train at shared corridor interface
- Fencing interferes with sighting distance resulting in an accident on crossing.

The human factors workshops helped inform the design to ensure proposed design mitigation measures are appropriate.

20.6 Sensitive receptors

Identifying and assessing risk requires an understanding of the potential impact of hazards on sensitive receptors. Receptors include people and society, as well as sensitive environmental ecosystems, significant infrastructure and areas of economical land use. Land users and uses identified as sensitive receptors include:

- Townships of Helidon, Gatton, Laidley, Grandchester and Calvert, which are characterised as predominantly rural and rural residential
- Township of Forest Hill is dominated by irrigated seasonal horticulture and grazing country
- Significant transport infrastructure of the Warrego Highway and the QR West Moreton System rail corridor
- The University of Queensland (UQ) Gatton Campus
- Lockyer National Park and Gatton National Park
- Main water courses and floodplains of Lockyer Creek, Western Creek and their associated tributaries
- Lockyer Creek Crossing within the township of Grantham, which is often affected by floods
- Potential unexploded ordinance (UXO) within or adjacent to the Project, particularly at Helidon.

20.6.1 Human receptors

The key human sensitive receptors potentially exposed to hazardous events associated with the Project are:

- Residential communities and other land use such as agriculture, industry, commercial, defence, and utilities adjacent to the railway network, Little Liverpool Range tunnel, maintenance site and rail facilities
- Various townships located along the alignment including Helidon, Placid Hills, Gatton, Forest Hill, Laidley, Grandchester, and Calvert. These townships have populations ranging between approximately 300 for Calvert and 7,100 for Gatton
- Pedestrians, motorists and residents who use the roads and footpaths near the Project
- Passengers travelling along the QR West Moreton System rail corridor, Warrego Highway and Toowoomba Bypass Road
- Tourists
- Staff and students of the UQ Gatton Campus
- Communities of the Yuggera Ugarapul People
- First responders.

20.6.2 Environmental receptors

The key environmental receptors that may potentially impacted or be impacted by the Project are:

- Water catchment of the Lockyer Creek (between Helidon and Laidley) and Bremer River (Grandchester) Catchment
- Water crossings of Sandy Creek, Lockyer Creek, Laidley Creek and Western Creek
- Threatened species, migratory, marine and pest species or species habitat within the Project, specifically the Lockyer National Park
- European heritage included in buildings and urban form (eight State Heritage Register places and 20 local heritage places within the cultural heritage study area)
- Environmentally sensitive areas including groundwater-dependent ecosystems, threatened ecological communities and areas containing conservation significance fauna
- Indigenous cultural heritage and artefacts (13 reported Aboriginal cultural heritage sites within the EIS investigation corridor, the majority of which consist of artefact scatters and scarred/carved trees, followed by cultural sites, landscape features and resource areas).

20.6.3 Industrial and commercial receptors and utilities

The key industrial, commercial and utility receptors that will potentially be exposed to or introduce hazardous events associated with the Project are:

- Existing railway lines such as the QR West Moreton System rail corridor
- Land formerly used by the Australian Defence Force, particularly during World War II, at Helidon
- Agriculture estates in the Lockyer Valley and Darling Downs
- Powerlink high voltage transmission line, Ergon and Energex distribution networks
- Roma to Brisbane gas pipeline
- Moonie to Brisbane oil pipeline
- Existing road network (State-controlled and local)
- Key resource area of former Gatton Shire extractive industries.

The Project is not located within close proximity to strategic airports or aviation facilities. The closest facility is the Royal Australian Air Force Base Amberley located 14 km to the east of the hazard and risk study area.

20.7 Safety records

20.7.1 General rail safety

The Project alignment intersects with the QR West Moreton System rail corridor (refer Section 20.8.2 for further detail on shared corridor). The types of potential railway incidents include collisions, derailments, and rail level crossing collision.

The Department of Transport and Main Road (DTMR) and the Office of the National Rail Safety Regulator (ONRSR) publish investigation reports into rail incidents, which are available on their websites. The ONRSR is an independent body corporate established under the *Rail Safety National Law (Queensland) Act 2017* (Qld), which aims to encourage and promote national rail operations and safety.

The data available from the *ONRSR Annual Report 2018–2019* (ONRSR, 2019a) has been broken down by nature of the incident, incident type, and movement type, where possible. Note that the figures have been taken over a period where the number of Australian States and Territories reporting to the ONRSR changed (Victoria and the Australian Capital Territory transitioned to ONRSR and joined in 2014, Western Australia in 2015, Queensland in 2017). Key information is summarised in Table 20.4.

TABLE 20.4: OFFICE OF THE NATIONAL RAIL SAFETY REGULATOR RAIL INCIDENCES DATA

Statistic	Value	Units
Running line derailment of freight train	0.423	per million kilometres (km) of train line
Running line collisions (trains with rolling stock)	0.018	per million km of train line
Collisions at crossing (passenger and freight train)	0.142	per million km of train line
Fatalities (involving passengers, workers, public and trespass excluding suspected suicide)	0.088	per million km of train line
Signal Passed at Danger Authority Exceeded	2.239	per million km of train line
Fire or explosion	<0.001	per million km of train line
Terrorist attack	<0.001	per million km of train line

Source: *ONRSR Annual Report 2018–2019* (ONRSR, 2019)

The nature of these incidences has informed the design to mitigate risks so far as is reasonably practicable. Further information on road–rail interfaces for the Project are found in Chapter 6: Project description and Chapter 19: Traffic, transport and access and Appendix U: Traffic Impact Assessment Technical Report.

20.8 External hazards, health and safety

There are risks and hazards in the existing environment (in the absence of the Project) such as natural events and infrastructure. Existing risks and hazards may potentially be escalated by the Project and an understanding of these hazards enables the Project's risk contribution to be analysed.

20.8.1 Existing natural hazards

Natural hazards exist as external risk influences on the Project. Key natural hazards identified for the Project include bushfire, flooding, landslides, wildlife and climate change.

20.8.1.1 Climate data

The BoM station closest to the Project is the UQ Gatton site, approximately 3 km to the north of the Project. A summary of the long-term climatic data recorded at this BoM station is provided in Table 20.5.

TABLE 20.5: CLIMATE DATA FROM UQ GATTON STATION (1897 TO 2019)

Parameter		Unit	Value
Highest mean maximum temperature		°C	31.6
Highest maximum temperature		°C	45.7
Lowest mean minimum temperature		°C	6.2
Lowest minimum temperature		°C	-5.6
Mean monthly rainfall	Highest	mm	110.1 (Jan)
	Lowest	mm	26.7 (Aug)
Monthly rainfall extremes	Highest	mm	452.9
	Lowest	mm	0.0
Mean solar exposure	Highest	MJ/m^2	24.2
	Lowest	MJ/m^2	11.8
9am mean wind speed	Highest	km/h	14.8
	Lowest	km/h	11.0
Maximum wind gust speed	Highest	km/h	131
	Lowest	km/h	65

Table notes:
°C = degrees Celsius, mm = millimetres, MJ = megajoules, m^2 = metres squared, h = hour

The historic temperatures at the UQ Gatton BoM station are consistent with a warm sub-tropical climate and the rainfall data shows distinct wet and dry seasons. These factors are consistent with the general climate of the Lockyer Valley region.

Historic climate data shows that there is the potential for extreme temperatures, evidenced by the 14.1 °C difference between the highest maximum temperatures and the highest mean maximum temperatures at the UQ Gatton station (refer Table 20.5). Extreme temperatures can create two forces in the rail—compression and tension—that have the following impacts:

- Compression. Rail will try to move sideways to lengthen to relieve compression. When the amount of compression generated in the rails exceeds the ability of the structure to hold itself in place, track movement or buckling occurs.
- Tension. Rail will try to move sideways to shorten to relieve tensile stress. When the amount of tension generated is greater than the resistance offered by the track structure, a curve will pull in towards its centre. This is less dramatic than a buckle; however, it can be extremely dangerous if clearances are affected.

Historic climate data also shows up to a 340 mm difference between the highest monthly mean rainfall and the highest monthly rainfall at the UQ Gatton BoM station. This indicates there is a current potential for extreme rainfall events that can lead to an increased potential for flooding and flash flooding, the impacts of which are discussed in Section 20.10.1.2.

For further details of the climate across the hazard and risk study area, refer to Appendix K: Air Quality Technical Report.

20.8.1.2 Bushfire

The hazard and risk study area is predominately mapped as a 'Medium Potential Bushfire Intensity' Bushfire Prone Area, with an area of significant potential bushfire hazard occurring at Lockyer Valley and Little Liverpool Range (Queensland Government, 2015). Historically, the most common sources of bushfire ignition have been lightning strike. The bushfire season extends from mid-late winter through to early summer. The threat of bushfires increases with periods of reduced rainfall, increased temperatures and reduced humidity, which can increase the availability of fuels (e.g. dry grass) to burn.

The climate statistics from the BoM shows the highest recorded temperature for the Project is +45.7 °C as measured at Gatton station in summer. Mean rainfall values collected at the station highlight the distinct wet (summer) and dry (winter) seasons experienced by the region, as well as the large variation in rainfall amounts received across the wider area.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) (CSIRO, 2019) climate modelling predicts that the combination of increased temperature predicted, combined with the lower rainfall predicted will result in a higher drought factor and thus an increased fire weather risk in the future. CSIRO (2019) predicts the following increases in fire danger for East Coast in the Representative Concentration Pathways 8.5 case (refer to greenhouse gas concentration trajectory):

- Forest Fire Danger Index increases from 1995 baseline by:
  - 12 per cent by 2030
  - 30 per cent by 2090
- Number of days with severe fire danger rating increases from 1995 baseline by:
  - 45 per cent by 2030
  - 130 per cent by 2090.

20.8.1.3 Floods

The hazard and risk study area cross major waterways and the floodplains of Lockyer Creek, Western Creek and their associated tributaries. The region surrounding the Lockyer Creek floodplain was heavily impacted during the 2011 floods, particularly around Grantham.

A review of the flood hazard areas on the (former) Department of State Development, Infrastructure, Local Government and Planning, now the Department of State Development, Tourism and Innovation's development assessment mapping system revealed that the northern section of the proposed Project alignment has existing flooding issues under rainfall events as low as 1% annual exceedance probability (AEP). The areas of elevated flood risk include regions near Placid Hills, Gatton and Laidley.

Further detail regarding the flood impact and mitigation measures is provided in Chapter 13: Surface water and hydrology.

20.8.1.4 Storm events

Severe storms are generally formed by a low-pressure system bringing hazardous winds and heavy rain that may extend over large areas. They can be associated with tropical cyclones and can be a substantial contributor to flooding.

Since 2000, there have been seven tropical cyclones of significance in Queensland, but no record was found that a cyclone has have traversed the hazard and risk study area. However, several major storms were recorded in 2011, 2012, 2014 and 2016 within proximity to the Project, including at Gatton and Helidon (BoM, 2019).

20.8.1.5 Landslides, sudden subsidence and movement of soil or rocks

Heavy rain generally causes landslides in Queensland. The rain saturates the soil on a hillside—often where there has been human activity (e.g. construction activities where there has been the removal of trees and plants)—past the point where any remaining vegetation can support the soil's weight against the force of gravity.

The Project alignment from Helidon features undulating hills with moderate to low elevation. The peak elevation is reached as the alignment climbs Little Liverpool Range to an approximate elevation of 240 m, and then rapidly begins to descend towards Grandchester and Calvert. Field observations highlighted evidence of erosion on some riparian banks throughout the Project corridor, primarily due to cleared vegetation, human access and a road crossing bridge.

Refer Chapter 9: Land resources for more detail.

20.8.1.6 Climate conditions

Climatic changes observed throughout the 20th century include increases in global average air and ocean temperature, rising global sea levels, long-term sustained widespread reduction of snow and ice cover, and changes in atmospheric and ocean circulation and regional weather patterns, which influence seasonal rainfall conditions. These changes are caused by extra heat in the climate system due to the addition of greenhouse gases to the atmosphere. The additional greenhouse gases are primarily due to human activities such as the burning of fossil fuels (coal, oil, and natural gas), agriculture and land clearing.

Climate modelling from the CSIRO (2019) has predicted temperature rises relative to the climate of 1986–2005 in the east coast region for a full range of emission scenarios. Figure 20.3 shows this trend with the following predicted temperature rises:

- 0.4 °C to 1.3 °C by 2030
- 2.7 °C to 4.7 °C by 2090.

Increases in temperature or number of extreme heat events may result in increased likelihood of track buckling due to thermal expansion if unmitigated.

This climate modelling also considered rainfall in eastern Australia until 2090. This predictive model displayed a drying trend clearly evident in eastern Australia (CSIRO, 2015a) and Figure 20.4 shows this trend with the following changes in predicted rainfall relative to 1995:

- -10 per cent to 5 per cent by 2030
- -25 per cent to 10 per cent by 2090.

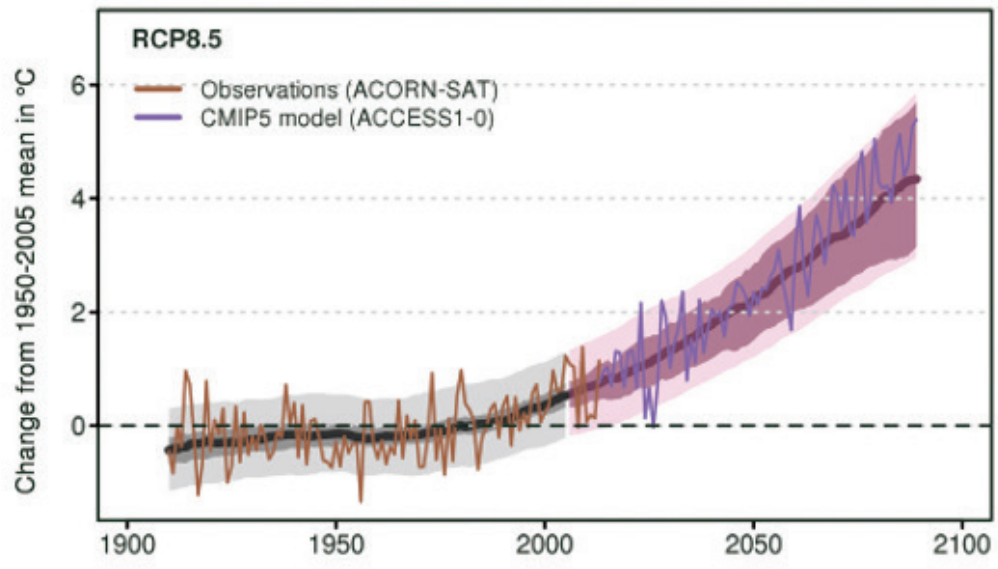

FIGURE 20.3: TIME SERIES FOR EASTERN AUSTRALIA ANNUAL AVERAGE SURFACE AIR TEMPERATURE

Figure note: RCP8.5 is Representative Concentration Pathways, which refers to greenhouse gas concentration trajectory, the 8.5 case represents a 'business as usual' scenario

Source: CSIRO, 2019

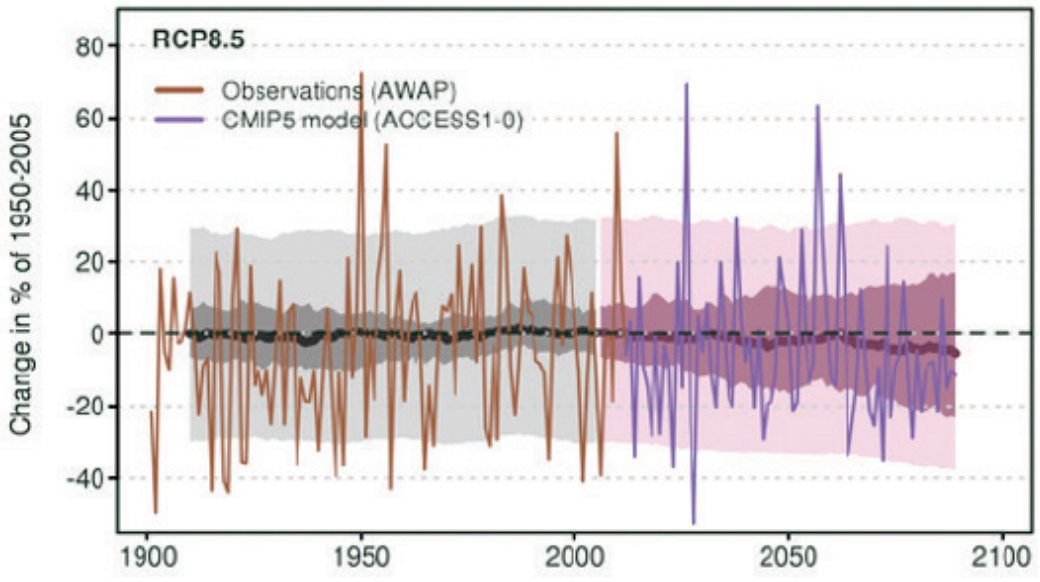

FIGURE 20.4: TIME SERIES FOR EASTERN AUSTRALIA RAINFALL ANNUAL AVERAGE

Figure note: RCP8.5 is Representative Concentration Pathways, which refers to greenhouse gas concentration trajectory; the 8.5 case represents a 'business as usual' scenario

Source: CSIRO, 2015a

The effects of changing climatic conditions may impact numerous environmental hazards, potentially resulting in increased severity and duration of weather activity, increased flooding extents and worsening extreme temperature events such as heat waves. Additionally, increased temperatures and lower rainfall may contribute to extended droughts and periods of dryness, which can contribute to increased fire weather risk, soil dispersion, increased salinity (and reduced asset life) and the potential for increased erosion.

Climate modelling from CSIRO indicates that the potential impacts to the Project associated with these occurrences may include:

- Changes in the magnitude and distribution of extreme weather, which may result in the increased frequency of events that prevent the operation of double-stacked freight trains
- Changes in precipitation and increased duration of drought, which can result in soil cracking and subsidence and lead to instability of drainage infrastructure, bridges/viaducts and track
- Increased wind speeds, which could potentially result in derailments or escalate the spread of fire (either from bushfire or burning trains)
- Increased flooding, resulting in inundation of track and trackside infrastructure (signalling/communications equipment and drainage basins)
- Increased incidence of extreme events (heat, rainfall and bushfire), resulting in disruption to power supply causing temporary loss of signalling and communication systems
- Increased heat events and increased temperatures leading to compression and tension, as a precursor to track buckling, and disruption of service.

For more details of climate conditions as an external hazard, refer to Chapter 7: Sustainability; Chapter 13: Surface water and hydrology; and Appendix L: Surface Water Quality Technical Report.

20.8.1.7 Wildlife

Wildlife is an external hazard to the Project as there is the potential for wildlife to interact with the Project via:

- Animal attacks on workers
- Collisions with fauna
- Fauna adopting rail infrastructure as habitat (e.g. bats)
- Fauna carrying diseases
- Pests and weeds that pose a biosecurity risk
- Flora that pose a risk to human health.

Three conservation significant species, (i.e. Koala, Grey Falcon and Grey-headed Flying Fox) were identified within the Project ecology study area.

Discrete areas of remnant vegetation are scattered across the Project ecology study area; however, most of the area is characterised by non-remnant vegetation, particularly cleared agricultural areas, which provide grassland habitat to fauna species.

Several restricted invasive animals and flora species listed under the *Biosecurity Act 2014* (Qld) were also identified to have the potential to occur within the Project ecology study area.

Refer Chapter 11: Flora and fauna for more detail.

20.8.1.8 Naturally occurring asbestos

The Project's geotechnical investigation found that none of the rock types found were associated with naturally occurring asbestos.

