CHAPTER 24

Air quality and greenhouse gas

NARRABRI TO NORTH STAR—PHASE 2 ENVIRONMENTAL IMPACT STATEMENT

ARTC

INLAND RAIL

An Australian Government Initiative

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This chapter details the air quality and greenhouse gas (GHG) impact assessment undertaken for the Narrabri to North Star (N2NS) Phase 2—Moree to Camurra project (the proposal). It describes the existing environment, assesses expected impacts from construction and operation of the proposal, and provides recommended mitigation and management measures.

The Secretary's Environmental Assessment Requirements (SEARs) relevant to air quality and GHG assessment are provided in Table 24-1.. A full list of the SEARs is available in Appendix A: Secretary's Environmental Assessment Requirements.

TABLE 24-1 SEARS FOR LAND USE AND PROPERTY

Key issue	Requirement	Where addressed
12. Other Issues	**1** An assessment of the following issues must be undertaken in accordance with the commitments in Section 6 of the Scoping Report: **a** air quality **b** greenhouse gases and energy.	Chapter 24

24.1 Summary of impacts

24.1.1 Construction

Air quality impacts are likely to be transient and short-term in nature, as the construction progresses along the alignment.

Potential impacts to local air quality include:

- dust generated from bulk earthworks, exposed soil and temporary stockpiles
- operation of construction plant, equipment and machinery
- increased vehicle movements associated with transport of construction materials (on sealed and unsealed roads)
- odour and emissions from disturbance of contaminated soils if present
- relocation of utility services
- construction and installation of infrastructure (e.g. new tracks, roads, culverts and bridges)
- demolition and removal of existing track, culverts and bridges
- combustion of fuel in both light and heavy commercial vehicles (HCVs), and mobile plant.

Of these potential construction air quality impacts, dust generation is considered the highest risk. Exhaust emissions produced by construction vehicles and plant are expected to be less significant due to their nature (discontinuous, transient and mobile) and the lack of sensitive receivers in a rural setting.

An air quality and dust management sub-plan would be prepared as part of the construction environmental management plan (CEMP) and implemented during construction to minimise air quality impacts. This would include dust suppression techniques, such as water carts, sealing haulage routes and implementing wind breaks. Monitoring of construction dust would also be undertaken at sensitive receiver locations during construction.

Combustion of diesel fuel is expected to be the most significant construction phase source of greenhouse gas emissions. The following provides an indicative understanding of activities most significantly contributing to this diesel consumption:

- transport of pre-cast concrete, bulk materials and deliveries (approximately 20 per cent)
- enabling works, bridge demolition and construction (approximately 25 per cent)
- culverts installation, earthworks and track formation construction (approximately 50 per cent)
- site rehabilitation works (approximately 5 per cent).

Electricity use and embodied energy in construction materials would also contribute to construction phase GHG emissions.

24.1.2 Operation

During operation, the increase in diesel-operated freight trains using the rail corridor has the potential to increase levels of pollutants, such as nitrogen oxides and particulate matter. The air quality impact assessment considered these potential increases and concluded that, while emissions would increase from current levels, impacts would remain below the relevant impact assessment criteria for all key pollutants at both 2027 and 2040 operating capacities.

The majority of the study area traverses a rural landscape with few sensitive receivers and low background emission levels. The potential for air quality impacts would be greater in the town of Moree, which has the highest density of residential housing close to the alignment.

As there are no identified significant sources of air pollutants within 20 m of the proposal (e.g. factories or industries likely to emit significant quantities of air pollution) cumulative impacts from operational activities are not expected.

Operational greenhouse gas emissions would occur through the combustion of diesel. Once fully operational, however, the Inland Rail Program is predicted to reduce current carbon emissions by 750,000 tonnes per year, as a result of transferring road freight to rail.

Specific mitigation measures to address air quality impacts during both the construction and operation are provided in section 24.4 and Chapter 27: Environmental management.