20.8.2 Existing land contamination

Based on the land uses within the hazard and risk study area and the findings of the desktop assessment, potential sources of contamination in the vicinity of the EIS investigation corridor are considered to include:

- Agricultural activities: Hydrocarbons (fuel and oil storage and use), pesticides and herbicides, asbestos and lead paint, arsenic (cattle dips), landfilling
- Quarries to the north-east of Helidon adjacent to the Project: Hydrocarbons (fuel and oil storage and use), metals/metalloids, hazardous materials
- Landfilling, waste disposal: Hazardous materials, hydrocarbons, metals/metalloids, phenols, polychlorinated biphenyls, phthalates, volatiles and pesticides and herbicides
- Existing rail corridor: Metals, asbestos, hydrocarbons, pesticides/herbicides
- Road crossings: Metals and hydrocarbons
- Unknown fill material within existing rail corridor: Asbestos, metals/metalloids, hydrocarbons, herbicides
- Sections of the alignment are shared by the QR West Moreton System rail corridor:
  - Helidon
    - Inland Rail chainages (Ch) 25.2 km to Ch 27.2 km
    - Queensland Rail Ch 115.8 km to Ch 117.8 km
  - Placid Hills to Laidley
    - Inland Rail Ch 37.4 km to Ch 55.7 km
    - Queensland Rail Ch 84.4 km to Ch 102.4 km
  - Grandchester to Calvert
    - Inland Rail Ch 67.5 km to Ch 74.5 km
    - Queensland Rail Ch 61.0 km to Ch 68.0 km.

There are 32 properties within the land resources study area subject to environmentally relevant activities listed on the environmental authorities register. Of the 32 properties that operate environmentally relevant activities, seven were listed on the Environmental Management Register, though none are listed on the Contaminated Land Register. These properties are recorded on the Environmental Management Register for the following activities:

- Hazardous contaminants
- Explosive production or storage
- Landfill
- Waste storage, treatment or disposal.

A search of the Department of Defence online mapping (Australian Government, 2017) identified a small area of Unexploded Ordnance (UXO) categorised as 'Other' along the southern border of the proposed site at Fred Gillam Park, southeast of Gatton. The Department of Defence categorises 'Other' UXO areas as land that has been used for military training but not confirmed as a site where live firing was undertaken. UXO or explosive ordnance fragments or components have not been recovered from these areas.

There are no key resource areas or coal resources located within the land resources study area, refer Chapter 9: Land resources for more detail on existing land contamination within the hazard and risk study area.

20.9 Hazard identification

Project-specific asset, health, safety and environment hazards have been identified through risk identification workshops, design reviews and impact assessments. Identified mitigation measures are detailed in Table 20.11 and discussed in Section 20.11. Risk levels for each hazard identified are provided in the risk assessment table, refer Section 20.12.3.

Occupational hazards exist throughout the Project life cycle, including construction and maintenance risks. The Project will comply with the *Work Health and Safety Act 2011* (Qld) and *Work Health and Safety Regulation 2011* (Qld) along with the ARTC's Safety Management System, including procedures, work instructions, engineering standards and guidelines. Ongoing workplace risk assessments will be carried out in accordance with the ARTC *Safety Management System* and the ARTC *Fatal and Severe Risk Program* (ARTC, 2017d). For the purposes of this EIS, these occupational risks will not be documented in this chapter.

Technical studies undertaken as part of the EIS have been incorporated where applicable; reference is provided to detailed assessments and sections of the EIS, as appropriate.

20.9.1 Natural hazards

Existing natural hazards within the hazard and risk study area have the potential to introduce risk to Project activities and require identification and mitigation. Natural hazards relevant to the Project are identified in Table 20.6.

20.9.1.1 Natural hazards include adverse weather conditions and natural events.

The Project also has the potential to generate or change the risk profile of hazards to the natural environment through interactions with existing sensitive environmental receptors. Earthquake activity was also examined as part of the reference design and was considered to be extremely low, with no further analysis undertaken as part of the EIS hazard and risk assessment.

TABLE 20.6: IDENTIFIED POTENTIAL IMPACTS ARISING FROM NATURAL EVENTS

Potential hazards	Impact category	Construction	Operation
Bushfire	Asset Environment Safety	Potential	Potential
Flooding and storm events	Asset Environment Safety	Potential	Potential
Climate conditions (e.g. increase in temperature and rainfall events)	Asset Environment Safety	Potential	Potential
Landslide, sudden subsidence, movement of soil or rocks	Asset Environment Safety	Potential	Potential
Wildlife (e.g. animal attacks, propagation of dust and weeds)	Safety Environment	Potential	Potential
Naturally occurring asbestos	Safety Environment	No Potential	No potential

20.9.2 Project hazards

Activities associated with the construction and commissioning, and operation Project phases have the potential to cause harm to the surrounding environment, communities and other sensitive receptors. Construction activities including clearing may impact areas of sensitive environmental value, while operations on the rail alignment may impact nearby communities.

Potential hazards introduced by the Project are identified in Table 20.7.

TABLE 20.7: IDENTIFIED POTENTIAL IMPACTS ARISING FROM THE PROJECT

Potential hazards	Potential causes	Potential impact types	Construction	Operation
Health (e.g. fatigue, asbestos, respirable silica, noise, vibration)	▸ Earth work ▸ Land clearing ▸ Construction work	Asset Safety Environment	Potential	Potential
	▸ Rolling stock	Asset Safety Environment	No Potential	Potential
Road incidents	▸ Construction traffic ▸ Detours ▸ Changing traffic conditions	Safety	Potential	Potential
Rail incidents	▸ Interface with live rail ▸ Concurrent operation	Safety	Potential	Potential
Pedestrian safety	▸ Level crossing ▸ Poor visibility ▸ Trespass	Safety	Potential	Potential
Tunnel	▸ Spill in tunnel, trespass, fire, explosion, chemical release, chemical mixing ▸ Excessive exposure to air contaminants and noise in tunnel	Asset Safety Environment	Potential	Potential
Infrastructure and services	▸ Underground pipes ▸ Overhead transmission lines	Asset Safety Environment	Potential	Potential
Gas and petroleum pipelines	▸ Interface with pipelines	Asset Safety Environment	Potential	Potential
Contaminated land	▸ Acid Sulfate Soil ▸ Leaks and spills from freight and vehicles	Asset Safety Environment	Potential	Potential
Overbridges	▸ Structural failure ▸ Derailment at elevated track	Asset Safety	Potential	Potential
Emergency access	▸ Restricted access for emergency evacuation ▸ Restricted emergency vehicle route ▸ Restricted fire trail	Safety	Potential	Potential
Dangerous goods	▸ Storage, handling, use and transport	Asset Safety Environment	Potential	Potential
	▸ Use of explosives (e.g. potential blasting for tunnel construction)	Asset Safety Environment	Potential	No potential

20.9.3 Dangerous goods and hazardous chemicals

20.9.3.1 Construction and maintenance chemicals

The Project will involve the use and storage of hazardous chemicals during construction, operation and/or maintenance including fuel, lubricant, oil, solvents, degreaser, concrete and other cleaning agents.

The expected list of chemicals used throughout the Project lifecycle, along with their purpose and dangerous goods details are presented in Table 20.8.

Generally, low volumes of hazardous chemicals would be stored in the temporary construction disturbance footprint near points of use. The quantities stored will be equivalent to the demand for activities within that area of the rail corridor.

Constructability investigations have developed expected chemical storage locations and quantities throughout the construction phase based on the planned execution of works within the hazard and risk study area. Operational chemical requirements are based on expectations of rail activities across similar projects. While the chemical quantities may change due to operational requirements and refinement of design detail during detailed design, the types and indicative quantities identified below are considered to represent the usage requirements.

During the construction phase, the following facilities are expected to be provided, which will include storage and distribution of construction chemicals:

- Laydown areas will be located at each bridge and between QR and Project alignment connection linkages, which will include small quantities of lubricants and oil (e.g. drum and Intermediate Bulk Container package stores)
- Diesel fuel depots located at approximately 20 km intervals along the Project alignment, which will include 40 kilolitres (kL) bulk storage of diesel
- Concrete batching plants within the vicinity of tunnel construction, which will include storage and usage of activity relevant chemicals.

Operational usage of chemicals is expected to be as required throughout the corridor and will typically involve limited quantities during specific maintenance activities.

Indicative chemical storage and usage details are provided in Table 20.8.

TABLE 20.8: INDICATIVE LIST OF DANGEROUS GOODS AND HAZARDOUS CHEMICALS

Chemical type	Typical chemicals	Design lifecycle stage	Purpose/use	DG class	Indicative rate of use	Expected storage method
Fuel oil	Diesel	Construction Operation	Fuel for mobile equipment	(C1)[1]	40 kL/2 weeks per depot	40 kL bulk storage (fuel depots)
Grease	Rocol Rail curve grease	Construction Operation	Lubricate plant and equipment	(C2)[2]	Limited	Package storage
	Caltex 904Grease	Construction Operation	Lubricate plant and equipment	(C2)[2]	Limited	Package storage
	Shell GADUS gauge face curve grease	Construction Operation	Lubricate plant and equipment	(C2)[2]	Limited	Package storage
	RS Claretech biodegradable grease	Construction Operation	Lubricate plant and equipment	(C2)[2]	Limited	Package storage
Explosives	Ammonium Nitrate	Construction	Tunnel construction	5.1[3]	Limited	Not stored
	Blasting explosives (e.g. Detonators, blast caps and boosters)	Construction	Tunnel construction	1	Limited	Not stored
Concreting	Concrete and concrete residue	Construction	Concreting for slab construction	N/A	As required by the local construction team	Truck deliveries
	Concrete curing compound	Construction	Concreting for slab construction	N/A	As required by the local construction team	Truck deliveries
Welding gases	Oxygen	Construction	Welding	2.2/5.1	Cylinders and/or manifold packs as required by the local construction team	Cylinder storage
	Acetylene	Construction	Welding	2.1	Cylinders and/or manifold packs as required by the local construction team	Cylinder storage
Pesticides	Australian Pesticides and Veterinary Medicines Authority approved pesticides	Construction Operation	Pests and weeds control	6.1 or 9	As required, in accordance with ENV-PR-003	Not stored in alignment

Table notes:
1. Class C1—a combustible liquid that has a flashpoint of 150 °C or less.
2. Class C2—a combustible liquid that has a flashpoint exceeding 150 °C.
3. Security Sensitive Ammonium Nitrate is classified as an explosive under the Explosives Act.

20.9.3.2 Freight dangerous goods

The Project will enable freight transport as part of Inland Rail. The design of the freight system including the tunnel, allows for the transport of dangerous goods. ARTC has indicated that the rail corridor is intended to be used for the freight of all classes of dangerous goods excluding explosives. ARTC cannot provide an exhaustive list of the types and quantities of dangerous goods that will be transported; however, explosives will not be included and transportation of any other dangerous goods will be managed under the Australian Dangerous Goods Code (National Transport Commission, 2018).

Operational transport of dangerous goods associated with freight activities has a risk of loss of containment during incidents such as derailment. Loss of containment of dangerous goods could have severe consequences depending on the location and type of goods. Minor leaks and spills are expected to be limited to within the rail corridor.

Where the Project traverses areas of environmental sensitivity such as watercourses, there is the potential for loss of containment events to significantly damage the environment through release of toxic, corrosive or flammable materials.

Fires and the release of harmful chemicals can result in injuries and fatalities. Other potential loss of containment from flammable liquid, solid or gas and toxic chemicals, can also create major incidents such as pool fire, jet fire, explosion or toxic release.

Schedule 2 of the Explosives Act defines security sensitive explosives including ammonium nitrate as:

a) a blasting explosive; or

b) a propellant powder; or

c) a firework other than an unrestricted firework; or

d) a pyrotechnic substance used in a firework; or

e) security sensitive ammonium nitrate which is defined as:

i) ammonium nitrate; or

ii) a solid substance that –

11. consists of a mixture of ammonium nitrate and another substance if the mixture contains more than 45 per cent

12. ammonium nitrate by mass; and

13. is not classified as a Class 1 explosive.

f) ammunition, other than small arms ammunition, that contains explosives.

Although explosives are not intended for freight, ammonium nitrate may be transported as a Class 5.1 dangerous good. When mixed with fuel, such as diesel, ammonium nitrate can explode with similar effects to that of Class 1 explosives. Additionally, ammonium nitrate is at risk of explosion if exposed to a heat source or ignition source, especially when in a confined space. Ammonium nitrate is declared to be an explosive under the *Queensland Explosives Regulation 2017* if it is defined as security sensitive. Security sensitive explosives including ammonium nitrate, or any Class 1 explosive will not be freighted during the operational phase. It is noted that audible track warning devices (which contain Class 1 explosives) will be used. These devices will be used in very small quantities and therefore do not require Project-specific mitigation and management measures.

ARTC does not own or operate rolling stock; however, the transportation of dangerous goods on the Project by independent operators will require authorisation by ARTC. The quantities and types of dangerous goods, which may be present as freight, and the allowance of bulk and packaged dangerous goods, will be managed in accordance with the requirements of the *Australian Dangerous Goods Code* (National Transport Commission, 2018).

Based on the variability of potential types and quantities of dangerous goods, there is the potential for freight activities to have significant impact on people, property and the environment surrounding the disturbance footprint. Accidents involving dangerous goods freight trains have the potential to create hazards for people and the environment associated with the properties of dangerous goods including flammability, toxicity (people and environmental) and corrosiveness.

20.9.3.3 Explosives

Explosives are classified as Class 1 dangerous goods. It is expected that blasting explosives or Security Sensitive Ammonium Nitrate will be used for the construction of the tunnel through the Little Liverpool Range. Explosives are hazardous by nature and the incorrect or inappropriate storage, handling or transport, may result in an unplanned detonation, causing harm to the environment and people. No borrow pits have been identified for the Project.

Blasting activities associated with construction work also introduce hazards to the surrounding environment through noise and vibration. Noise and vibration impacts are discussed in detail in Chapter 15: Noise and vibration.

Explosives must be stored, handled and transported as stipulated by the Explosives Act. Additionally, a range of explosive related activities require notification under the Explosives Act, including:

- Before undertaking a blast
- Before importing or exporting explosives
- When storing or interacting with stored explosives at explosive storage facilities and government activities
- When there are changes to buildings and vehicles related to the storage or transport of explosives
- After conducting an explosive trail.

Construction methodologies are being evaluated and have considered the requirements of explosives use including the Explosives Act and AS 2187-1998—Explosives—storage, transport and use (Standards Australia, 1998).

Explosives may also impact the Project through vehicle movements in and out of the Helidon Explosives Magazine Reserve (refer Section 20.10.2.2).

20.9.4 Existing infrastructure

The rail alignment is likely to interact with numerous existing services during construction, such as the Queensland Urban Utilities, National Broadband Network, Nextgen, Optus, Telstra, TPG, Energex and Powerlink, APA and the currently non-operational Santos Moonie–Brisbane high-pressure oil pipeline.

The rail alignment crosses and aligns with a number of highways, main roads and local roads. In particular, the rail alignment crosses Airforce Road, Connors Road, Old College Road, Seventeen Mile Road, Warrego Highway, Eastern Drive, Hunt Street, Laidley Plainland Road, Rosewood Laidley Road, Grandchester Mount Mort Road and Calvert Station Road. In total, the rail corridor is identified to impact on 36 public roads, of which 31 are managed by the local governments (28 in Lockyer Valley Regional Council and three in Ipswich City Council), and five of which are State-controlled roads managed by DTMR. These impacts exclude works associated with proposed level crossings and drainage works proposed for Hickey Street.

The Warrego Highway is the key road transport route within the hazard and risk study area, and primarily functions as the east–west major freight route, extending 714 km from Brisbane to Charleville. The new Toowoomba Bypass has been built to address the rapid traffic growth on the Warrego Highway.

Refer Chapter 8: Land use and tenure, and Chapter 19: Traffic, transport and access for more detail.

20.10 Potential impacts

The potential impacts of the identified hazards include interaction between the Project and the local environment throughout the Project lifecycle. Technical studies undertaken as part of the EIS have been incorporated where applicable, and reference is provided to detailed assessments and chapters of the EIS as appropriate.

20.10.1 Natural hazards

20.10.1.1 Bushfire

Project activities have the potential to escalate the risk of bushfire by introducing ignition sources, such as welding. Construction activities, in particular the use of temporary facilities, can increase the severity of fire incidents by providing additional fuel such as combustible liquids storage. Leaks and spills from freight and other machinery can also increase the potential for bushfires. Furthermore, the Helidon Explosives Magazine Reserve has the potential to act as an ignition source for a bushfire.

Residential housing located within bushland and adjacent to the hazard and risk study area, specifically within the area of 'Very High Potential Bushfire Intensity' are vulnerable to the risk of bushfires. The evacuation route for some of the local residents crosses the Project, which could potentially affect evacuation plans. It is also acknowledged that other assets, including infrastructure (e.g. Powerlink transmission line, Ergon and Energex distribution network, Roma to Brisbane gas pipeline, Moonie to Brisbane oil pipeline), rural-residential properties, agricultural estates and farming assets are exposed and vulnerable to damage or destruction by bushfire.

Increased bushfire frequency has the potential to result in environmental damage, as well as potential safety and asset loss impacts (e.g. infrastructure damage and track buckling). The increased temperature predicted, combined with the lower rainfall predicted in Eastern Australia for the years 2030, 2050, 2070 and 2090 (CSIRO, 2019), results in a higher drought factor and thus an increased fire weather risk in the future.

The Project also provides some benefits in the case of a bushfire, such as: improved access to the area, acting as a firebreak and providing the opportunity to potentially involve the local disaster management groups during construction and operation.

20.10.1.2 Flooding and storm events

The Project spans two catchments, the Lockyer Creek Catchment and the Bremer River Catchment, and crosses approximately 18 km of Lockyer Valley floodplain. Flooding can have significant impacts on the wider area due to the nature of this natural hazard. Key impacts are often associated with loss of life and significant damage to property and the environment. Examples of these impacts were seen in the floods experienced in 2011, which affected the area.

Construction of bridges and rail in the vicinity of water crossings and floodplains has the potential to affect drainage characteristics, which may impact existing dwellings, sheds, farm buildings and infrastructure, crops and roads.

Hydrology and flooding studies identified that the extent of the flooding impacts is likely to include:

- Changes in peak water levels and associated areas of inundation
- Concentration of flows, redirection of flows and/or changes to flood flow patterns
- Increased velocities leading to localised scour and erosion
- Changes to duration of inundation
- Increased depth of water affecting trafficability of roads and tracks.

For further impacts assessment of any structures such as bridges, culverts and embankments on flood levels for a range of flood events, refer to Chapter 13: Surface water and hydrology.

20.10.1.3 Climatic conditions

The potential impacts of climatic conditions that may affect the management of the Project are generally associated with variability of temperature, wind, rainfall and flooding. As discussed in Section 20.8.1.1, the Project is subject to a warm sub-tropical climate and is vulnerable to seasonal conditions consistent with the general climate of South East Queensland (i.e. wet and dry seasons). The Project may therefore be vulnerable to extremes of climate including tropical cyclones and prolonged rain events which, while relatively uncommon, do occur in Queensland, as well as natural or induced hazards including bushfires, which are likely to occur during periods of reduced rainfall and increased temperatures. The Project may also be vulnerable to flooding as major flooding events have been evident in the past 10 years in the hazard and risk study area.

Climate modelling from CSIRO projects an increase in intensity of heavy rainfall events. The heaviest rainfall events usually occur in summer, which is strongly influenced by the easterly trough, an elongated zone of low-pressure forms as a result of strong surface heating west of the Great Dividing Range. Summer thunderstorms can be hazardous due to accompanying winds, hail, flash floods and potentially damaging lightning strikes. During the operational phase of the Project, potential impacts of climatic conditions include tracks buckling due to increased heat events (e.g. heat waves), inundation of tracks and trackside infrastructure from increased flooding and interruption to power supply or network communications from severe weather events.