24.2 Air quality

Air pollutants include gases, chemicals and airborne particles that are produced from anthropogenic (human-induced) activities, including industrial processes and motor vehicles. Natural events, including bushfires and strong winds, also produce air pollutants. Levels of air pollution vary spatially and temporally, affected by a complex range of parameters, including meteorology, topography and the activity level of emission sources. Increased levels of air pollution reduce the quality of air.

Exposure to poor air quality results in adverse human health impacts. While these impacts are complex, they can include respiratory illnesses and increased risk of premature deaths. As construction and operation of N2NS Phase 2 has the potential to increase emissions of air pollutants in the study area, it is important to establish the expected risks of these potential air quality impacts.

24.2.1 Assessment approach

This air quality assessment identifies potential construction and operation phase impacts, focusing on those impacts expected to be the highest risk. During construction, nuisance dust impacts are expected to be most significant. Although exhaust emissions would be produced by construction vehicles and plant, these emissions are expected to be less significant due to their nature—discontinuous, transient and mobile.

During operation, the highest risk impacts are likely to occur from rail exhaust emissions as a result of the increase in train movements, with the main emissions for consideration being oxides of nitrogen (NOx) and particulate matter.

The air quality assessment included:

- reviewing existing regional ambient air quality and meteorology
- identifying sensitive receivers located near the N2NS Phase 2 alignment that may be exposed to increased air pollution
- undertaking a desktop construction air quality impact assessment
- undertaking a desktop assessment of potential operation air quality impacts
- recommending mitigation measures.

24.2.1.1 Legislative and policy context

The *Protection of the Environment Operations Act 1997* (NSW) (POEO Act) provides the statutory framework for managing pollution in NSW, including the procedures for issuing licences for environmental protection on aspects such as waste, air, water and noise pollution control. Companies and property owners are legally bound to control emissions (including particulates and deposited dust) from construction sites under the POEO Act. Activities undertaken onsite must not contribute to environmental degradation, and pollution and air emissions must not exceed the standards. Where an environment protection licence (EPL) applies, air quality requirements (including criteria) will be specified by the licence. ARTC will need to obtain an EPL for construction of the proposal, as outlined in Chapter 3. In relation to operation, ARTC currently holds a licence to carry out railway systems activities on other parts of the NSW rail network (licence number EPL3142). This licence may be amended to include the operation of the proposal or a new licence, specific to this proposal, may be obtained.

Licensing requirements for the proposal would be considered in consultation with the NSW Environment Protection Authority (EPA).

The Protection of the Environment Operations (Clean Air) Regulation 2010 (the Clean Air Regulation) provides regulatory measures to control emissions from motor vehicles, fuels and industry. The proposal would be operated to ensure it complies with the Clean Air Regulation.

Air quality impact assessment criteria for the proposal are prescribed by the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016) (known as 'the Approved Methods').

Odour from stationary sources is generally assessed using the *Technical framework: Assessment and management of odour from stationary sources* in NSW (Department of Environment and Conservation (DEC), 2006). Odorous air emissions are not typically associated with locomotives and freight haulage, as the concentrations of odorous substances, such as nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and volatile organic compounds (VOCs), have relatively low odour thresholds and are generally not detected at concentrations below their health-related air quality objectives. Accordingly, an odour assessment has not been included as part of this air quality assessment.

The monitoring and regulation of prevalent air pollutants is governed by the *National Environment Protection (Ambient Air Quality) Measure* (Australian Department of Agriculture, Water and the Environment (DAWE), 2021), often referred to as the AAQ NEPM, developed by the National Environment Protection Council (NEPC). This policy sets out uniform national standards for the seven listed pollutants, also establishing monitoring and reporting protocols. The AAQ NEPM specifies non-binding maximum allowable concentrations and goals that apply to region-wide air quality, affecting the general population. The standards do not apply to local areas impacted by localised air emissions, such as industrial sources, construction activity, and heavily trafficked streets and roads.

The National Environment Protection (Air Toxics) Measure (the Air Toxics NEPM) (DAWE, 2004), sets out procedures to collect information regarding five hazardous air pollutants based on investigation limits (for reporting only).

24.2.1.2 Relevant pollutants

Table 24-2 provides all of the potential pollutants associated with construction and operation of rail infrastructure.