For more details of the potential impacts of climatic conditions, including impacts on flooding regime under climatic conditions to 2090 through considering an increase in rainfall intensity as per Australian Rainfall and Runoff guidelines, refer to Chapter 7: Sustainability and Chapter 13: Surface water and hydrology.

20.10.1.4 Landslides, sudden subsidence, movement of soil or rocks

Activities within the hazard and risk study area may result in a number of potential impacts relating to landslides, sudden subsidence, and movement of soil or rocks. Construction activities within the hazard and risk study area have the potential to disturb the stability of existing ground formations, which includes areas of black soils and dispersive clays. Potential impacts of construction activities and ongoing operations include:

- Cracking and/or settlement of structures including sudden subsidence due to the high potential for shrinkage and swelling of the black soils and cracking clays. Cracking may also result from the removal of vegetation in these soils
- Slope instability including sudden subsidence requiring stabilisation of cut faces
- Sudden movement of soil or rock (particularly associated with tunnelling works)
- Gully erosion due to the dispersive nature of cracking clays and black soils
- Erosion due to the loamy soils on alluvial plains and terraces
- Rock fall onto track due to colluvial loose scree on existing slopes or weathering
- Risks of landslides, slump features and mass wasting due to some instability issues including the erodibility of the Marburg Formation.

Due to the nature of the bedrock that will be encountered and the relatively short length of the Little Liverpool Range tunnel, it is envisaged that the tunnel will be excavated using mined tunnel techniques (road header/drill and blast).

For more detail refer to Chapter 9: Land resources.

20.10.1.5 Wildlife

Clearing as a result of the construction has the potential to impact ecosystems within the rail corridor as well as surrounding ecosystems. A rail corridor may create barrier effects, particularly those that may create a hard barrier that restricts fauna movement (e.g. access tracks, easements).

The key potential impacts include:

- Loss of fauna habitat and impacts on threatened species and endangered populations
- Disturbance to natural waterways and aquatic habitat from the replacement and/or upgrade works of bridges and culverts
- Habitat fragmentation and connectivity issues for flora and fauna
- Potential for wildlife to be struck by operating trains or having migration patterns or habitats disrupted by construction
- Dispersion and potential encouraged growth of weeds during construction activities by exposing soil and clearing vegetation
- Noise and light impacts to wildlife during construction and operation
- Animal attacks (e.g. bites, stings, trampling) to construction and maintenance workers
- Proliferation of weed and pest species can also damage native vegetation through competition, grazing and trampling.

The Project has the potential to negatively impact land use and biodiversity within the area through:

- Transfer biosecurity hazards into the disturbance footprint and surrounding areas. This includes hazards that may be transported with goods during operations. Dispersion and potential encouraged growth of weeds during construction activities by exposing soil and clearing vegetation.
- Proliferation of weed and pest species can also result in damage to native vegetation and impact wildlife. Weeds can affect the ecological diversity and balance by competing with native flora and reducing available food sources, while pest species can impact native vegetation and wildlife through grazing, digging, trampling and predation. Specifically, the disturbance footprint will traverse areas contained within fire ant biosecurity zones.

Exotic grasses can make bushfires hotter and spread faster. For more detail refer to Chapter 11: Flora and fauna and Appendix J: Terrestrial and Aquatic Ecology Technical Report.

20.10.2 Project hazards

20.10.2.1 Health

Project activities have the potential to impact the health of site workers and the local community.

Fatigue and heat stress

Heat stress can lead to cramps, dizziness, disorientation, exhaustion and, in severe cases, death. Fatigue can increase the risk of incidents, for example errors during equipment operation or misjudging the speed and distance of approaching traffic. The onset of fatigue can lead to poor decision making, lack of alertness and slower reaction to a situation. In this way, fatigue and heat stress can impact surrounding communities through escalation of incidents initiated by the Project.

Asbestos

No naturally occurring asbestos has been found to be present during geotechnical investigations undertaken to date; however, asbestos containing materials may be present in infrastructure within the disturbance footprint including sheds, houses as well as rail infrastructure (e.g. signal boxes, insulation) associated with the QR West Moreton System rail corridor.

Disturbance of asbestos-containing materials can result in the release of airborne fibres. Asbestos fibres are carcinogenic and have significant potential health impacts over the long term. Asbestos fibres released into the environment are persistent and can result in contamination of soil.

Impacts associated with asbestos release are generally limited to the local environment; however, the extent of potential impacts are influenced by the quantity and type of asbestos containing material and weather conditions during disturbance. The inappropriate handling of asbestos material, such as improper disposal and transport can also contribute to widespread impacts.

Dust, respirable silica and other airborne contaminants

Earthworks and truck movements over unpaved surfaces during construction (e.g. land clearing and blasting) result in the disturbance of surface material, which may generate airborne contaminants and cause amenity impacts for sensitive receptors downwind.

For construction workers, particularly as related to tunnel construction works, high levels of exposure can lead to potential WH&S issues. Exposure to silica concentrations at low levels can lead to chronic silicosis which causes fibrotic nodules and shortness of breath if the exposure is repeated for a long period.

The Cancer Council (2019) states that prolonged exposure to silica concentrations may lead to the subsequent development of lung cancer, acute and accelerated silicosis, kidney disease, and chronic obstructive pulmonary disease. For the general community, the risk of exposure to respirable crystalline silica from construction works and operations is considered negligible.

Trains moving through tunnels result in short-term increases in concentrations of emissions at tunnel portals in comparison to traveling along in the open air. Due to this, air contaminant concentrations at either side of the Little Liverpool Range tunnel could exceed short-term exposure limits, which is typically a 15-minute time-weighted average that cannot be exceeded at any time during an 8-hour day.

Based on a review of published monitoring and modelling studies of rail freight projects, beyond 25 m of the rail alignment it is expected that there will be negligible influence from particulate emissions from diesel engines, emissions from loads, and recirculated dust. Additionally, beyond 50 m of the rail alignment, the gaseous criteria (as defined in *Environmental Protection Policy (Air) 2019* for human health and impacts on agriculture and sensitive ecological areas and in the *National Environmental Protection Measure for human health protection*) are expected to be met.

The deposition of larger dust particles (e.g. coal dust) can cause nuisance to nearby communities. Testing the impact of coal dust has been conducted for the Project alignment and the worst-case particle concentration is predicted to be below the Department of Environment and Science (DES) threshold of 120 milligrams per square metre per month (mg/m^2/month) at the nearest potentially affected sensitive receptors. The outcome is considered to be very conservative and is expected to show little difference between coal freight and other train types. Refer Chapter 12: Air quality for more detail.

Construction and operation works have the potential to impact local water and groundwater sources due to contamination of surface water and groundwater. This could result in adverse public health impacts associated with water contamination. Refer Chapter 13: Surface water and hydrology and Chapter 14: Groundwater for more detail on water quality and potential impacts.

Noise and vibration

Exposure to loud noise and vibration over an extended period are expected to result in human discomfort including:

- Disturbance to sleep pattern and quality
- Reduction in level of concentration and slower reaction times
- Increase in stress and depression level affecting mental wellbeing.

Additionally, vibration can cause damage to infrastructure, which can lead to asset damage of both the Project infrastructure and surrounding infrastructure sensitive receptors. Damaged infrastructure has the potential to physically harm humans.

Noise and vibration will be acute and temporary during the construction phase due to the requirement of construction plant, vehicles, equipment (including earth moving machinery, vibratory rollers, and hydraulic hammers) and activities such as piling, tunnelling and blasting.

Train and freight movements will also be a potential source of noise pollution and vibration during the operations phase.

For detailed discussion of noise and vibration impacts associated with the Project, refer to Chapter 15: Noise and vibration, Appendix O: Noise and vibration (construction, fixed infrastructure and operational road noise) technical report and Appendix P: Operational Railway Noise and Vibration Technical Report.

20.10.2.2 Accidents

Accidents that could potentially occur within, and in the vicinity of, the hazard and risk study area arise from increased traffic on roads, concurrent operation of trains, trespass and level crossings. Additional assessments will be undertaken during the detailed design phase to ensure that all hazards and risks associated with potential accidents will amended within the design as far as practicable. Refer Chapter 19: Traffic, transport and access for more detail on traffic interactions and assessment of conditions. Refer Chapter 23: Draft Outline Environmental Management Plan for currently proposed mitigation measures.

Road incidents

Increased light and heavy vehicle traffic on the Warrego Highway, Seventeen Mile Road and other roads in the area surrounding the alignment, such as Gatton Esk Road, Gatton Laidley Road, Gatton Helidon Road, Old Laidley Forest Hill Road, Laidley Plainlands Road, Stokes Road and the Grandchester Mt Mort Road are expected during the construction phase. Vehicles used during construction and maintenance include graders, loaders and light vehicles. Construction and maintenance vehicles operating on roads and access roads around the Project can create interface conflict with local and access roads.

Altered traffic conditions such as detours, restricted lane widths and temporary access points are also the potential causes of accidents during the construction phase. Changes in road access, including increased road–rail interface, has the potential to decrease the accessibility and increase travel times associated with accessing key destinations, facilities and community services for local residents.

Road routes can be interrupted from minor accidents of motor vehicles or interaction between wildlife. The major road interruption usually arises from heavy vehicle use or vehicles carrying hazardous chemicals. The risks of road accidents associated with the movement of this type of freight are significantly increased with frequency of freight carriage and freight of dangerous goods. This road traffic introduces a risk of accidents occurring that could cause serious injury or death. The consequence following this accident could affect the capacity of emergency and essential services and cause disruption to road freight networks.

Due to the presence of a Helidon Explosives Magazine Reserve located at Helidon, road traffic within the area is expected to include a higher proportion of vehicles carrying explosives. The increased potential for road accidents caused by construction traffic has a greater potential for impact within this area, as there is the potential for explosives incidents or detonations as a result of traffic accidents.

Rail incidents

The increased frequency of rail movements during the operational phase will increase the potential for rail incidents, including derailment. The potential consequences of rail incidents increase significantly when considering the freight of dangerous goods. Derailments can result in significant damage to local environment and communities, depending on the location of an incident and the contents of an involved freight train. Derailments are rare events, with historical incident data indicating a potential frequency of 0.423 per million freight train km based on 2015 to 2019 four year's average data (ONRSR, 2019). Other events include vehicle strikes at level crossings, running line collisions with rolling stock and trespass.

The hazard and risk study area include a tunnel and areas of steep grading. Areas of steep grades introduce the potential of uncontrolled movement and excessive speeding of trains due to gravity, which can increase the potential for derailment or train collisions. Additionally, trains could potentially be stopped and subsequently deplete their air brakes which can lead to uncontrolled movement along a grade or in a tunnel. The likelihood of uncontrolled movements is low and requires failure of on-board systems such as speed controls and brakes.

Level crossing and pedestrian safety

The Project includes seven active level crossings, with the majority of the level crossings located at Grandchester and Gatton. Level crossings can create dangerous points at which trains, cars and pedestrians interface, increasing the risk of collisions, which may result in loss of life and impacts to communities. Such crashes can have a significant social and economic impact.

While the assessment recognises that human factors and influence on road user behaviours also contribute to level crossing incidents, the number of tracks and the speed of trains approaching these crossing points are also prominent factors which determine the potential impacts.

Tunnel

The rail alignment crosses areas of steep slopes, specifically the Little Liverpool Range, which requires significant cuttings and the use of a tunnel. The construction of the Little Liverpool Range tunnel aims to reduce the risk of landslips; however, tunnels introduce hazards associated with the risk of trespass, fire, explosion, flooding and subsidence. The fire prevention and access strategy will require specific consideration to address the event of emergencies.

A serious accident in the Little Liverpool Range tunnel would potentially involve temporary closure and significant expenditure for repair.

The construction of the tunnel may involve blasting activities using explosives. The risks associated with such activities are further described in Section 20.10.3.3.

20.10.2.3 Safety

Underground and overhead services

A total of 662 known utilities, pipelines and services have been identified within the hazard and risk study area (including one non-operational high-pressure pipeline (Santos)). Construction activities around existing services introduce a risk of service strikes of underground utilities (e.g. underground gas pipeline) during excavation or collision of plant and equipment with aboveground services (e.g. transmission line). Interactions with existing services could pose a risk to public and worker safety as well as the natural environment and habitat. Damage to or contact with services during construction could result in service outage to nearby communities and sensitive facilities, such as Gatton Hospital within 1 km of the Project alignment.

Impinging and rupturing the Roma to Brisbane gas pipeline near Helidon has the potential to result in fire or explosion risks.

Contaminated land

Construction activities in existing rail corridors generally have the potential to generate contaminated waste as a product of excavations and drainage construction. Connection to existing railways of the QR West Moreton System rail corridor is expected to produce asbestos containing waste material.

Acid sulfate soil (ASS) is considered a hazard as it can generate large amounts of sulfuric acid, iron, aluminium and, sometimes, heavy metals. Excavation activities can expose ASS and cause major impacts to the environment and to infrastructure in areas where ASS is present. Soil mapping of the area indicates that disturbance of ASS is unlikely during construction of the alignment. To further reduce the risk, the Project will avoid ASS where possible, and will managed impacts in accordance with Queensland and national guidelines.

Construction activities will also produce stockpiles of excavated spoil and construction waste residues at 5 km to 10 km intervals along the hazard and risk study area. Domestic waste can attract vermin, while hazardous construction wastes can pollute the surface water and or waterways if not appropriately managed.

During construction, the Project has the potential to result in contamination as a result of any spills or leaks from construction equipment and site compounds. There is also the potential for contamination to occur during operation, as a result of any fuel or oil spills, leaks from trains or transportation of hazardous materials. Although leaks are not expected to occur as part of normal operations, the extent and severity of any land contamination would be dependent on the freight. Leaks or minor spills that do occur would be expected to be confined to areas within the rail corridor.

Refer Chapter 9: Land resources for more detail on land contamination.

Bridges and viaducts

The Project comprises a total of 31 bridges, including: 13 rail-over-waterway; six rail-over-waterway-and-road; six rail-over-road; four road-over-rail; one rail-over-existing-rail and one pedestrian-over-existing-rail crossings. Bridge crossings will occur for existing major transport infrastructure such as the Warrego Highway, Seventeen Mile Road and Rosewood Laidley Road.

Structural failures of bridge crossings have the potential to impact major transport corridors and could cause harm to motorists, railway passengers and pedestrians. As the bridges will be used for freight transport of dangerous goods, collapse or damage to bridges can lead to falling of freight from elevated track, subsequently causing dangerous goods loss of containment and spills resulting in environmental damage.

The rail alignment and overbridges may also provide a route for passenger trains of up to 72 passengers. Failure to stop the en-route trains through the faulty overbridges can result in loss of life and societal impact.

Other Project hazards include falling and dropped objects such as objects thrown or double stacked freight containers.

Emergency access

The Project crosses rural residential areas, large-lot grazing areas and the mountainous terrain of the Little Liverpool Range. The increase in the number of construction vehicles and oversized machinery during construction has the potential to impact the existing fire trails within the vicinity of these locations, reducing access to bushfire response.

Additionally, construction activities may also introduce obstruction and congestion on adjacent (existing) public roads, which could impact private landowner evacuation during emergency incidents (e.g. bushfire). Failure to accommodate for emergency access or the provision of poor access can result in restricted emergency vehicle response options (e.g. ambulance and fire and rescue services), delay in response or rescue time and even fatality in the event of emergency.

During the operational phase, events such as wildlife entering Little Liverpool Range tunnel, tunnel subsidence, inundation of the tracks and structural failure have the potential to trap trains inside the tunnel. Although these events are considered to be relatively rare, personnel trapped in tunnel will require a means of escape such as emergency evacuation routes.

Similarly, for the 19 rail over water bridges if not designed correctly in the event of flooding, the Project may increase the extent or duration of flooding of local roads within Lockyer Creek floodplain, which could lead to road closure and restrict movement of emergency vehicles.

20.10.3 Dangerous goods and hazardous chemicals

20.10.3.1 Storage and handling

The storage and handling of hazardous chemicals introduce potential impacts associated with material properties such as flammability, corrosiveness and toxicity. Significant releases of hazardous chemicals can impact nearby sensitive receptors, particularly sensitive environmental areas and communities.

The hazardous chemicals expected to be used during construction activities will generally be limited to various combustible liquids associated with fuel and lubrication uses. These materials have the potential to contribute to fires, although the high flash points reduce the potential for small incidents to create significant consequences.

Although dangerous goods incidents are not expected to occur during construction, incidents would generally be limited to the local area of storage, although there is the potential for incidents to spread via waterways. Specifically, the laydown areas for the construction of bridges of Sandy Creek, Lockyer Creek, Laidley Creek and Western Creek water crossings are located on a floodplain with low-lying watercourses. There is potential for quick rising of water levels during heavy rainfall events, which may inundate the hazardous chemicals depot and flush away contaminants.

20.10.3.2 Freight dangerous goods

Operational transport of dangerous goods associated with freight activities has a risk of loss of containment during incidents such as derailment. Loss of containment of dangerous goods could have severe consequences depending on the location and type of goods. Minor leaks and spills are expected to be limited to within the rail corridor. There is the potential for significant loss of containment events to damage the environment through release of toxic, corrosive or flammable materials where the Project traverses areas of environmental sensitivity such as watercourses.

Incidents involving dangerous goods within the Little Liverpool Range tunnel have potentially significant safety risks for train operators. Fires and the release of harmful chemicals can result in injuries and fatalities. Other potential loss of containment from flammable liquid, solid or gas and toxic chemicals, can also create major incidents such as pool fire, jet fire, explosion or toxic release.

Although explosives are not intended for freight, ammonium nitrate may be transported as a Class 5.1 dangerous good, as long as a Licence to Transport has been obtained from the Queensland Explosives Inspectorate. When mixed with fuel, such as diesel, ammonium nitrate becomes a Class 1 explosive. Additionally, ammonium nitrate is at risk of explosion if exposed to a heat source or ignition source, especially when in a confined space. It is because of this that ammonium nitrate is considered a Security Sensitive Explosive under the Queensland Explosives Regulation 2017 when it meets the definition of Security Sensitive Ammonium Nitrate.

20.10.3.3 Explosives

Construction methodologies are evaluated by the Explosives Inspectorate against the requirements under the Explosives Act and AS 2187-1998—*Part 2* USE-2006 (Standards Australia, 1998 and 2006).

Explosives must be stored, handled and transported by licensed person as stipulated by the Explosives Act. Additionally, a range of explosive related activities require notification under the Explosives Act, including:

- Before undertaking a blast
- Before importing or exporting explosives
- When storing or interacting with stored explosives at explosive storage facilities and government activities
- When there are changes to buildings and vehicles related to the storage or transport of explosives
- After conducting an explosive trail.

Blasting explosives (including blast caps, detonators and boosters) and Security Sensitive Ammonium Nitrate are expected to be required during construction in order to achieve the requisite cutting depth in locations where hard rock is expected to be encountered. Explosives are likely to be transported, stored, handled and used during the construction phase of the Project. The potential hazards associated with these activities are identified above. The possible impacts associated with these hazards are as follows:

- Serious injury or death to workers and/or members of the public in the immediate vicinity of inadvertent detonation or as a consequence of residual geotechnical instability
- Damage to machinery, existing infrastructure and proximal structures (including residences)
- Health effects on workers and/or members of the public as a consequence of the generation of noise, vibration and dust.

For more detail refer Chapter 12: Air quality.

20.11 Initial mitigation

Hazard mitigation measures have been developed for the Project and will be applied throughout the Project lifecycle. Controls include mitigation measures incorporated into engineering and design development, in addition to management strategies and procedures for construction and operations.

Managing risks throughout the Project lifecycle will involve ongoing risk reporting, monitoring, reviewing and documenting. The Project will also ensure that the requirements of the *Safety Management System*, summarised in Section 20.4.2 are implemented and communicated to all personnel.

Chapter 23: Draft Outline Environmental Management Plan provides further context and the framework for implementation of these proposed mitigation and management measures.

20.11.1 Natural hazards mitigation

The Project traverses potential bushfire, flooding and erosion prone regions. In designing and implementing the Project, consideration has been given to the impacts of potential natural hazards. The Project design and operational systems will be developed to manage these hazards to minimise potential impacts to asset, health, safety and environment to so far as is reasonably practicable.

The potential impacts to environmental values throughout the Project lifecycle will be managed in accordance with ARTC's *Safety Management System*, e.g. *Emergency Management Procedure* (ARTC, 2019), Engineering Procedures, applicable Code of Practice; and relevant Australian Standards to ensure compliance with the legislative requirements, including the *Environmental Protection Act 1994* (Qld). Emergency management is discussed in Section 20.12.2.

20.11.1.1 Bushfire

ARTC operates rail infrastructure in bushfire hazard areas and has an established policy for bushfire hazards management. The existing ARTC Safety Management System and strategies including Section 17 (Right of Way) of the *Engineering Code of Practice—Right of Way* (ARTC, 2013c), *Fire Prevention Management* (ARTC, 2007) and *Total Fire Ban Engineering Procedures* (ARTC, 2018e) will be applied throughout the Project lifecycle to minimise damage to property and maximise the safety of people.

These procedures will be implemented in accordance with ARTC standards to minimise fire risk within the rail corridor. Specific design measures include the use of bare earth firebreaks, and the formation of dirt fire mounds. An approximate 5 m-wide strip of land on either side of the tracks will be clear from vegetation. Depending on site-specific requirements, ARTC will remove unsafe vegetation as necessary, which can include the use of weed control, spot spraying, slashing of high grass and pruning overhanging trees or large shrubs.

High fire risk activities such as hot work will be restricted as per the ARTC (2018a) *Total Fire Ban* procedure. A permit will be required to be submitted to the Queensland Fire and Emergency Services (QFES) office if hot work activities need to be carried out during maintenance. The ARTC *Fire Management Plan* (ARTC, 2007) and contingency plans will be in place to manage maintenance activities such as requiring notification of local fire authorities, checks that the work site is free of vegetation prior to hot works and that appropriate firefighting equipment (e.g. water tankers) and trained personnel are available.

The design of the Project will ensure adequate emergency service access during construction and operation. Consideration will be given to providing and maintaining access where local roads can facilitate emergency access, first response firefighting, accessible and sufficient water supply for firefighting purposes and safe evacuation.

Local fire authorities and local emergency services will be consulted to ensure appropriate operational actions are taken, such as providing feedback on the firefighting vehicles accessibility, *Fire Prevention Plans* and cooperation on burning-off activities.

For more detail on consultation with QFES refer Chapter 5: Stakeholder engagement and Appendix C: Consultation Report.

20.11.1.2 Flooding

The design and location of the Project will comply with ARTC standards such as *Track Drainage—Inspection and Maintenance* (ARTC, 2006), *Track Drainage—Design and Construction* (ARTC, 2013b), Section 10 (Flooding) of the *Engineering Code of Practice* (ARTC, 2011)—*Flooding* and Section ETD-10-01 (Automatic Rainfall Monitoring) of the *Engineering Code of Practice* (ARTC, 2010c). The Project will be designed to achieve a 1% AEP flood immunity and at the same time to minimise unacceptable impacts on the existing flooding and drainage regime.

Key strategies that have been adopted include:

- Using the existing rail corridor to avoid introducing further linear infrastructure across the floodplain
- Using bridge and culvert structures to maintain existing flow paths and flood flow distributions
- Locating and sizing bridge and culvert structures to avoid unacceptable increases in peak water levels, flow distribution, velocities and duration of inundation
- Including scour and erosion protection measures in areas determined to be at risk
- Construction staging to include construction of drainage structures before embankment sections.

In line with ARTC's *Track and Civil Code of Practice—Structures* Section 9 (Structures) of the *Engineering Code of Practice* (ARTC, 2017f), inspections will be carried out to identify defects and conditions that may affect waterway and drainage system capacity or indicate increased risk of flooding such as scour, blockages, debris build up, indication of floods overtopping a structure and culvert or drain damage or collapse.

For more detail on flooding refer to Chapter 13: Surface water and hydrology.

20.11.1.3 Climatic conditions

There are a number of opportunities for the reduction of greenhouse gas generation during construction and operation of the Project including:

- Optimising tunnel ventilation to reduce energy requirements during operation
- Selecting construction materials with low embodied energy
- Optimising the cut/fill balance for earthworks to minimise material transport requirements
- Providing driver assistance systems and speed management.

The Project will implement safety measures for the potential damage of tracks and assets as a result of extreme hot weather events, such as considering the use of elastic fasteners or heavier sleepers to reduce track buckling, selection of materials and colour to reduce heat load on trackside equipment and reducing train speed when trackside temperature exceeds 35 °C.

The Project design will also factor in the potential increase in flood risk arising from any increase in extreme rainfall as a consequence of climate change. Mitigation measures will be implemented to reduce potential future flood risks such as installing an early flood warning system to alert ARTC to impending flood risks, locating critical electrical systems (signalling and communications huts) above potential flood zones and the use of solar and battery devices to ensure uninterrupted operation of signalling and network communication in the event of power failure.

Prior experience of flooding at a location can raise awareness and allows for the implementation of new flood mitigation strategies, such as locating hazardous chemicals depot away from watercourses and flood zones. ARTC will also work towards minimising future risk in emergencies and engage with the local council and the Local Disaster Management Group. Section 20.12.2.4 outlines the consultation undertaken with the relevant emergency management authorities.

For more detail refer to Chapter 12: Air quality and Chapter 13: Surface water and hydrology.

20.11.1.4 Landslides, sudden subsidence, movement of soil or rocks

Design and ratings of earthwork and geotechnical structures including tunnel, culverts, viaducts, and bridges will be in accordance with geotechnical investigation findings and slope design as per Section 8 (Earthworks) and Section 9 (Structures) of the ARTC *Engineering Code of Practice—Earthworks and Structures* (ARTC, 2018h; ARTC, 2017f). Geotechnical structures and their stability, specifically track sections prone to earthwork instability, will be identified and managed in accordance with AS 5100-*Bridge Design* (Standards Australia, 2007), AS 7363-*Railway Structures* (Standards Australia, 2013b) and other applicable Australian Standards.

Regular earthworks inspections will be implemented to determine defects and conditions that may affect or indicate problems with the stability of earthworks such as fissures, rocks or debris on or near tracks, loss of track geometry, track subsidence, water seepage and damage to embankments.

Clearing of land and ground disturbance works to accommodate the construction of track work will be staged sequentially to minimise areas exposed to erosion and sediment risk, with specific consideration given to physical and topographical impacts including rocky and uneven terrain. Appropriate erosion and sediment control measures will also be implemented in accordance with a Construction Erosion and Sediment Control Plan. The location of temporary construction facilities has considered the presence of nearby flood areas and been selected to avoid unnecessary clearance of established vegetation where possible.

For more detail refer Chapter 13: Surface water and hydrology.

20.11.1.5 Wildlife

A Flora and Fauna Sub-plan has been prepared as part of the draft Outline EMP, which details wildlife management and impact mitigation actions. Measures of key importance include:

- Clearing of large hollow-bearing trees is minimised. Vegetation clearing is to be undertaken in a sequential manner, and clearing extents are to be clearly defined
- Biodiversity/fauna and flora management actions to be undertaken by suitably qualified personnel and inspection and corrective actions to be in place during construction and rehabilitation activities
- Siting of temporary construction facilities compounds, stockpiles, fuel storage, laydown areas, temporary access roads and staff parking in accordance with the conditions of approval for the Project, and located away from sensitive receptors where possible
- Temporary and permanent fauna fencing installed at locations, which are deemed required by design outcome, to limit fauna strike and fauna mortality risk and/or maintain habitat connectivity. The placement of fauna fencing will account for an appropriate clearance zone between adjacent vegetation and fauna fencing to limit opportunities for fauna to jump or climb from adjacent vegetation over the fence into the proposed works site and rail corridor.

The Flora and Fauna Sub-plan includes a requirement for the preparation of a Biosecurity Management Plan in compliance with the *Biosecurity Act 2014* (Qld) to detail pest and weeds management. The Biosecurity Management Plan will include:

- Requirements for pre-clearing surveys, including weeds, pest animal presence or risk of presence—map existing extent and severity of weed infestation and to determine weed management requirements
- Pest animal management (including fire ants in fire ant biosecurity zones), weed surveillance and treatment during construction and rehabilitation activities, and site hygiene and waste management to deter pest animals
- Pesticide and herbicide use, documentation and limitations on use
- Vehicle, machinery and imported fill hygiene protocols and documentation.

For more detail refer to Chapter 11: Flora and fauna and Chapter 23: Draft Outline Environmental Management Plan.

20.11.2 Project hazards mitigation

20.11.2.1 Health

Fatigue and heat stress

ARTC has an existing *Fatigue Policy* and the Project will adhere to the ARTC *Work Health and Safety Work Instruction for Fatigue Management* (ARTC, 2016e) to ensure conditions of work for personnel align with the *Work Health and Safety Act 2011* (Qld) (WHS Act). For any work that is required outside ARTC's *Work Health and Safety Work Instruction for Fatigue Management* (ARTC, 2016e), the likely level of additional risks involved will be assessed and appropriate risk control measures will be identified.

Asbestos

Older infrastructure and existing land within the Project construction site might contain asbestos. The Project will adhere to ARTC's *Work Health and Safety Work Instruction for Asbestos* (ARTC, 2016b), along with Safe Work Australia's *Model Code of Practice—How to Manage and Control Asbestos in the Workplace* (Safe Work Australia, 2018a) and Safe Work Australia's *Model Code of Practice—How to Safely Remove Asbestos*. (Safe Work Australia, 2018b). These policies will relate to any activities that could potentially disturb asbestos containing materials, specifically within existing rail environment of the QR West Moreton System rail corridor or within structures and rail infrastructure insulation, signal boxes, switchboxes and building fabric.

Construction activities likely to disturb asbestos will review the presence and requirement for specific controls for the work. Additionally, the Project will only engage with competent contractors who are appropriately licensed for asbestos disturbance work. In the event if there is uncertainty as to whether exposure standards may be exceeded or work may generate airborne fibres by any method, suitable management and mitigation measures will be implemented.

Respirable silica and other airborne contaminants

Exposure of construction workers to respirable silica and other airborne contaminants will be controlled through the use of construction dust suppression techniques (e.g. water sprays), use of suitable construction equipment and appropriate personal protective equipment (PPE) in line with ARTC *Work Health and Safety Work Instruction for Personal Protective Equipment* (ARTC, 2016c).

Speed limits will be enforced for unsealed, off road access tracks during dry and windy weather to reduce the formation of construction dust. Watering of work areas will be carried out as required as a dust suppression measure.

Vehicles and equipment used within the rail corridor during operations will be fitted with appropriate exhaust systems and will be maintained in good working condition to minimise pollutant generation.

The design of the tunnel will ensure sufficient natural ventilation provision to remove and treat diesel exhaust and dust generation associated with freight (e.g. coal freight). Air quality modelling has been performed to ensure that the tunnel ventilation system is appropriately designed such that it does not significantly impact surrounding sensitive receptors.

Although coal freight operations are not expected to generate excessive coal dust, the Project is expected to apply the measures required by the South West Supply Chain (West Moreton System rail corridor).

Refer to Chapter 12: Air quality for more detail.

Noise and vibration

The level of noise at a sensitive receptor will vary depending on the type of machinery in use, traffic in the area and separation distance. The Project has considered the location of sensitive receptors including residents of Helidon, Gatton, Laidley, Grandchester and Calvert and has generally tried to avoid introducing significant noise impacts.

Refer Chapter 15: Noise and vibration for specific considerations.

Noise and vibration sources from construction and maintenance work involving heavy machinery will incorporate appropriate noise mitigation equipment and devices including mufflers and acoustic barriers. Application of the ARTC *Asset Management System* (ARTC, 2018i) will maintain equipment in good working order to reduce the potential for offensive noise.

The Project will adhere to the ARTC Noise Management and Noise Strategy as well as the requirements of the draft Outline EMP (Chapter 23: Draft Outline Environmental Management Plan) and relevant sub-plans to reduce and manage noise as much as is possible through a range of noise management measures. Noise disruption from night works will be kept to a minimum and work will be undertaken as quickly and efficiently as possible.

20.11.2.2 Accidents

ARTC will manage critical pedestrian, road and rail safety risks during operation in accordance with the ARTC *Fatal and Severe Risk Program* (ARTC, 2017d) , as described in Section 20.4.2.3.

A Construction Environmental Management Plan (CEMP) will be developed for construction activities. The plan will include traffic management, and will incorporate a specific Construction Traffic, Transport and Access Management Sub-plan. The sub-plan will be developed in consultation with the Lockyer Valley Regional Council, Ipswich City Council and relevant Queensland Emergency Services.

For detailed controls and strategies, refer to Chapter 19: Traffic, transport and access.

Road incidents

The Construction Traffic, Transport and Access Management Sub-plan will include the approach to segregation and work method plans to ensure sufficient separation of pedestrians from traffic hazards. These will include provision of roads and footpaths in accordance with ARTC Standards. Specific hazard control measures to be applied include clearly defined access for vehicles and pedestrians around the rail corridor and the provision of gating for all corridor access points to prevent unauthorised entry.

Construction workers operating vehicles at the Project will be trained and authorised. Traffic will be controlled by the provision of adequate crossing points, demarcation, signage and speed limits. Positive communication and give way rules in accordance with the Construction Traffic, Transport and Access Management Sub-plan will be adopted to reduce risk of vehicular interactions.

The arrangement and layout of temporary laydowns will consider vehicle access sight lines. Storage areas and equipment laydowns will be maintained in good condition to maintain visibility for vehicles accessing the area.

Rail incidents

The design of the railway will be in accordance with relevant Australian Standards, including railway radius curves and vertical grades to be designed to prevent uncontrolled movement of rolling stock. Structures, earthworks, track geometry and lateral track stability will be designed in accordance with relevant ARTC Engineering Code of Practice requirements, to ensure safe trackwork.

The construction of crossing loops in the Project alignment will increase rail safety. Crossing loops arrangements allow for the separation of trains and facilitate movement in each direction simultaneously. Track spacing has been designed to accommodate the expected train types and freight loading.

The Project will implement the ARTC train control system. The train control system is used in other ARTC operated railways to improve network capacity, operational flexibility, train service availability, transit times, rail safety and system reliability. Track design will incorporate a trackside monitoring system, which will detect faults in the wheel set and monitor rail wheel condition and defects at locations which are deemed required by the design outcome.

Appropriate operations and maintenance plans will be developed to ensure communication and manage risk associated with QR interfaces, particularly in connection to the QR West Moreton System rail corridor.

Safety elements for double stack freight trains such as loading requirements, centre of gravity and inspections for rolling stock are required to meet the ARTC *Rolling Stock Outlines and Loading Requirements* (ARTC, 2018f) to ensure stability and prevent excessive movements of loads and containers during train movements or severe weather events.

Level crossing and pedestrian safety

Each road–rail interface has considered pedestrian safety and operational needs. Four road-over-rail and 13 rail-over-road grade-separated intersections are anticipated. The installation of grade separation removes the interaction between rail and road traffic, by locating the traffic on different levels (e.g. a rail bridge over road). Where grade separation is not practical, the design applies recognised engineering design practices in accordance with Section 16 (Level Crossings) of the ARTC *Engineering Code of Practice—Level Crossings* (ARTC, 2011b). Additional physical controls such as boom gates and warning lights will be provided in accordance with the code of practice. Seven active level crossings are proposed for the Project. These crossing points have also been the focus of safety in design studies and risk assessments in accordance with the *Australian Level Crossing Assessment Model* (ALCAM) (Transport for NSW, 2016a) to identify and reduce as far as practicable potential risks associated with these crossings.

Grade separation is proposed at the Airforce Road road–rail interface point to reduce security and public risks associated with queued explosive vehicles at level crossings. ARTC will continue to consult with the Department of Resources (former Department of Natural Resources Mines and Energy (DNRME)) regarding this interface point.

The design of pedestrian level crossings similarly applies recognised engineering practice and ARTC requirements. ARTC has considered physical risk controls such as pedestrian sighting distance, grade separation, provision of booms and access exclusion measures such as fencing. Fencing will be provided where the rail corridor passes through the vicinity of private properties or where a specific risk of pedestrian access has been identified.

Following construction, ARTC will conduct routine inspections of crossing infrastructure, and will regularly review crossing performance and incident information to identify and remedy potential hazards.

ARTC is also committed to continued delivery of railway safety messages to the community, through awareness activities, community engagement activities and campaigns to increase public awareness. Fact sheets and guidelines are also available on the ARTC website, which aim to provide guidance to the community about safety around level crossings. Appropriate operational communication and education will be implemented prior to the commencement of operations to provide information about ARTC operations and safety.

In the event of trespass or vandalism on the ARTC rail corridor, ARTC Security Patrols and trackside staff will be empowered to instruct intruders to leave the corridor immediately. As required, incidents will be reported to the Queensland Police Service for assistance and resolution.

Tunnel

The design of the Little Liverpool Range tunnel will be based on geotechnical assessment and detailed ground modelling along the Project alignment. Parameters such as space proofing, cross section, structure, design life and tunnel linings will also meet the requirement of relevant Australian Standards. If a relevant Australian Standard does not exist for the design of any element of the Project work, then relevant and appropriate international standards will be applied (meeting best practice).

Tunnel construction might require blasting work. The use of explosive substances will be managed meeting the requirements of the *Explosive Act*. Section 20.11.3.3 further discusses the control measures of explosive use.

The design of the Little Liverpool Range tunnel incorporates natural ventilation requirements to facilitate heat control. The current design considers indoor air quality levels and potential exposures for key contaminants. Refer Chapter 12: Air quality for more detail on air quality limits.

The fire and life safety elements of the tunnel will incorporate fire resistance levels of 120 minutes when tested with the Rijkswaterstaat (RWS) temperature time curve, if it is a load bearing element, or achieve - /120/120 if not a load-bearing element. Additionally, emergency telephones will be provided inside the tunnel and longitudinal egress passage. Other safety equipment and devices, such as emergency exit stairways, emergency lighting, fire doors, hydrants and extinguishers will be provided. The design of the tunnel systems includes mitigation measures such as limiting the amount of combustible materials for construction, provision of fire detection systems, bi-directional longitudinal tunnel ventilation, prevention of trains that have derailed from entering the tunnel and prevention of trains on fire stopping in the tunnel.

20.11.2.3 Safety

Underground and overhead services

Site investigations and visual inspections of the hazard and risk study area have been undertaken to identify underground and overhead service hazards. Inspections have focused on identifying soil conditions, trenches, pits, bores, standing water and any potentially dangerous obstructions which may impact on the safe execution of construction work. Inspections have been undertaken in accordance with ARTC's *Underground/Overhead Services Work Method Statement* (ARTC, 2016a).

The Project will lodge a Dial Before You Dig enquiry before extraction or drilling work, which provides information about underground services on the worksite. Procedural control for the Project will ensure that excavation work will comply with Safe Work Australia's model *Code of Practice—Excavation Work* (Safe Work Australia, 2018d).

Overhead transmission lines and buried telecommunication cables will be managed to satisfy the requirements of the *Electrical Safety Act* 2002 (Qld) and subordinate legislation and Safe Work Australia's model *Code of Practice—Managing Electrical Risk in the Workplace* (Safe Work Australia, 2018c). The ARTC's Engineering Standard for *Requirements—Electric Aerials Crossing ARTC Infrastructure* (ARTC, 2005a) requires that all structures supporting a span of electric aerials over ARTC railway track or sidings be located that in the event of failure, no part of them will fall within 1.8 m of the outside rail of any railway track.