TABLE 24-2 KEY POLLUTANTS OF INTEREST

Pollutant	Construction	Operation
Total suspended particulates (TSP)	✓	–
Particulate matter with an equivalent aerodynamic dimeter less than 10 microns (PM_{10})	✓	✓
Particulate matter with an equivalent aerodynamic diameter less than 2.5 microns ($PM_{2.5}$)	✓	✓
Oxides of nitrogen (NOx)	–	✓
Nitrogen dioxide (NO_2)	–	✓
Carbon monoxide (CO)	–	✓
Sulphur dioxide (SO_2)	–	✓
Volatile organic compounds (VOCs) e.g. benzene	–	✓
Polycyclic aromatic hydrocarbons (PAHs) as benzo(a)pyrene equivalents	–	✓
Trace metals (e.g. arsenic, cadmium, lead, nickel and chromium VI)	–	✓
Ozone	–	✓

For N2NS Phase 2, the most significant air quality impact during construction is expected to be dust. Based on the impact assessment criteria specified in the Approved Methods, relevant pollutants to this proposal are fine particles of diameter ≤ 10 µm (PM_{10}), fine particles of diameter ≤ 2.5 µm ($PM_{2.5}$), and total suspended particulates (TSP).

During operation of N2NS Phase 2, impacts resulting from train exhaust emissions are expected to be most significant. With the understanding that the trains are diesel-powered, key pollutants are expected to be PM_{10}, $PM_{2.5}$, oxides of nitrogen (NOx) and benzene (Environ Australia, 2013).

24.2.2 Assessment criteria

Assessment criteria for relevant pollutants, as prescribed by the Approved Methods, are summarised in Table 24-3.

In assessing potential air quality impacts, it is important to acknowledge the transient, short-term nature of construction-phase emission sources. At any given assessment location, only criteria for short-term averaging periods (1-hour and 24-hour) are relevant for potential construction air quality impacts.

All criteria are applicable to assessment of operational impacts.

While assessment criteria for PM_{10}, $PM_{2.5}$, TSP and deposited dust are relevant to the assessment of particulate matter impacts, this assessment assumed impacts of PM_{10} and $PM_{2.5}$ are representative of impacts for all particulate matter assessment criteria.

TABLE 24-3 ADOPTED AIR QUALITY ASSESSMENT CRITERIA

Pollutant	Averaging period	Criteria
PM_{10}	24 hours	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24 hours	25 µg/m^3
	Annual	8 µg/m^3
TSP	Annual	90 µg/m^3
Deposited dust	Annual	4 g/m^2/month
NO_2	1 hour	246 µg/m^3
	Annual	62 µg/m^3
Benzene	1 hour	29 µg/m^3

24.2.3 Existing environment

The existing environment is one of many considerations affecting air quality in the study area, and for the purpose of this assessment, is best described by sensitive receiver locations, local meteorology, topography and local air quality. These factors are described in the following sections.

24.2.3.1 Sensitive receivers

In assessing expected air quality impacts, it is important to identify sensitive receiver locations. These are land use types and properties that are considered likely to host sensitive groups (i.e. residential dwellings, childcare facilities, elderly care facilities, and hospitals). While environmental features can also be considered sensitive to changes in air quality, such as dust impacts, environmental features have not been assessed as sensitive receivers in this EIS.

While much of the study area traverses sparsely settled rural land, there are a number of sensitive receivers located in the vicinity of the proposal that are largely residential properties and most densely located in the town of Moree. Residential properties are intermittently located along the rest of the alignment. The following summarises other sensitive receivers located within proximity (200 metres (m)) of the proposal:

- Moree ANZAC Centenary Park (REAx0008, REPx0005), located between chainage (CH) 665.800 and CH668.900, adjacent to the southern end of the construction zone boundary
- Moree TAFE campus (Rx2251), located between chainage 671.200 and 671.300 at 130 metres from the construction zone boundary
- people using Mehi River crossing
- people using Gwydir River crossing.

Sensitive receivers located in proximity to the study area are shown in Figure 24-1.