The Project will also comply with the clearance distance as specified in the ARTC's Engineering Standard for *Requirements— Electric Aerials Crossing ARTC Infrastructure* (ARTC, 2005a) to ensure sufficient clearance and prevent contact with live electricity.

Contaminated land

Registered contaminated sites, hazardous facilities, landfills, areas of dryland salinity and acid sulfate soil risk have been assessed for the hazard and risk study area. The risks will be reviewed before execution of any excavation work.

A Contaminated and Hazardous Materials Management Plan will also be implemented to ensure personnel health risk is managed and pollution to the natural environment is minimised. In the event that contaminated sites are identified during the course of the construction activities, incident notification and action plans will be carried out promptly.

Waste generation from construction activities, such as concrete wastage, steel waste and sewage can potentially contaminate the land and will be managed in accordance with the Waste and Resource Management Sub-plan and ARTC's *Environmental Policy* (ARTC, 2014b). Waste materials that are known to attract vermin will be stored and handled in a hygienic manner before removal by a licensed waste removal contractor. Hazardous (regulated) waste, such as hydrocarbons and hydrocarbon contaminated products (e.g. oily waste or oil filters), will be collected and disposed of by a licensed waste transporter. Concrete waste and residue will be collected as appropriate to prevent spillage to areas that can restrain water flow.

For more detail refer to Chapter 21: Waste and resource management.

Overbridges

Risk of ballast dropping from rail over road bridges, such as Warrego Highway and Rosewood Laidley Road will be mitigated by incorporating the track design with ARTC's Construction Specifications, such as Section 4 (Ballast) of the *Engineering Code of Practice—Ballast* (ARTC, 2012b). This will ensure that the ballast kerb profile on the overbridge for concrete sleepers will achieve sufficient height to maintain the ballast on the rail over road bridge for their corresponding nominal freight speed.

Emergency access

Emergency access, especially in the Little Liverpool Range tunnel, will be addressed by developing an access strategy. Consideration will be given to the use of the maintenance access road by emergency vehicles when evaluating the position of corridor access points.

To facilitate emergency egress, multiple access points into and out of the rail corridor will be provided. This will include the consideration for the access of three pumpers, one rescue/incident control appliance, one urban rescue tender and one urban hazmat medium in the event of a major train tunnel incident (QFES, 2018).

Further discussion of tunnel emergency access can be found in Section 20.11.2.2 and Chapter 19: Traffic, transport and access.

Safe corridor access and vehicle turnaround points will be provided for maintenance work to ensure sufficient setback while working adjacent to live railway. Maintenance and emergency access roads will be designed to allow separation to prevent interaction between trains and vehicles without impeding escape or rescue activities.

A Traffic, Transport and Access Sub-plan (refer Chapter 19: Traffic, transport and access) will be in place during construction to manage construction traffic and minimise impacts to surrounding land users. Construction access management will also consider the presence of fire trails and emergency access routes to prevent restriction of access availability.

20.11.3 Dangerous goods and hazardous chemicals

20.11.3.1 Chemicals spillage and loss of containment

Chemicals used will be limited where possible, including the storage inventory. Chemicals stored and handled as part of construction or operations activities will be managed in accordance with the WHS Act and WHS Regulation, the relevant Australian Standards and the requirements of the chemical safety data sheets. Safety data sheet information will be obtained from the supplier of these chemicals and stored in an easily accessible location.

The location of construction stores containing hazardous chemicals has been selected in accordance with the requirements of the SPP. The locations of hazardous chemical stores have been selected so that the stores are not within flood zones and sensitive habitat areas. Additionally, the locations of construction facilities, where vehicle maintenance and refuelling activities are expected to take place, have been selected to achieve appropriate separation to riparian vegetation and waterways.

Standard procedures for the storage, containment, disposal and spills response for chemicals will be managed in accordance with their applicable Australian Standards, such as AS1940-2017 *Storage and Handling of Flammable and Combustible Liqui*d (Standards Australia, 2017) and AS 3780-2008 *Storage and Handling of Corrosive Substance* (Standards Australia, 2008).

Procedures for the management of hazardous chemical spills and leaks will be developed in accordance with ARTC emergency management requirements. The relevant emergency services will be consulted as required and the procedures will meet the requirements of the DES. In line with ARTC's *Work Health and Safety Work Instruction for Chemicals* (ARTC, 2016d), the Inland Rail Incident Management Plan will provide the following:

- A site map that indicates where hazardous chemicals are located
- Consideration as to whether fire protection systems are appropriate for where hazardous chemicals may be stored
- Consideration of whether hazardous chemicals may affect where an evacuation point should be (e.g. is there a risk of fire, explosion or toxic fumes)
- Consideration of any specific emergency equipment or safety equipment needs (e.g. type of fire extinguisher, required first aid kit contents, and whether emergency showers or eyewash stations are needed, and best location for such equipment)
- Spill kits for the appropriate chemicals (e.g. hazardous chemicals (Hazchem), general, aquatic and marine spill kits), adequately signed, located and staff to be trained in the use of spill kits (chemical compatibility)
- The spill response controls and clean up procedures as per the provision of their safety data sheet, ensuring environmental harm is minimised
- Environmental incident checklist and Communication Plan in the event of reportable environmental incident arising from major spills, such that a procedure prepared to ensure that emergency services can be told of the location, types and quantities of the hazardous chemicals
- The Project will be managed to ensure that only Australian Pesticides and Veterinary Medicines Authority-approved chemical products will be used for operational weed spraying
- A CEMP will be developed prior to construction work beginning.

During the construction phase of the Project, dangerous goods will be required at construction sites and facilities. Licensed transporters operating in compliance with the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (National Transport Commission, 2018) will be used for dangerous goods deliveries.

The ARTC's *Work Health and Safety Work Instruction for Chemicals* (ARTC, 2016d) will be applied for all maintenance activities requiring the transport of dangerous goods within the rail corridor. The work instruction includes the following control measures to reduce the risk associated with dangerous goods storage and transport:

- Where practical, dangerous goods will be transported in their original packaging and stored separately from one another on the vehicle, specifically detonators
- All dangerous goods will be adequately restrained within the vehicle's confines to prevent movement during transit (e.g. gas bottles restrained to headboard or in designated ventilated storage compartments)
- The combined (aggregate) quantity of dangerous goods will not exceed 1,000 litres (L) or 1,000 kilograms (kg)
- Any individual receptacle used for transporting dangerous goods will have capacity less than 500 L/kg or dangerous goods licensing for both the vehicle and driver will apply
- All vehicles carrying mixed loads of dangerous goods will display the appropriate mixed-class placard at least on the front and rear of the vehicle
- The vehicle will be fitted with appropriate safety equipment for the load as per ARTC transport documents, including double-sided triangle reflector signals, fire extinguishers and PPE
- Emergency information holder containing the Initial Emergency Response Guide and dangerous goods transport and consignment documents.

20.11.3.2 Freight dangerous goods

The Project rail corridor is intended to be used for the freight of all classes of dangerous goods, excluding products and substances deemed to be an explosive under the Explosives Act, due to the Little Liverpool Range tunnel. During operation, the transportation of Class 1 explosive dangerous goods through the tunnels will be prohibited. The design of the tunnel accounts for the presence of dangerous goods in the specification of safety features (refer Section 20.11.2.2).

The freight transportation of dangerous goods on the Project will be in accordance with the Australian Dangerous Goods Code (National Transport Commission, 2018). Freight carts will be required to display appropriate Hazchem signage, including placards, and carry appropriate spill containment equipment to be used by emergency services personnel in the event of an emergency. Spill control and management plans will be maintained for these events. Refer Section 20.12.2 for more detail.

In addition, train operators will also comply with the ARTC Inspecting Trains policy, such that inspections of dangerous goods loading (e.g. restraining of packages, segregation of dangerous goods), brake conditions and train integrity are compliant with the ARTC Train Operating Conditions manual, before and during travel on ARTC Network. Details of the train's consignment or content will also be provided to the ARTC Network Control.

20.11.3.3 Explosives

Where explosives are used for construction, the works will be undertaken by licensed shotfirers in accordance with the Explosive Act. Licensed shotfirers will notify an explosives inspector in writing of any blasting activity at least seven days before the proposed blasting activity is carried out. The record of the amount and the type of explosives purchased and used, and a record of each blast conducted by the shotfirer will be kept in accordance with legislative requirements.

Blasting experts will be responsible for identifying safe blast design, control of access, including temporary site road closure, and evacuation warnings before blasting.

The training and management of the blast crew will be required to ensure personnel involved in blasting activities have the appropriate knowledge and skills. Safety procedures will be strictly adhered to on site to limit the probability of dangerous detonation events. All tunnel construction personnel will use appropriate PPE as well as observe safe distances during blasting activities.

Proper stemming (sealing of blast holes) 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 be carried out by a licensed explosive contractor or shotfirer, in accordance with *AS 2187—Explosive—Storage, Transport and Use* (Standards Australia, 1998).

At all times, the handling and use of explosives will incorporate procedures to:

- Prevent misfire
- Minimise the risk associated with material projected by a blast
- Minimise adverse effects of ground vibration and shock waves caused by a blast
- Ensure explosives are not used after either the manufacturer's recommended shelf life or the approved, extended shelf-life
- Ensure the security of an explosive used in blasting activities
- Ensure public safety, vehicular access and security
- Identify other activities within proximity of explosive use
- Identify the environment of explosive use, including flood, bushfire, landslide zones.

WH&S Management Plans are to include appropriate measures to manage risk associated with blasting such as exclusion zones, trails, and buffers.

20.11.4 Summary of mitigation measures

A summary of mitigation measures developed for the Project are listed in Table 20.9 and are outlined in further detail in Chapter 23: Draft Outline Environmental Management Plan.

TABLE 20.9: INITIAL MITIGATION OF RELEVANCE TO HAZARD AND RISK

Aspect	Initial mitigation
Natural hazards	
Flooding	▸ The Project has been designed to comply with ARTC standards such as: ▸ *Engineering Practice Manual for Track Drainage—Inspection and Maintenance* (ARTC, 2006) ▸ *Engineering Practice Manual for Track Drainage—Design and Construction* (ARTC, 2013a) ▸ *Engineering Practice Manual—Flooding* (ARTC, 2011b) ▸ *Engineering Practice Manual—Structures* (ARTC, 2017f) ▸ *Engineering Code of Practice—Flooding and Automatic Rainfall Monitoring* (ARTC, 2010c). ▸ The Project has been designed to achieve a 1% Annual Exceedance Probability flood immunity and at the same time to minimise unacceptable impacts on the existing flooding and drainage regime, with the exception of connections to existing infrastructure that has an existing lower immunity ▸ Key strategies that have been incorporated into the design include: ▸ Use of bridge and culvert structures to maintain existing flow paths and flood flow distributions ▸ Locating and sizing bridge and culvert structures to avoid unacceptable increases in peak water levels, velocities and duration of inundation ▸ Inclusion of scour and erosion protection measures in areas at risk ▸ Flash flooding—Drainage design has been undertaken to control cross flow and longitudinal flow from local and regional catchments to ensure the rail alignment has the required immunity and there are minimal impacts upstream.
Climatic conditions	▸ The Project has been designed to comply with operation and maintenance practices such as ARTC's Standard Managing Track Stability (ETM-06-08) (and associated standards) provide the means for managing buckling force by establishing and re-establishing if necessary, the correct stress-free temperature, and managing the track resistance to buckling. ETM-06-08 includes preparation of Track Stability Management Plans (TSMP), required for each section of track, which outline the activities to ensure track stability during hot weather. The plans are reviewed at the end of the high temperature season each year at which time the trigger temperature for imposing speed restrictions and undertaking inspections is re-evaluated. Annual review of the TSMP will provide a currency in management practice through changes in seasonal conditions. The reference track structure design has allowed for temperature-based adjustment in operation particularly with regard to rail stress, to minimise chance of buckling incidents. This is an ongoing procedure that provides adequate track management in changing seasonal conditions.
Landslide, sudden subsidence, movement of soil or rocks	▸ Design and ratings of earthwork and geotechnical structures including culverts, viaducts, and bridges has been developed in accordance to geotechnical investigation findings and slope design. ARTC existing requirements that the Project complies with include: ▸ *Engineering Code of Practice—Earthworks* (ARTC, 2018c) ▸ *Engineering Code of Practice—Structures* (ARTC, 2017e) ▸ *AS 5100 Set-2017 Bridge Design* (Standards Australia, 2007) ▸ *AS 7636-2013 Railway Structures* (Standards Australia, 2013b) ▸ Other applicable Australian Standards.
Project hazards	
Respirable silica and other airborne contaminants	▸ The design of the tunnel has ensured sufficient natural ventilation is achieved considering the presence of diesel exhaust and dust generation associated with freight (e.g. coal freight). ▸ Air quality modelling has been performed to ensure that the tunnel ventilation is appropriately designed such that it does not significantly impact surrounding areas.

Aspect	Initial mitigation
Rail incidents	▸ The elements of the railway including railway radius curves and vertical grades has been designed to prevent uncontrolled movement. ▸ Rolling stock will be designed in accordance with applicable industry and Australian Standards and ARTC requirements.

Road–rail interfaces	▸ The appropriate road–rail interface treatment has been assessed case-by-case for design purposes, with consideration given to current and future usage, its location relative to other crossings of the rail corridor and the road and rail geometry at the crossing location.
	▸ In the development of the proposed treatments, ARTC has also taken into consideration State and national guidelines and strategies.
	▸ Treatments for public road–rail interfaces can be categorised as:
	  ▸ Grade-separated crossings—road and rail cross each other at different heights so that traffic flow is not affected.
	▸ Level crossings—road and rail cross each other at the same level. Level crossings have either passive or active controls to guide road users:
	  ▸ Passive—have static warning signs (e.g. stop and give way signs) that are visible on approach and are unchanging with no mechanical aspects or light devices
	  ▸ Active—flashing lights with or without boom barriers for motorists, and automated gates for pedestrians. These devices are activated prior to and during the passage of a train through the level crossing.
	▸ Crossing consolidation, relocation, diversion or realignment—existing road–rail interfaces may be closed, consolidated into fewer crossing points, relocated or diverted. Roads will only be closed where the impact of diversions or consolidations is considered acceptable, or the existing location is not considered safe and cannot reasonably be made safe. Approval for closures, where required, will be progressed in accordance with the requirements of the relevant legislation.
	▸ The Project will be fenced with three- or four-strand barbed wire fence except where fauna fencing is specified. The fencing is reflective of the largely agricultural land use of the Project and seeks to ensure that stock and people do not enter the railway line. It is also consistent with fencing used in other sections of the railway line. Where superior fencing is required near roads or where trespass is likely to occur, a 1.8 m chain wire fence is proposed.
	▸ To assess potential level crossings locations, ARTC uses ALCAM, which considers factors such as future road traffic numbers, vehicle types, typical train numbers, speeds and sighting distances.

Tunnel	▸ The design of the Little Liverpool Range tunnel has been based on geotechnical assessment and detailed ground modelling. Parameters such as space proofing, cross section, structure, design life and tunnel linings will meet the requirement of relevant Australian Standards. ▸ The tunnel has been designed with natural ventilation for management of heat, particulate matter, and gases. Key design considerations include maintaining air quality parameters below regulatory specified Time-Weighted Average and Short-Term Exposure Limit.
Underground and overhead services	▸ Site investigations the corridor have been undertaken to identify underground and overhead service hazards. Inspections have focused on identifying soil conditions, trenches, pits, bores, standing water and potentially dangerous obstruction, in accordance with the ARTC *Underground/Overhead Services Work Method Statement* (ARTC, 2016a).
Contaminated land	▸ Potential sources of contamination including registered sites, hazardous facilities and known areas of dryland salinity and ASS risk have been identified within the corridor and mapped using GIS.

Aspect	Initial mitigation
Gas and petroleum pipelines	▸ The Project design adopted a risk-based approach to assessment of utility and pipeline clashes, with consideration of the asset location, project design at the clash location (cut or fill), time, cost and operational requirements with regards to access. ▸ Discussions with Santos and APA, as outlined in Chapter 5: Stakeholder Engagement, in relation to pipeline assets in the Project area has resulted in the development of an approach to management and associated treatment of clashes identified during the design process. ▸ Consultation with APA has also resulted in the provision of interaction information, which details requirements for risk management in future design and construction when working around the identified clashes between transmission gas mains.

Overbridges	▸ Risk of ballast dropping from rail over road bridges, such as Warrego Highway and Rosewood Laidley Road has been mitigated by incorporating ARTC's Construction Specification into the track design, such and relevant ARTC *Engineering Code of Practice* documents. The ballast profile for concrete sleepers or timber sleepers will need to achieve sufficient height and width for their corresponding nominal freight speed.
	▸ Design to uphold the following ARTC and Australian Standards:
	  ▸ *Engineering Code of Practice—Earthworks* (ARTC, 2018h)
	  ▸ *Engineering Code of Practice—Structures* (ARTC, 2018f)
	  ▸ *AS 5100 Set-2007 Bridge Design* (Standards Australia, 2017)
	  ▸ *AS 7636-2013 Railway Structures* (Standards Australia, 2013b)
	  ▸ Other applicable Australian Standards.
	▸ If superior fencing is required, where trespass is likely to occur, a 1.8 m chain wire fence is proposed.

Abandoned mines and underground collieries	▸ The initial design of the alignment has considered the surrounding land uses and geological investigation in regard to known abandoned mines and underground collieries. ▸ To mitigate against the collapse of abandoned mines underneath the Project, the alignment has considered the surrounding land uses and geological investigation. Due to the investigation of land use and existing infrastructure associated with the Project, the risk of an unknown mine being underneath the alignment is considered highly unlikely. ▸ The reliability of mapping for both accuracy and completeness cannot be readily established and the possibility of unrecorded mine workings cannot be ruled out. As such, it is recommended that any activity in the proposed Project footprint includes a preliminary ground inspection for open shafts/adits and any other mine working features as a precaution.
Dangerous goods and hazardous chemicals hazards	
Freight dangerous goods	▸ The rail corridor is intended to be used for the freight of all classes of dangerous goods, excluding explosives (Class 1) as the railway passes through a tunnel. The design of the tunnel accounts for the presence of dangerous goods in the specification of safety features.

20.12 Residual risks

Considering the Project's location, topography and mitigation measures, the residual risks that remain medium to high include potential incidents related to:

- Flooding or storm events
- Dangerous goods freight transport
- Potential use of explosive for Little Liverpool Range tunnel construction
- Trespass, pedestrian and community safety
- Specifically, in tunnel, interface with live trains and derailment or involving private access route
- Overbridges
- Emergency access.

Other potential risks to people and environment, such as wildlife hazards, natural events, overbridge collapse, use of explosive and dust and vibration associated with general earthwork have been assessed with medium- or low-residual risks, given the low frequency of occurrence or minor impact in the event of such incidents occurring.

A risk management strategy will be developed to manage the potential for risks in the situation where the minimum distance from the sensitive receptors cannot be achieved. Further hazard analysis and ongoing communication and improvement strategies will also be carried out to enhance pedestrian safety during design development. Specific management plans listed in Section 20.12.1 will be developed in consultation with the relevant authorities and will be incorporated into the Program Safety Management System. This will serve to reduce the impacts and manage the risks of the Project.

20.12.1 Specific management plans

Both the CEMP and ARTC's Operational Environmental Management Plan (Operational EMP) will include requirements for managing hazardous substances and dangerous goods (refer Chapter 23: Draft Outline Environmental Management Plan and Chapter 9: Land Resources). These plans will cross-reference and/or be supported by other specific management plans that will be developed to further enhance environmental, health and safety values as the Project progresses:

- Some of these plans may be sub-plans to the CEMP and Operational EMP others may be standalone plans focusing on a particular aspect of proposed activities. Sub-plans to support CEMP will include, but not necessarily be limited to, the following: Hazard and Risk Sub-plan (including incident management and spill response) (refer Section 20.12.2)
- Traffic, Transport and Access Sub-Plan (refer Chapter 19: Traffic, transport and access)
- Contaminated and Hazardous Materials Management Plan (refer Chapter 9: Land resources)
- Reinstatement and Rehabilitation Plan (refer Chapter: 9: Land resources)
- Erosion and Sediment Control Management Plan (refer Chapter: 9: Land resources and Chapter 13: Surface water and hydrology)
- Surface Water Management Sub-plan (refer Chapter 13: Surface water and hydrology)
- Soil Management Sub-plan (refer Chapter 13: Surface water and hydrology)
- Groundwater Management Sub-plan (refer Chapter 14: Groundwater)
- Waste and Resource Management Sub-plan (refer Chapter 21: Waste and Resource Management).

These plans and their relationship to the Project CEMP and the Operation EMP are outlined further in the draft Outline EMP (refer Chapter 23: Draft Outline Environmental Management Plan).

20.12.2 Emergency management

ARTC's existing *Emergency Management Procedure* (RLS-PR-044) (ARTC, 2019), which provides a systematic approach to incident response and recovery or incident investigation on the ARTC network, will be applied to Inland Rail and the Project. As such, a Hazard and Risk Sub-plan will be developed to detail the procedures and resources with which emergencies related to the incidents identified in Table 20.10 and hazard types and potential impacts identified in Table 20.11 will be responded to and managed. ARTC *Emergency Management Procedure* (RLS-PR-044) (ARTC, 2019) will be used for emergency management including emergency response and emergency planning. The procedures required to manage incidents and emergencies are the responsibilities of ARTC and rail operators.

Security and crisis management will be developed for the Inland Rail network and will be in line with business continuity plans, which will be issue-specific.

20.12.2.1 Incident management

A Hazard and Risk Sub-plan will detail the response procedures and available resources to manage emergencies. The Hazard and Risk Sub-plan will be in accordance with the ARTC *Emergency Management Procedure* (RLS-PR-044) (ARTC, 2019) and will consider the requirements in relation to training, availability of resources and communication interfaces with relevant emergency organisations.

The Hazard and Risk Sub-plan will address the hazard types and potential impacts by Project phase identified in Table 20.11. An outline of the information to be included for each incident is outlined in Table 20.10.

TABLE 20.10: OUTLINE MANAGEMENT OF INCIDENTS IDENTIFIED

Aspect	Incident	Incident management outline
Bushfire	Damage to infrastructure, injury to workers or public from bushfire	▸ Follow ARTC's *Fire Prevention Management Procedure* (PP0167) (ARTC, 2007). ▸ Activities (including construction works) to stop in areas affected by bushfire. ▸ Construction workers to have access to firefighting equipment. ▸ Trains to be equipped with firefighting equipment. ▸ Emergency phones provided on trains to ensure drivers can reach emergency services in the event of a bushfire.
Flooding	Damage to infrastructure, potential for impacts to freight goods caused by flooding events	▸ Follow ARTC's Section 10 (Flooding) of the *Engineering Code of Practice* (ARTC, 2011a). ▸ Operations (including construction works) to stop in areas affected by flooding. ▸ Emergency phones provided on trains to ensure drivers can reach emergency services in the event of flooding.
Climatic conditions	Failure of infrastructure/derailment accidents i.e. track buckling resulting in loss of dangerous goods freight.	▸ Follow ARTC's *Track Stability Handbook* (ETN-06-01) (ARTC, 2017f) for track buckling incident management through managing track stability. ▸ Follow ARTC's *Accidents or Derailments—Actions to be Taken* (SMP 03) (ARTC, 2005b) in the event of a derailment. ▸ Emergency phones provided on trains to ensure drivers can reach emergency services in the event of derailment.
Landslide, sudden subsidence, movement of soil or rocks	Damage to infrastructure and worker/public injury from landslide, sudden subsidence, movement of soil or rocks	▸ Regular earthworks inspections will be implemented to determine defects and conditions that may affect or indicate problems with the stability of earthworks.
Wildlife	Wildlife injury or deaths from impact with Project worker injury from wildlife	▸ Emergency phones provided on trains and at construction sites to ensure workers can reach emergency services in the event of an animal attack. ▸ If safe to do so, leave area where animal attack occurred. ▸ Contact the local council (Lockyer Valley or Ipswich) for animal control services.
Biosecurity	Damage to biosecurity of surrounding environment due to propagation of invasive species	▸ Notify an inspector of a biosecurity notifiable incident under the Biosecurity Act 2014 (Qld).
Noise and vibration	Disruption to public from noise and vibration	▸ Noise and vibration sources from construction or maintenance work involving heavy machinery will incorporate appropriate noise mitigation equipment and devices including mufflers and acoustic barriers. ▸ Noise disruption from night works are kept to a minimum and work will be as quickly and efficiently as possible. ▸ Follow ARTC's *Asset Management System* (ARTC, 2018e) by maintaining equipment in good working order to reduce the potential for offensive noise.
Fatigue and heat stress management	Worker injury from fatigue and heat stress	▸ Follow ARTC's *Fatigue Policy* and Work Health and Safety's *Work Instruction for Fatigue Management* (ARTC, 2016e). ▸ Follow Safe Work Australia's *Guide to managing the risks of working in heat* (Safe Work Australia, 2020). ▸ Emergency phones provided on trains and at construction sites to ensure workers can reach emergency services.
Asbestos	Health impacts from asbestos	▸ Follow ARTC's *Work Health and Safety Work Instruction for Asbestos* (ARTC, 2016b), along with Safe Work Australia's model *Code of Practice—How to Manage and Control Asbestos in the Workplace 2018* (Safe Work Australia 2018b) and Safe Work Australia's model *Code of Practice—How to Safely Remove Asbestos 2018* (Safe Work Australia, 2018a). ▸ The Project will engage with competent contractors who are appropriately licensed for asbestos disturbance work.

Aspect	Incident	Incident management outline
Dust, respirable silica and other airborne contaminants	Impacts from dust, respirable silica and other airborne contaminants	▸ Inform relevant stakeholders with sufficient information to enable them to understand the likely nature, extent and duration of dust and emissions impacts.
Rail incidents	Rail accidents caused by increased rail movements	▸ Emergency phones provided on trains to ensure workers can reach emergency services. ▸ Follow ARTC's *Accidents or Derailments—Actions to be Taken (SMP 03)* (ARTC, 2005b) in the event of a derailment.
Road incidents	Road accidents caused by increased vehicles required for the Project	▸ Emergency phones provided on construction sites to ensure workers can reach emergency services.
Road–rail interface	Accidents due to increased number of road–rail interface	▸ Emergency phones provided on trains to ensure workers can reach emergency services.
Tunnel	Accidents due to construction of and rail use through the tunnel	▸ Emergency phones provided on trains and at construction sites to ensure workers can reach emergency services in the event of services strike. ▸ Comply with Safe Work Australia's *Guide for Tunnelling Work* (Safe Work Australia, 2013).
Bridges/ viaducts	Bridge/viaduct collapse or falling object strikes	▸ Emergency phones provided on trains and at construction sites to ensure workers can reach emergency services in the event of services strike.
Overhead and underground services	Worker injury from services strike at existing infrastructure and underground and overhead services	▸ Inform the owner of the service impacted as soon as possible. ▸ Emergency phones provided on trains and at construction sites to ensure workers can reach emergency services in the event of services strike. ▸ Lodge a Dial Before You Dig enquiry prior to excavation or drilling work. ▸ Comply with Safe Work Australia's model *Code of Practice— Excavation Work* (Safe Work Australia, 2018d).
Contaminated land	Health impacts to workers and public and environmental impact from contaminated land	▸ Notify the regulator as required, undertake an impacted site review, report site contamination to authorities as required, record the site contamination and develop and implement an action plan.
Abandoned mines and unrecorded underground collieries	Collapse of mine shaft or colliery leading to asset damage and/or injury	▸ Provide a site map that indicates where abandoned mines and/or underground collieries may be present, and plan evacuation assembly points where possible.
Emergency access	Impaired emergency access resulting in escalation of incident	▸ Plan and develop alternative means of access for use in emergencies.
Chemicals spillage and loss of containment	Loss of containment of dangerous goods during storage and handling	▸ Workers to assess the risk and respond appropriately. ▸ Leaders to assess severity of events and confirm relevant stakeholders are aware as appropriate. ▸ Follow ARTC's Work Health and Safety Work Instruction for Chemicals (ARTC, 2016d).
Freight dangerous goods	Loss of containment of freight dangerous goods and hazardous chemicals	▸ Report the incident to ARTC's *Network Control*. ▸ Follow ARTC's Work Health and Safety Work Instruction for Chemicals (ARTC, 2016d).
Explosives	Damage to infrastructure or injury or fatality caused by explosives incidents during blasting during construction or by adjacent operators	▸ Report the incident to ARTC's *Network Control*.

20.12.2.2 Emergency response

Throughout the life of the Project, emergency management will adhere to the ARTC's *Emergency Management Procedure* (ARTC, 2019). Where sources of emergency and disruption are foreseeable, the coordinated approach to the management of incident response will be based on the following components:

- A structured approach for initiating and implementing incident assessment, escalation and response
- The availability of trained and capable response personnel
- Appropriate and timely communications and decision making between site and ARTC management
- Debriefing sessions for incidents with the relevant emergency management authorities.

In the event of an incident or imminent threat, the nominee from whom the information was reported and ARTC management will assess the incident as Level 1, Level 2, Level 3 or Level 4. The categories of incidents are determined based on impact level following the incident:

- **Level 1**—An occurrence that has been classified as an emergency, requiring a sustained response, by Police or Fire Services.
- **Level 2**—An occurrence that involves or affects operations on the network, which has resulted in or has the potential to result in death or serious injury to a person, significant impact/damage to the environment, property or infrastructure. These incidents will require external resources, control and sustained coordinated response.
- **Level 3**—An occurrence where minor injury, disruption, damage or environmental impact to the network, has occurred. These incidents will not require a sustained response from other organisations or outside resources and will be managed and investigated by the line manager or the organisation involved.
- **Level 4**—An occurrence that has resulted in a small impact on the ARTC network. These incidents are nominally routine operational incidents and unsafe acts identified during safety observations.

The Incident Management Team will be available to manage threats including large-scale natural disasters and other type of incidents involving medical emergencies, such as electric shock, burn, height rescue, snake and insect bites, hazardous chemical spill and threats in accordance with ARTC's *Emergency Management Procedure* (ARTC, 2019). An appropriately trained Incident Management Team will be triggered to coordinate site restoration, unless Emergency Services are present. Emergency Services organisations may be in attendance, depending on the nature and magnitude of the incident. These services may take charge of an incident site. Where more than one Emergency Service attends, the site will be under the overall command of the Police Service, except in the event of a fire or dangerous goods spill, where the Fire Service will take charge. ARTC and Network Operators will work with these services, and as directed by them.

Following an incident, an incident investigation team will commence investigation of the incident. The incident investigation team will have the authority to take action to preserve any evidence that may be required to assist in the investigation, including requesting sections of the incident site to be quarantined from entry, delaying the restoration work until the completion of incident investigation and instigating interviews with personnel involved in the incident. All relevant data and information will be collected in a clear and concise manner to complete an investigation report.

Figure 20.5 illustrates the overview of the ARTC's approach to emergency management (including incident management and investigation).

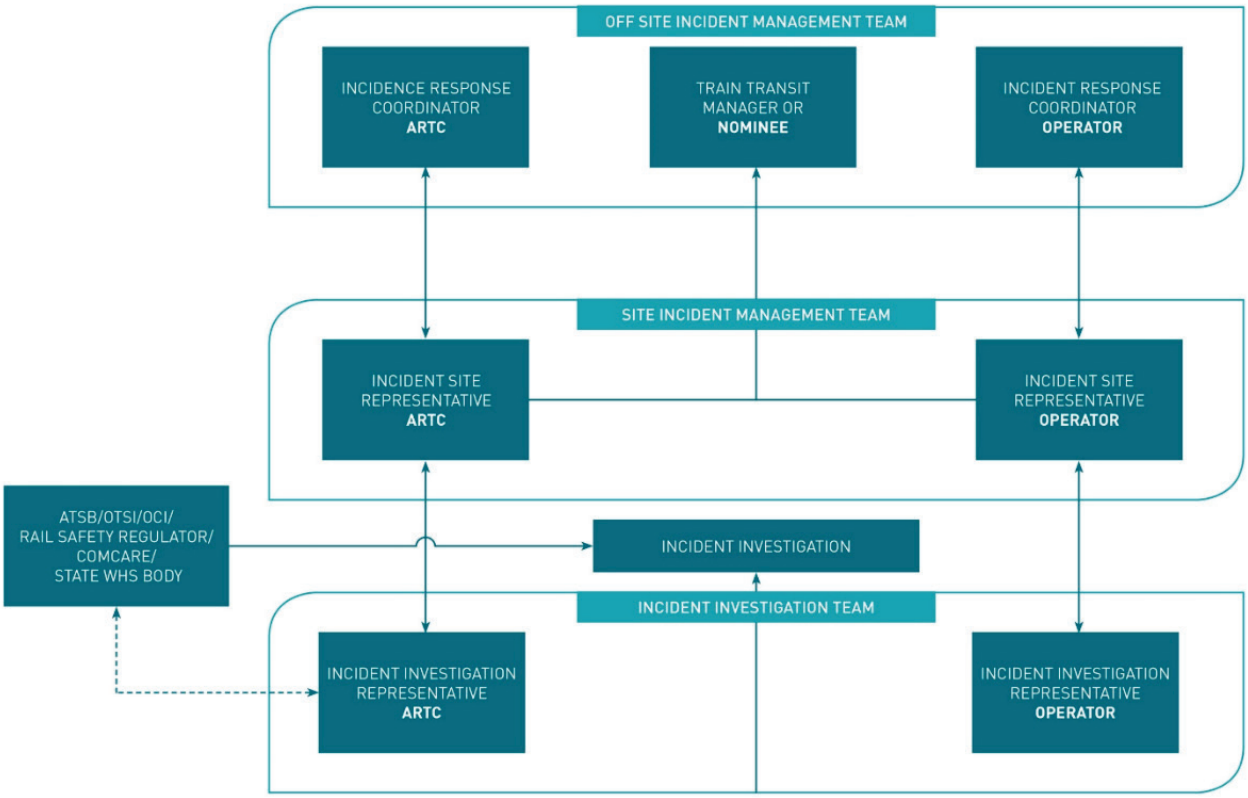

FIGURE 20.5: ARTC EMERGENCY MANAGEMENT OVERVIEW
Source: ARTC Emergency Management Procedure 2019 (RLS-PR-044) (ARTC, 2019)

20.12.2.3 Emergency planning

Emergency procedures will be tested to evaluate the effectiveness of emergency preparedness and response. Emergency procedure testing will involve desktop scenarios and procedural tests, through to complete organisation-wide simulated incident exercises involving emergency services, dependent on relevant emergency risk potential. Desktop test exercises will take place only when an actual event involving parties has not occurred within a two-year period.

Rail operators will obtain approval from ARTC prior to any exercise on the network with the potential to affect network operations. This includes activities conducted on adjacent rail networks with potential impacts on the ARTC network such as the West Moreton System rail corridor. A safety plan will be prepared for all exercises involving full-size equipment on the network.

Desktop and simulated test exercises will be designed to ensure that individually and collectively the Incident Management Procedures adequately address the requirements for emergency management and that the procedures are effectively integrated. The exercise will nominally evaluate communications response time, interface working relationship recovery mechanisms, procedures response and training needs that will then be used to amend the Hazard and Risk Sub-plan, where required. Pre-incident planning with external emergency responders will be undertaken.

Competency of ARTC personnel in emergency response roles will be ensured through competency training.

Appropriate, compliant and maintained first-aid equipment, consumables, trained personnel, facilities and medical support will be available to minimise any adverse impact on the health and safety of people or operations.

Incident management personnel will be visibly identifiable onsite to assist in the recovery and restoration in the event of an emergency. Urgent medical or emergency capabilities, including warning, communication and evacuation, will be provided in accordance with the Emergency Management Procedure.

The business-level ARTC *Emergency Management Procedure* (ARTC, 2019) will be used as guidance for an asset-specific integrated emergency management plan for the Project. This will be developed in later stage of the Project, closer to the construction of the asset.

20.12.2.4 Consultation

The Project has been and will continue to be developed in consultation with relevant emergency management authorities to ensure that external support will be provided by these services in an event of an emergency. These include:

- Ipswich and Toowoomba District Disaster Management Groups
- Ipswich and Lockyer Valley Local Disaster Management Groups
    - Membership of group includes: QFES, Queensland Ambulance Services, Queensland Police Service, State Emergency Services, Queensland Health, DTMR, National Broadband Network, Red Cross, Department of Communities, Housing and Digital Economy (former Department of Communities Disability Services and Seniors) and local councils
- Emergency Services including:
    - Police Station, Fire Station and Rural Fire Services
    - Queensland Police Services
    - Queensland Ambulance Services
    - Queensland State Emergency Services
    - QFES (Project updates and site tour).

Consultation and engagement activities focusing on engaging with the local community including landowners, Councils and regional community groups have been ongoing since 2017. Consultation activities have included providing information and gathering feedback from stakeholders and the local community allowing ARTC to gain an understanding of the issues and opportunities across the disturbance footprint.

Refer to Chapter 5: Stakeholder engagement, Chapter 16: Social, Chapter 22: Cumulative impacts, and Appendix C: Consultation Report for more detail.

20.12.3 Mitigation measures

Project-specific hazard and risk mitigation measures are detailed in in Table 20.11.

With proposed mitigations in place, the outcomes of the risk assessment are shown in Table 20.11. The risk rating for the hazard is the highest risk rating across risk categories of safety, environment, regulatory, and assets.

TABLE 20.11: HAZARD AND RISK MITIGATION MEASURES

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Detailed design	Natural	Bushfire	▸ Design to maintain appropriate access during construction and operation, ensuring local roads allow emergency access, first-response firefighting, access to water supply for firefighting purposes, and safe evacuation routes. ▸ A landscaping design to include (where possible) cleared land on either side of the tracks to act as a fire break.
	Natural	Flooding and flash flooding	▸ Work with stakeholders including directly impacted landowners, relevant community stakeholders and local councils to inform and refine assessments and design. ▸ Continue to refine Project design in response to hydraulic modelling. This includes consideration of peak water levels, flow distribution, velocities and duration of inundation. This will inform bridge lengths, culvert sizing and numbers, scour and erosion protection measures for both rail, road and other permanent Project infrastructure ▸ Review flood risk assessment to inform the siting and scale of temporary construction areas (including stockpiles, construction compounds, access roads, laydown areas). ▸ Locate plant, equipment maintenance activities and refuelling facilities in accordance with AS1940-2017 T*he storage and handling of flammable and combustible liquids* (Standards Australia, 2017)
	Natural	Landslide, sudden subsidence, movement of soil or rocks	▸ Incorporate batter slopes and scour protection into design.
	Natural	Climatic conditions	▸ The Project design will implement safety measures for the potential damage of tracks and asset as a result of extreme hot weather events, such as considering the use of elastic fasteners or heavier sleepers to reduce the risk of track buckling, selection of materials and colour to reduce heat load on trackside equipment. ▸ The Project design has been developed to achieve a design life of 100 years. In doing so, designs for formation, track and structures have been developed in accordance with the ARTC Codes of Practice. The management of temperature fluctuation would be assured by sourcing components that have the assurance from manufacturers that the components maintain integrity at the required or envisaged temperatures. ▸ Factor for the potential increase in flood risk arising from any increase in extreme rainfall as a consequence of climate conditions. Adaption strategies such as installing an early flood warning system to alert ARTC to impending flood risks, locating critical electrical systems (signalling, communications huts) above potential flood zones and considering the use of solar and battery devices to ensure uninterrupted operation of signalling and network communication in the event of power failure will be incorporated into the detailed design. ▸ Design for future climate, including consideration of existing ARTC protocols for operating in extreme temperatures. ▸ Sustainability initiatives, particularly in relation to energy consumption and savings throughout the Project lifecycle must be incorporated in detailed design.