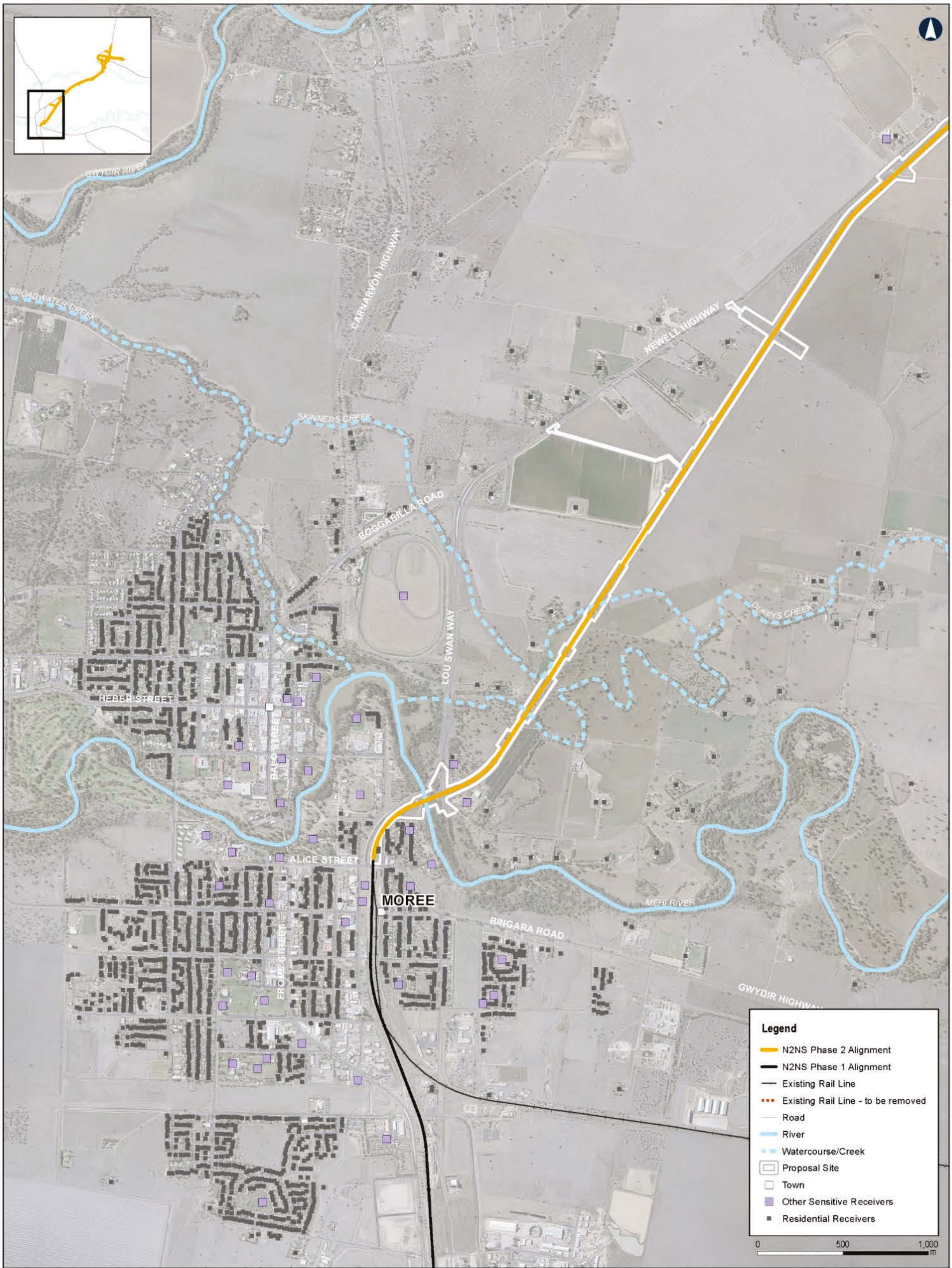


Figure 24-1 Location of sensitive receivers

Data Sources: ARTC, IRDJV, LPI

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:400,000
Paper size: A3
Date: 9/22/2021
Map 1 of 3