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Detail design (continued)	Project	Rail incidents	▸ Track design will incorporate trackside monitoring systems, which will detect faults in the wheel set and monitor rail wheel condition and defects at various locations deemed necessary by the design team.
	Project	Underground and overhead services	The Project will also comply with the clearance distance as specified in the ARTC Engineering Standard for *Requirements—Electric Aerials Crossing ARTC Infrastructure* (ARTC, 2005a) to ensure sufficient clearance and prevent contact with live electricity. ▸ Design to confirm that the construction methods will not infringe on the Defence air space restrictions.
	Project	Gas and pipelines	The Project design will comply with the clearances or agreed risk mitigation design treatments developed through consultation with: ▸ APA ▸ Santos.
	Project	Road–rail interfaces	▸ Any physical controls such as boom gates and warning lights that have been determined necessary, will be detailed in the Project design. ▸ Detailed design of 1.8 m chain fencing is required near roads or where trespass risk is identified.
	Project	Emergency access	▸ Emergency access, especially in the Little Liverpool Range tunnel, will be addressed by the development of an access strategy. Consideration of the use of the maintenance access road by emergency vehicles will be made when evaluating the position of corridor access points. ▸ To facilitate emergency egress, multiple access points into and out of the rail corridor will be provided. This will include the consideration for the access of three Pumpers, one Rescue/Incident Control appliance, one Urban Rescue Tender and one Urban Hazmat Medium in the event of a major train tunnel incident (QFES, 2018). ▸ Safe corridor access and vehicle turnaround points will be provided for maintenance work to ensure sufficient setback while working adjacent to live railway. Maintenance and emergency access roads will be designed such that it will allow separation to prevent interaction between trains and vehicles without impeding escape or rescue activities.
	Project	Tunnel	▸ The fire and life-safety controls for the tunnel will include detailed design fire resistance level (load bearing elements to achieve 120-minute structural adequacy when exposed to the RWS temperature time curve, while non-load bearing elements are to achieve Fire Resistance Level of -/120/120, safety equipment and devices, such as emergency phones, emergency exits, emergency lighting, fire doors, hydrants and extinguishers. ▸ Tunnel design has incorporated fire and life safety mitigation measures, to ensure appropriate facilities are available. These mitigation measures include limiting the amount of combustible materials used in construction, providing fire detection systems, preventing derailed trains from entering the tunnel, and preventing trains that are on fire from stopping in the tunnel.
	Project	Abandoned mines and underground collieries	▸ Engage with Abandoned Mines Program in the Department of Resources (former DNRME) to identify potential risk of disturbance footprint interacting with abandoned or disused mines or underground collieries.

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Pre-construction	Project	Underground and overhead services	▸ The Project will identify known services that require relocation prior to construction. ▸ Site investigations and visual inspections of the hazard and risk study area will be undertaken to identify underground and overhead service hazards. Inspections will focus on identifying soil conditions, trenches, pits, bores, standing water and any potentially dangerous obstructions which may impact on the safe execution of construction work. Inspections will be undertaken in accordance with ARTC *Underground/Overhead Services Work Method Statement* (ARTC, 2016a). ▸ The Project will lodge a 'Dial Before You Dig' enquiry before extraction or drilling work, which provides information about underground services on the worksite. Procedural control for the Project will ensure that excavation work will comply with Safe Work Australia Model *Code of Practice—Excavation Work* (Safe Work Australia, 2018d). ▸ Overhead transmission lines and buried telecommunication cables will be managed to satisfy the requirements of the *Electrical Safety Act 2002* (Qld) and subordinate legislation and Safe Work Australia Model *Code of Practice—Managing Electrical Risk in the Workplace* (Safe Work Australia, 2018c). The ARTC Engineering Standard for *Requirements—Electric Aerials Crossing ARTC Infrastructure* (ARTC, 2005a) requires that all structures supporting a span of electric aerials over ARTC railway track or sidings be located that in the event of failure, no part of them will fall within 1.8 m of the outside rail of any railway track.
	Project	Contaminated land	▸ Registered contaminated sites, hazardous facilities, landfills, areas of dryland salinity and acid sulfate soil risk have been assessed for the hazard and risk study area. The risks will be reviewed before execution of any excavation work. ▸ Undertake contaminated land assessments and appropriate investigations for land identified as having known or suspected contaminated areas and prepare Contaminated Site Management Plan to document management controls for works on the relevant contaminated areas and outline the process to identify, document and manage each of the contaminated sites.
	Project	Asbestos	▸ Older infrastructure and previously disturbed land within the disturbance footprint may contain asbestos. The Project will adhere to Safe Work Australia's model *Code of Practice—How to Manage and Control Asbestos in the Workplace* (Safe Work Australia, 2018b) and Safe Work Australia's model *Code of Practice—How to Safely Remove Asbestos* (Safe Work Australia, 2018a). ▸ Survey of infrastructure that will be removed or disturbed by the Project will be conducted to potentially identify asbestos containing materials. ▸ Construction activities likely to disturb asbestos will review the presence and requirement for specific controls. ▸ The Project will engage with competent contractors who are appropriately licensed for asbestos disturbance work.
	Project	Bridges	▸ Ground surveys will be carried out with boreholes at all pier locations and abutment during construction early works to mitigate against bridge collapse.
	Project	Abandoned mines and underground collieries	▸ Develop measures for encountering unrecorded historic collieries (or voids or similar) under the 'Unexpected Finds Protocol/Procedure' as part of the CEMP. ▸ In the event an interface with abandoned mines or underground collieries is determined, develop a construction management strategy to minimise risk in consultation with the Department of Resources (former DNRME).

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Pre-construction (continued)	Project	Road–rail interfaces	▸ Crossing consolidation, relocation, diversion or realignment—existing road–rail interfaces may be closed, consolidated into fewer crossing points, relocated or diverted. Roads will only be closed where the impact of diversions or consolidations is considered acceptable, or the existing location is not considered safe and cannot reasonably be made safe. Approval for closures, where required, will be progressed in accordance with the requirements of the relevant legislation and road closure permits.
Construction and commissioning	Natural	Bushfire	▸ High fire risk activities such as hot works including flash-butt welding will be carried out in accordance with ARTC's *Fire Prevention Management Procedure* (ARTC, 2007), *Total Fire Bans Procedure* (ARTC, 2018d) and Section 17 (Right of Way) of the *Engineering Code of Practice* (ARTC, 2013b). These procedures establish processes to manage hot work/high fire risk activities, including observation of relevant QFES directives, check extent of work site vegetation prior to hot work, and ensure appropriate firefighting equipment and trained personnel are available. ▸ Depending on site-specific requirements, ARTC will remove unsafe vegetation as necessary, which can include the use of weed control, spot spraying, slashing of high grass and pruning overhanging trees or large shrubs.
	Natural	Flooding and flash flooding	▸ Construction staging to include construction of drainage structures before embankment sections to mitigate flooding potential during construction. ▸ Locate laydown areas away from creeks (such as the Western Creek, Lockyer Creek, Bremer River, Laidley Creek, Sandy Creek, Tent Hill Creek, and various other unnamed creeks).
	Natural	Landslide, sudden subsidence, movement of soil or rocks	▸ Implement a Soil Management Plan to manage the topsoil onsite, such that it can be reused in rehabilitation and landscaping activities, soil stockpiles are to be managed in accordance with erosion and sediment control plans. ▸ Regular earthworks inspections will be implemented to identify defects and conditions that may affect or indicate problems with the stability of earthworks. ▸ Clearing of land and ground disturbance works to accommodate the construction of track work will be staged sequentially to minimise areas exposed to erosion and sediment risk, with specific consideration given to physical and topographical impacts including rocky and uneven terrain. ▸ The period that soil is exposed will be minimised through progressive ground cover revegetation to minimise erosion. ▸ Temporary construction facilities will be sited to avoid flood areas, overland flow paths and minimise clearance of established vegetation where possible.
	Natural	Climatic conditions	▸ Consider opportunities for the reduction of greenhouse gas generation during construction. ▸ Laydown areas have been nominated along the length of the Project and at strategic locations, such as near the tunnel ports or structures. These will act as a centralised point for material storage, with some storing hazardous materials such as fuel. The locations of laydown areas have been chosen to avoid areas that are within the 1% AEP floodplains where possible. However, by virtue of the requirement of laydown areas for constructing bridges, some laydown areas must be within flood plains and near water sources. ▸ ARTC will work towards minimising future risk in emergencies and engage with the local councils and the Local Disaster Management Groups. ▸ Weather station environmental monitoring for all areas especially those subject to high winds. ▸ Construction water will be obtained from appropriate sources, with the necessary water entitlement, water allocation, water licence or water permit.

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Construction and commissioning (continued)	Natural	Wildlife	▸ Construction works will be undertaken in accordance with a Flora and Fauna Sub-plan.
	Natural	Biosecurity	▸ Develop and implement a Biosecurity Management Plan as part of the CEMP to include: ▸ Requirements for pre-clearing surveys to determine the risk of weeds or pest animals being present ▸ Maps of the existing extent and severity of weed infestation and weed management requirements ▸ Pest animal management (including fire ants in fire ant biosecurity zones) ▸ Site hygiene and waste management procedures to deter pest animals ▸ Weed surveillance and treatment during construction and rehabilitation activities ▸ Requirements in relation to pesticide and herbicide use and documentation, including any limitations on use, such as, restrictions on use in sensitive environmental areas, drainage lines that flow to waterways and aquatic habitats, and ensuring that broad scale use does not result in an increased erosion and sediment risk ▸ Vehicle, machinery and imported fill hygiene protocols and documentation ▸ Erosion and sediment control risks associated with broad scale weed removal or treatment.
	Project	Fatigue and heat stress management	▸ Ensure construction management plans, systems, workplace conditions and facilities align with requirements of the *Work Health and Safety Act 2011* (Qld). ▸ Follow Safe Work Australia's, *Guide to managing the risks of working in heat* (Safe Work Australia, 2020).
	Project	Asbestos	▸ Depending on the type and amount of asbestos containing materials, if they are disturbed by the Project, the Project will engage with a Class A or Class B licensed asbestos removalist for the handling and disposal of asbestos. In the event if there is uncertainty as to whether exposure standards will be exceeded, or work will generate airborne fibres by any method, air monitoring will be carried out by appropriately qualified personnel.
	Project	Dust, respirable silica and other airborne contaminants	▸ Direct construction worker exposure to respirable silica and other airborne contaminants will be controlled through the use of appropriate personal protective equipment. ▸ Where sensitive receptors, agricultural land uses or protected vegetation are located within close proximity (350 m from the boundary of construction works, or 50 m from a construction haul route), or where visible dust is generated from vehicles using unsealed access roads, watering or other appropriate controls are to be implemented. ▸ Cover vehicles transporting potentially dust and/or spillage generating material to and from the construction site immediately after loading (prior to traversing public roads). ▸ Where necessary, use additional controls such as wheel wash and/or rumble grids at site entrances. ▸ Limit clearing to the disturbance footprint. ▸ Where practical, stage clearing and grubbing and construction activities to minimise exposure to erosive processes. ▸ Implement controls to prevent and/or minimise dust generation during activities involving excavation or disturbance of soils or vegetation, or handling ballast (i.e. use water sprays or water carts for dust suppression as required). ▸ Avoid ground-disturbing activities during windy conditions (i.e. winds >10 m/s) or when prevailing winds are likely to result in dust impacts to sensitive receptors. ▸ Implement additional dust suppression controls prior to the onset of adverse weather. This may include covering of stockpiles and additional watering of access roads. ▸ Longer term material stockpiles will be suitably treated to prevent risk of windborne erosion and dust.

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Construction and commissioning (continued)	Project	Noise and vibration	▸ The Project will develop and adhere to a Construction Noise and Vibration Management Plan as part of the CEMP. ▸ Noise and vibration sources from construction involving heavy machinery will incorporate appropriate noise mitigation equipment and devices including mufflers and acoustic barriers. The Project will reduce and manage noise as much as is possible through a range of noise management measures. Noise disruption from night works are kept to a minimum and work will be as quickly and efficiently as possible.
	Project	Road incidents	▸ A Traffic, Transport and Access Sub-plan will be implemented to identify the impacts that construction traffic is likely to have on the transport infrastructure and detail ameliorative measures required to mitigate all identified impacts of the development. ▸ Specific hazard control measures that will be applied, including clearly defined access for vehicles and pedestrians along the rail corridor and the provision of fencing and gating for all corridor access points to prevent unauthorised entry. ▸ ARTC will manage critical pedestrian, road and rail safety risks during operation in accordance with the ARTC's *Fatal and Severe Risk Program*. ▸ Storage areas and equipment laydowns will be maintained in good condition to maintain visibility for vehicles.
	Project	Tunnel	▸ Tunnel construction will likely require blasting work. The use of explosive substance will comply with the *Explosives Act 1999* (Qld).
	Project	Underground and overhead services	▸ Procedural control for the Project will ensure that excavation work will comply with Safe Work Australia *Model Code of Practice —Excavation Work* (Safe Work Australia, 2018d) ▸ ARTC's Engineering Standard for Requirements—*Electric Aerials Crossing ARTC Infrastructure* (ARTC, 2005a) requires that all structures supporting a span of electric aerials over ARTC railway track or sidings be located so that in the event of failure, no part will fall within 1.8 m outside rail of any railway track.
	Project	Gas and pipelines	▸ Procedural control for the Project will ensure that excavation work will comply with Safe Work Australia's *Model Code of Practice—Excavation Work* (Safe Work Australia, 2018c) and other construction safety and clearance measures as agreed with Santos and APA.
	Project	Contaminated land (including unexploded ordnances)	▸ Construction personnel involved in ground-disturbing works will be trained in the identification of potential contaminated soil/material and the relevant controls that will be put in place in the event of its discovery. ▸ Waste generation from construction activities can potentially contaminate the surrounding land and will be managed in accordance with the Waste and Resource Management Sub-plan and ARTC's *Environmental Policy* (ARTC, 2014b). ▸ A Contaminated and Hazardous Materials Management Plan will be developed and implemented as part of the Waste and Resource Management Sub-plan. ▸ Identification of unexploded ordnance will be subject to a risk assessment. Where there is a risk of encountering known or possible unexploded ordnance, a Suitably Qualified Person will assess and identify management options. ▸ Implementation of the Contaminated Site Management Sub-plan if contaminated land is suspected.

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Construction and commissioning (continued)	Project	Emergency access	▸ The maintenance of emergency access will be managed through the development and implementation of a Project Access Strategy. Access for emergency vehicles during construction of the Project will be discussed with services providers during development of the strategy. In instances where construction phase emergency access is affected, use of the rail maintenance access road by emergency vehicles may be appropriate. Multiple access points into and out of the rail corridor will be provided. ▸ A Construction Traffic Management Plan will be in place during construction to manage construction traffic and minimise impacts to surrounding land users.
	Project	Abandoned mines and underground collieries	▸ If an unrecorded, historic colliery is encountered during construction, the measures outlined under the 'Unexpected Finds Protocol/Procedure' in the CEMP will be followed. This risk will be controlled during construction such that construction above collieries or abandoned mines will be avoided, leading to a removal of the risk in the operational phase.
	Dangerous goods and hazardous chemicals	Chemicals spillage and loss of containment	▸ Where it has been identified that hazardous materials may be used or stored, construction facilities will be located outside floodplains and away from areas of social and environmental receptors in accordance with the Queensland State Planning Policy 2017. Additionally, the locations of construction facilities where vehicle maintenance and refuelling activities are expected to occur, will be selected to achieve appropriate separation to riparian vegetation and waterways. ▸ During the construction phase of the Project, dangerous goods will be required at construction sites and facilities. Licensed transporters operating in compliance with *Australian Code for the Transport of Dangerous Goods by Road & Rail* (National Transport Commission, 2018) will be used for dangerous goods deliveries. Additionally, the locations of construction facilities where vehicle maintenance and refuelling activities are expected to occur, will be selected to achieve appropriate separation to riparian vegetation and waterways. ▸ Standard procedures for the storage, containment, disposal and spills response for chemicals will be managed in accordance with their applicable Australian Standards, such *AS 1940-2017 Storage and Handling of Flammable and Combustible Liqui*d (Standards Australia, 2017) and *AS 3780-2008 Storage and Handling of Corrosive Substance* (Standards Australia, 2008). ▸ Construction chemicals stored and handled will be managed in accordance with the *Work Health and Safety Act 2011* (Qld) and Regulation, the relevant Australian Standards and the requirements of chemical safety data sheets. Safety data sheet information will be obtained from the supplier of these chemicals and stored in an easily accessible location.

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures

Construction and commissioning (continued)	Dangerous goods and hazardous chemicals	Explosives	▸ Where explosives are used for significant cuttings during construction, the works will be undertaken by licensed shotfirers in accordance with the *Explosive Act 1999* (Qld) and *AS 2187-2006 Explosive—Storage, Transport and Use* (Standards Australia, 2006).
			▸ Where explosives are used during construction, a Blast Management Plan will be developed as part of the Construction Noise and Vibration Management Plan within the CEMP.
			▸ At all times, the handling and use of explosives will follow procedures to:
			  ▸ Prevent misfire
			  ▸ Reduce the risk associated with material projected by a blast
			  ▸ Minimise adverse effects of ground vibration and shock waves caused by a blast
			  ▸ Ensure explosives are not used after either the manufacturer's recommended shelf life or the approved, extended shelf-life
			  ▸ Maintain public safety, vehicular access and security
			  ▸ Identify other activities within proximity of explosive use
			  ▸ Characterise the environment of explosive use, including flood, bushfire, landslide zones.
			▸ WH&S Management Plans to include appropriate measures to manage risk associated with blasting such as consultation with service providers, comply with separation requirements and access controls, exclusion zones, trails, and buffers.
			▸ WH&S Management Plans will seek to minimise interruption to dangerous goods and hazardous materials (including explosives) transport routes, by communicating with relevant stakeholders regarding the schedule and activities of the Project.

Operation	Natural	Bushfire	▸ Existing ARTC's Safety Management System and strategies including *Engineering (Track and Civil) Code of Practice—Right of Way* (ARTC, 2013b), *Fire Prevention Management* (ARTC, 2007) and *Total Fire Ban Engineering Procedures* (ARTC, 2018d) will be applied throughout the Project life cycle to minimise damage to property, disruption to operations and maximise the safety of people. ▸ Section 17 (Right of Way) of the *Engineering Code of Practice* (ARTC, 2013c) will be implemented to minimise fire risk within the rail corridor, which includes specifications for vegetation management/fire hazard reduction within the corridor. ▸ Local fire authorities and local emergency services will be consulted to ensure appropriate operational actions are taken, such as providing feedback on the firefighting vehicles accessibility, Fire Prevention Plans and cooperation on burning-off activities.
	Natural	Flooding and flash flooding	▸ In line with ARTC's *Track Drainage—Inspections and Maintenance* standards (ARTC, 2006) will be carried out to identify defects and conditions that may affect waterway and drainage system capacity or indicate increased risk of flooding such as scour, blockages from debris, indication of floods overtopping a structure, and culvert or drain damage or collapse. ▸ Established site safety protocol (procedures, warnings, depth, indicators). ▸ Inspections and assessments will be carried out regularly to identify mud holes and other drainage defects that impact the operation of the Project.

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Operation (continued)	Natural	Landslide, sudden subsidence, movement of soil or rocks	▸ Regular embankment inspections will be implemented to determine defects and conditions that may affect or indicate problems with the stability of engineered formations in accordance with ARTC standards.
	Natural	Climatic conditions	▸ Operations on the corridor will comply with ARTC's Route Access Standard General Information Route Standards: Speed Restrictions During Hot Weather (ARTC, 2018g). ▸ The Operational Track Buckling Emergency Management and Mitigation Plan will be employed to ensure integrity of the track during increased extreme heat events. The *Track Stability Handbook* (ENT-06-01) will be used as guide for track buckling mitigation plans through managing track stability. These plans will ensure regular rail inspection, maintenance, and de-stressing of the rail to maintain track stability during both seasonal and annual temperature fluctuations. The track structure design has allowed for temperature-based adjustment in operation.
	Natural	Wildlife	▸ Stock fencing, fauna fencing and wildlife permeability structures will be inspected and maintained as per Section *17 (Right of Way) of the Engineering Code of Practice* (ARTC, 2013b).
	Natural	Biosecurity	▸ Pest and weed management will be carried out within the rail corridor in accordance with Section 17 (Right of Way) of the Engineering Code of Practice (ARTC, 2013b). ▸ Adhere to quarantine rules and regulations.
	Project	Noise and vibration	▸ Adhere to the Construction Noise and Vibration Management Plan as part of the draft Outline EMP (and CEMP). ▸ Noise and vibration sources from maintenance work involving heavy machinery will incorporate appropriate noise mitigation equipment and devices including mufflers and acoustic barriers. Application of the ARTC *Asset Management System* (refer to Appendix F: Corporate Policies) will maintain equipment in good working order to reduce the potential for offensive noise.
	Project	Fatigue and heat stress management	▸ ARTC has an existing Fatigue Policy and the Project will adhere to ARTC's *Work Health and Safety Work Instruction for Fatigue Management* (ARTC, 2016e) to ensure conditions of work of personnel align with requirements of the *Work Health and Safety Act 2011* (Qld) ▸ For any work that is required outside the hours specified in ARTC's *Work Health and Safety Work Instruction for Fatigue Management* (ARTC, 2016e) guidelines, the likely level of additional risks involved will be assessed and appropriate risk control measures will be identified ▸ Follow Safe Work Australia's *Guide to managing the risks of working in heat* (Safe Work Australia, 2020).
	Project	Asbestos	▸ Adhere to ARTC's Work Health and Safety Work Instruction for Asbestos, along with Safe Work Australia Model *Code of Practice—How to Manage and Control Asbestos in the Workplace* 2018 (Safe Work Australia, 2018b) and Safe Work Australia *Model Code of Practice—How to Safely Remove Asbestos* 2018. (Safe Work Australia, 2018a).

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Operation (continued)	Project	Airborne contaminants	▸ Operators will ensure that significant dust generating activities on the Project are managed in a proper and efficient manner to minimise dust emissions and comply with any relevant conditions of approval. ▸ Provide the relevant stakeholders with sufficient information to enable them to understand the likely nature, extent and duration of dust and emissions impacts. ▸ If coal is to be transported in future operational scenarios, the potential for coal dust generation would be managed in accordance with a coal dust management plan, similar in requirements to Aurizon Limited's Coal Dust Management Plans for Central Queensland Coal Networks.
	Project	Road–rail interface	▸ ARTC will conduct routine inspections of crossing infrastructure, in accordance with Section 17 (Right of Way) of the *Engineering Code of Practice* (ARTC, 2013b) and will regularly review crossing performance and incident information to identify and remedy potential hazards. ▸ Training of personnel through desktop and simulated test exercises will be designed to ensure that individually and collectively the Incident Management Procedures adequately address the requirements for emergency management. ▸ ARTC is committed to continued delivery of railway safety messages to the community, through the awareness activities, community engagement activities and campaigns to increase public awareness. ▸ In the event of trespass or environmental vandalism on the ARTC rail corridor, ARTC Security Patrols and trackside staff will be empowered to instruct intruders to leave the corridor immediately. As required, incidents will be reported to the Queensland Police Service for assistance and resolution.
	Project	Rail incidents	▸ Trackside monitoring systems, which will detect faults in the wheel set and monitor rail wheel condition and defects.
	Project	Bridges	▸ Safety elements for double stack freight trains such as loading requirements, centre of gravity and inspections for rolling stock are required to meet ARTC's *Rolling Stock Outlines and Loading Requirements* (ARTC, 2018f) to ensure stability and prevent excessive movements of loads and containers during train movements or severe weather events. ▸ Inspections and assessments will be carried out regularly to identify mud holes, wet spots, sleeper condition, and excessive track vibration, which indicate potential defects that may affect the integrity of the track structure and ballast profile.
	Project	Tunnel	▸ Uphold fire and lifesaving controls for the tunnel in accordance with tunnel operational procedures.
	Project	Emergency access	▸ Training of personnel through desktop and simulated test exercises will be designed to ensure that individually and collectively the Incident Management Procedures adequately address the requirements for emergency management. ▸ Local fire authorities and local emergency services will be consulted to ensure appropriate operational actions are taken.
	Project	Overhead and underground services	▸ The Project will also comply with the clearance distance as specified in ARTC's *Engineering Standard for Requirements—Electric Aerials Crossing ARTC Infrastructure* to ensure sufficient clearance and prevent contact with live electricity.
	Project	Contaminated land	▸ Hazardous (regulated) waste such as hydrocarbons and hydrocarbon contaminated products (e.g. oily waste or oil filters) that could potentially be generated during operation (either from maintenance operations or from freight spillages) will be collected and disposed of by a licensed waste transporter. ▸ Implementation of the Contaminated Site Management Sub-plan if contaminated land is suspected.

Delivery phase	Hazard type	Potential impacts	Mitigation and management measures
Operation (continued)	Dangerous goods and hazardous chemicals	Freight dangerous goods	▸ Emergency information holders will be readily available containing Initial Emergency Response Guide, dangerous goods transport and consignment documents. ▸ The freight transportation of dangerous goods on the Project will be in accordance with the Australian Dangerous Goods Code (National Transport Commission, 2018). ▸ Freight carts will be required to display appropriate Hazchem Signage, including placards, and carry appropriate spill containment equipment to be used by emergency services personnel in the event of an emergency. ▸ Train operators will comply with the ARTC Inspecting Trains policy, such that inspections of dangerous goods loading (e.g. restraining of packages, segregation of dangerous goods), brake conditions and train integrity are compliant with the ARTC Train Operating Conditions manual, before and during travel on the ARTC Network. Details of the train's consignment (a sequence of train carriages or cars) and content will also be provided to the ARTC Network Control.
	Dangerous goods and hazardous chemicals	Explosives	▸ Comply with ARTC's guidelines on blasting in proximity to ARTC rail infrastructure in the event blasting operations are undertaken in area. ▸ WH&S Management Plans will seek to minimise interruption to mine explosive transport routes, by communicating with mine management in regard to the schedule and activities of the Project.

TABLE 20.12: IMPACT ASSESSMENT FOR POTENTIAL IMPACTS ASSOCIATED WITH HAZARD AND RISK

			Initial risk			Residual risk		
Aspect	Potential impact	Phase	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
Bushfire	Damage to infrastructure, injury to workers or public from bushfire	Construction	Possible	Moderate	Medium	Possible	Moderate	Medium
		Operation	Possible	Moderate	Medium	Possible	Moderate	Medium (though to 2090)
Flooding	Damage to infrastructure, potential for impacts to freight goods caused by flooding events	Construction	Possible	Major	High	Unlikely	Major	Medium
		Operation	Possible	Major	High	Unlikely	Major	Medium
Climatic conditions	Increased temperatures, leading to failure of infrastructure/derailment accidents i.e. track buckling or too dangerous conditions for dangerous goods, caused by climatic conditions (extreme weather events)	Construction	Possible	Major	High	Unlikely	Major	Medium
		Operation	Possible	Major	High	Unlikely	Major	Medium
Climatic conditions	Impact of Project on greenhouse gas emissions	Construction	Possible	Major	High	Unlikely	Major	Medium
		Operation	Possible	Major	High	Unlikely	Major	Medium

			Initial risk			Residual risk		
Aspect	**Potential impact**	**Phase**	**Likelihood**	**Consequence**	**Risk**	**Likelihood**	**Consequence**	**Risk**
Landslide, sudden subsidence, movement of soil or rocks	Damage to infrastructure and worker/public injury from landslide, sudden subsidence, movement of soil or rocks	Construction	Possible	Major	High	Unlikely	Major	Medium
		Operation	Possible	Minor	Low	Unlikely	Minor	Low
Wildlife	Wildlife injury or deaths from impact with Project or worker injury from wildlife	Construction	Likely	Minor	Medium	Possible	Minor	Low
		Operation	Likely	Minor	Medium	Possible	Minor	Low
Biosecurity	Damage to biosecurity of surrounding environment due to propagation invasive species	Construction	Likely	Minor	Medium	Possible	Minor	Low
		Operation	Likely	Minor	Medium	Possible	Minor	Low
Noise and vibration	Disruption to public from noise and vibration	Construction	Likely	Minor	Medium	Possible	Minor	Low
		Operation	Likely	Minor	Medium	Possible	Minor	Low
Fatigue and heat stress management	Worker injury from fatigue and heat stress	Construction	Almost Certain	Moderate	High	Possible	Moderate	Medium
		Operation	Likely	Moderate	High	Possible	Moderate	Medium
Asbestos	Health impacts from asbestos	Construction	Possible	Moderate	Medium	Unlikely	Moderate	Low
		Operation	Possible	Moderate	Medium	Unlikely	Moderate	Low
Dust, respirable silica and other airborne contaminants	Impacts from dust, respirable silica and other airborne contaminants	Construction	Possible	Moderate	Medium	Unlikely	Moderate	Low
		Operation	Possible	Minor	Low	Unlikely	Minor	Low
Road–rail interface	Road accidents caused by increased vehicles required for the Project (e.g. traffic from construction or maintenance)	Construction	Possible	Extreme	High	Unlikely	Extreme	Medium
		Operation	Unlikely	Extreme	Medium	Unlikely	Extreme	Medium
Rail incidents	Rail accidents caused by increased rail movements	Construction	N/A	N/A	N/A	N/A	N/A	N/A
		Operation	Possible	Extreme	High	Unlikely	Extreme	Medium
Road–rail interface	Accidents due to increased number of road–rail interface	Construction	N/A	N/A	N/A	N/A	N/A	N/A
		Operation	Likely	Major	Very High	Unlikely	Major	Medium
Tunnel	Accidents due to construction of and rail use through the tunnel	Construction	Possible	Extreme	High	Unlikely	Extreme	Medium
		Operation	Possible	Extreme	High	Unlikely	Extreme	Medium
Overhead and underground services	Worker injury from services strike at existing infrastructure and underground and overhead services	Construction	Possible	Extreme	High	Unlikely	Extreme	Medium
		Operation	Possible	Extreme	High	Unlikely	Extreme	Medium

			Initial risk			Residual risk		
Aspect	**Potential impact**	**Phase**	**Likelihood**	**Consequence**	**Risk**	**Likelihood**	**Consequence**	**Risk**
Contaminated land	Health impacts to workers and public and environmental impact from contaminated land	Construction	Possible	Major	High	Unlikely	Major	Medium
		Operation	Possible	Minor	Low	Unlikely	Minor	Low
Bridges	Bridge collapse or falling object strikes	Construction	Unlikely	Major	Medium	Unlikely	Major	Medium
		Operation	Unlikely	Major	Medium	Unlikely	Major	Medium
Emergency access	Impaired emergency access resulting in escalation of incident	Construction	Possible	Major	High	Unlikely	Major	Medium
		Operation	Possible	Major	High	Unlikely	Major	Medium
Chemicals spillage and loss of containment	Loss of containment of dangerous goods during storage and handling	Construction	Possible	Moderate	Medium	Unlikely	Moderate	Low
		Operation	N/A	N/A	N/A	N/A	N/A	N/A
Freight dangerous goods	Loss of containment of freight dangerous goods	Construction	N/A	N/A	N/A	N/A	N/A	N/A
		Operation	Possible	Extreme	High	Rare	Extreme	Medium
Explosives	Damage to infrastructure or injury or fatality caused by explosives incidents during blasting during construction or by adjacent operators	Construction	Possible	Extreme	High	Rare	Extreme	Medium
		Operation	Unlikely	Extreme	Medium	Rare	Extreme	Medium
Abandoned mines and unrecorded underground collieries	Collapse of mine shaft or colliery leading to asset damage and/or injury	Construction	Unlikely	Major	Medium	Unlikely	Major	Medium
		Operation	N/A	N/A	N/A	N/A	N/A	N/A

20.12.4 Residual risks

From the risk assessment, all risk rankings after mitigation are medium or below. This means that the risks have been reduced to a level that is tolerable or will be considered tolerable if they are reduced so far as reasonably practicable which will be determined by ARTC. A further assessment of whether risks are so far as reasonably practicable will be completed during the detailed design phase. This risk reduction can be demonstrated by ensuring all mitigation proposed and any further mitigations identified in detailed design are implemented for both residual medium and low risks.

20.13 Cumulative impacts

It is a requirement of the ToR for this Project that the potential for cumulative impacts be considered. This section provides a discussion on the potential for cumulative impacts in relation to hazard and risks. Details on the assessment methodology for cumulative impacts is presented in Chapter 4: Assessment methodology.

This chapter provides coverage of potential hazards and risks associated with the development of the Project, some of which have been discussed in greater detail in corresponding chapters of this EIS. For the purpose of assessing cumulative impacts from hazards and risks, those attributed to the following potential impacts have been assessed in respective EIS chapters of:

- Landslide, sudden subsidence, movement of soil or rocks—Chapter 8: Land resources
- Wildlife and biosecurity—Chapter 10: Flora and fauna
- Flooding and climate change—Chapter 12: Surface water and hydrology
- Traffic—Chapter 18: Traffic, transport and access.

Impacts associated with the following aspects have been assessed in this Section for their cumulative potential:

- Hazardous materials and dangerous goods
- Blasting and explosives.

Further details on the potential for cumulative impacts to arise as a consequence of the Project, in combination with others, is presented in Chapter 22: Cumulative impacts.

20.13.1 Hazards and risk

Seven projects were initially identified as having potential to contribute to cumulative impacts in combination with the Helidon to Calvert Project. These projects are either currently operational, expected to undergo future expansion or are currently going through an approval process. A full list of the projects, with a description of each, is presented in Chapter 22: Cumulative impacts.

The types and quantities of hazardous chemicals that are expected to be used for the construction or operation and maintenance of other projects are not considered to be sufficient to introduce the potential for significant offsite impacts or the potential to contribute to cumulative impacts at the adjacent, regional, and national level.

The loss of containment of dangerous goods through transportation during construction and operation is regarded as having potential for cumulative impacts between the Project and concurrent projects or future projects. As such, only two of the initial projects identified meet these criteria. The projects considered to have a potential for cumulative impacts with the Project have been identified as:

- Gowrie to Helidon Section of Inland Rail—potential for construction and operational phase interactions
- Calvert to Kagaru Section of Inland Rail—potential for construction and operational phase interactions.

20.13.1.1 Loss of containment of dangerous goods

During construction, the expected quantities of hazardous chemicals are not considered to be sufficient to introduce significant offsite impacts or the potential to contribute to cumulative impacts at the adjacent, regional and national level. Impacts associated with construction storage of hazardous chemicals are expected to be localised to the area of use for the expected quantities and types of dangerous goods. Natural hazards in the surrounding area such as bushfires may increase the risk at site and can negatively impact hazardous chemical storage; however, hazardous chemical storage locations have been located outside bushfire impact areas, where possible. The Cunningham Highway upgrades may also overlap with the Project resulting in an increase of workforce and transportation of construction materials within the Project. However, the duration of these activities is only temporal and the potential of hazardous chemicals transportation collision, developing into a societal and environmental impact is considered to be low.

The potential for cumulative impacts during operations are associated with dangerous goods freight. Freight of dangerous goods through Little Liverpool Range tunnel, across river bridges and within the vicinity of newly developed areas and future development areas such as the Gatton West Industrial Zone, Principal Rural Activity Centre and Urban Footprint land use designation around Helidon, Gatton, Forest Hill and Laidley have the potential for a cumulative increase in risk as a result of the land use activities and increased likelihood for incidents (e.g. increased road traffic, other hazardous industry land uses). Particularly for industrial land uses, overlapping risk contributions from adjoining facilities/activities can increase the overall level of risk for a specific location. The adjoining land use and infrastructure increase the interactions between live trains and the local community and environment which have the potential to increase the societal risks.

Certain conditions can increase the potential for harm, for instance, hot work activities within the bushfire zone, the presence of highly reactive chemicals or compressed gas and strong wind conditions. High fire risk activities such as hot work will be restricted as per the ARTC *Total Fire Ban* (ARTC, 2018d) procedure. A permit will be required from the QFES if hot work or other high fire risk activities need to be carried out during fire danger season.

Overall, the significance of cumulative impact assessment of loss of containment of dangerous goods associated with the Project is likely to be low (refer Table 20.13).

20.13.1.2 Blasting and explosion

The potential uses of explosives for the tunnel construction have potential cumulative impacts to the environment. Explosives incidents have the potential for significant impact distances and could potentially cause secondary incidents at surrounding land uses (e.g. impacts on industrial facilities, initiation of landslide). The amount of explosive used, and the timing and duration of blasting are critical to ensure safe and controlled blasting works.

For instance, blasting failures and improperly conducted blasting works have the potential to create unstable land and may cause damage to surrounding structures, including road and rail assets. The presence of controls described in Section 20.11.3.3 will limit the potential for basting failures and control the risk of cumulative impact.

A number of non-ARTC projects could potentially coincide during the construction phase of the Project; however, the uncertainty with the construction dates and the distance of non-ARTC projects to the Project; therefore, it can be expected that the Project have a low cumulative impact.

Overall, the outcome of cumulative impact assessment of loss of containment of dangerous goods and blasting and explosives associated with the Project is shown in Table 20.13.

TABLE 20.13: CUMULATIVE IMPACT ASSESSMENT RESIDUAL RISKS

Value	Potential cumulative impacts	Residual impact significance	Recommended mitigation measures
Hazard and risk	Loss of containment of dangerous goods—during construction, no sufficient risk of hazardous chemical contamination anywhere outside of the area of use. Operational risks may involve the future freight of dangerous goods, or activities along hazardous stretches of the Project area may combine to create potential impacts. The likelihood of these is low.	Low	Additional mitigation is not required as the cumulative residual impact is considered to be low.
	Blasting and explosion—the use of explosives during tunnel construction has the potential for cumulative impacts to the environment.	Low	

20.14 Conclusion

The development of railway infrastructure has a number of hazards and risks, which have been identified and will be managed throughout the lifecycle of a Project through construction and commissioning, and operation. The Project has incorporated risk identification and assessment practices throughout the design development, and ARTC has a strong commitment to implementing and maintaining appropriate safety practices throughout operations.

A preliminary risk assessment has been conducted for the Project, complying with the ToR.

The implementation of ARTC risk management policies and procedures as described in Section 20.4.2, and mitigations and management measures, are anticipated to effectively reduce most of the risks associated with the Project to a low to medium level. The residual risk associated with some particular incidents, includes potential events related to dangerous goods freight transport, potential use of explosive for Little Liverpool Range tunnel construction, pedestrian and community safety, interface with live trains and derailment or involving private access route, overbridges and emergency access.

Risk assessment is an ongoing process and as the Project design evolves, the impact on risks will be regularly reviewed to ensure risks are reduced to so far as is reasonably practicable. This risk reduction can be demonstrated by ensuring all mitigation proposed and any further mitigation identified in detailed design are implemented for both residual medium and low risks.