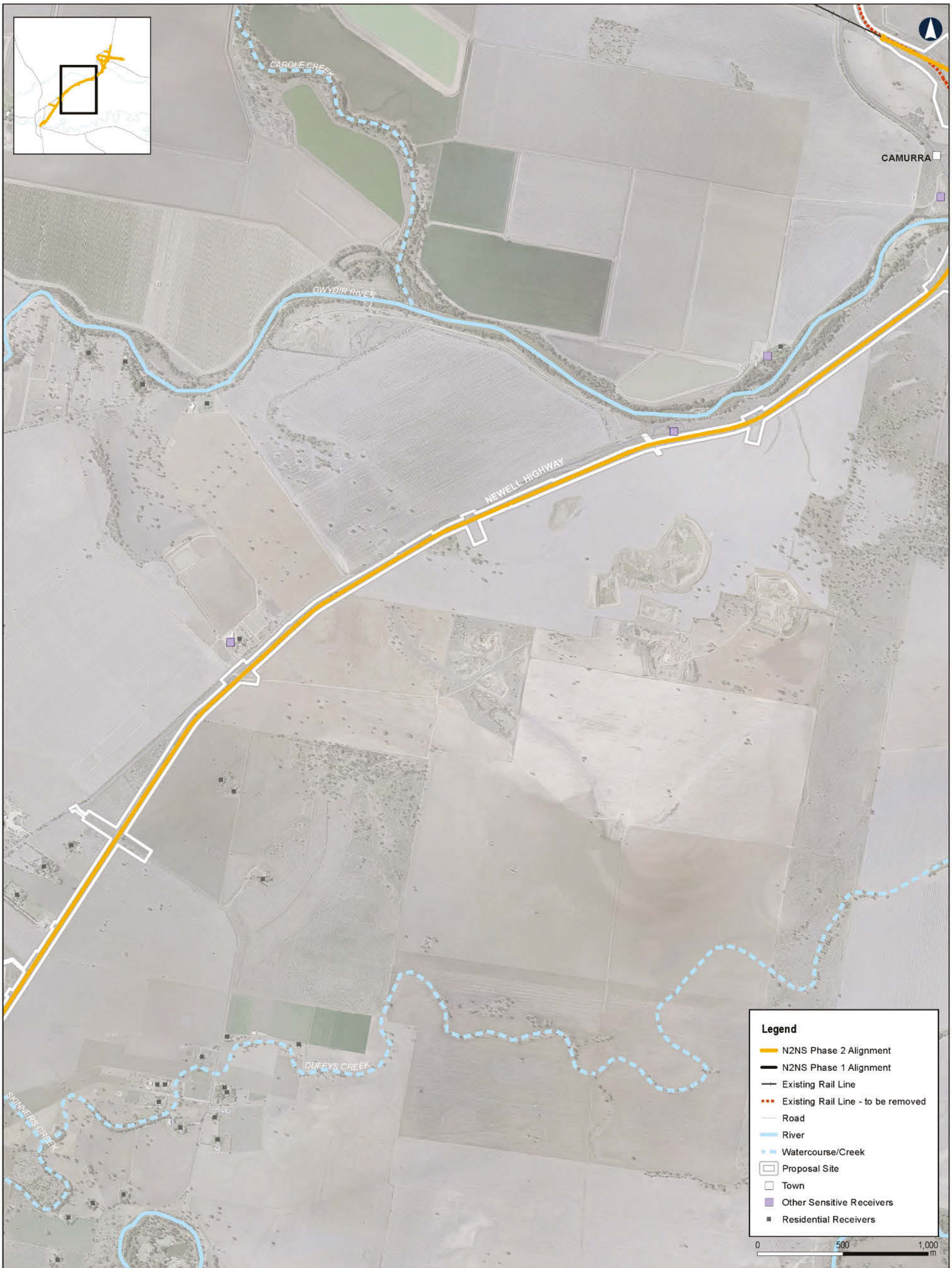


Figure 24-1 Location of sensitive receivers

Data Sources: ARTC, IRDJV, LPI

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:400,000
Paper size: A3
Date: 9/22/2021
Map 2 of 3

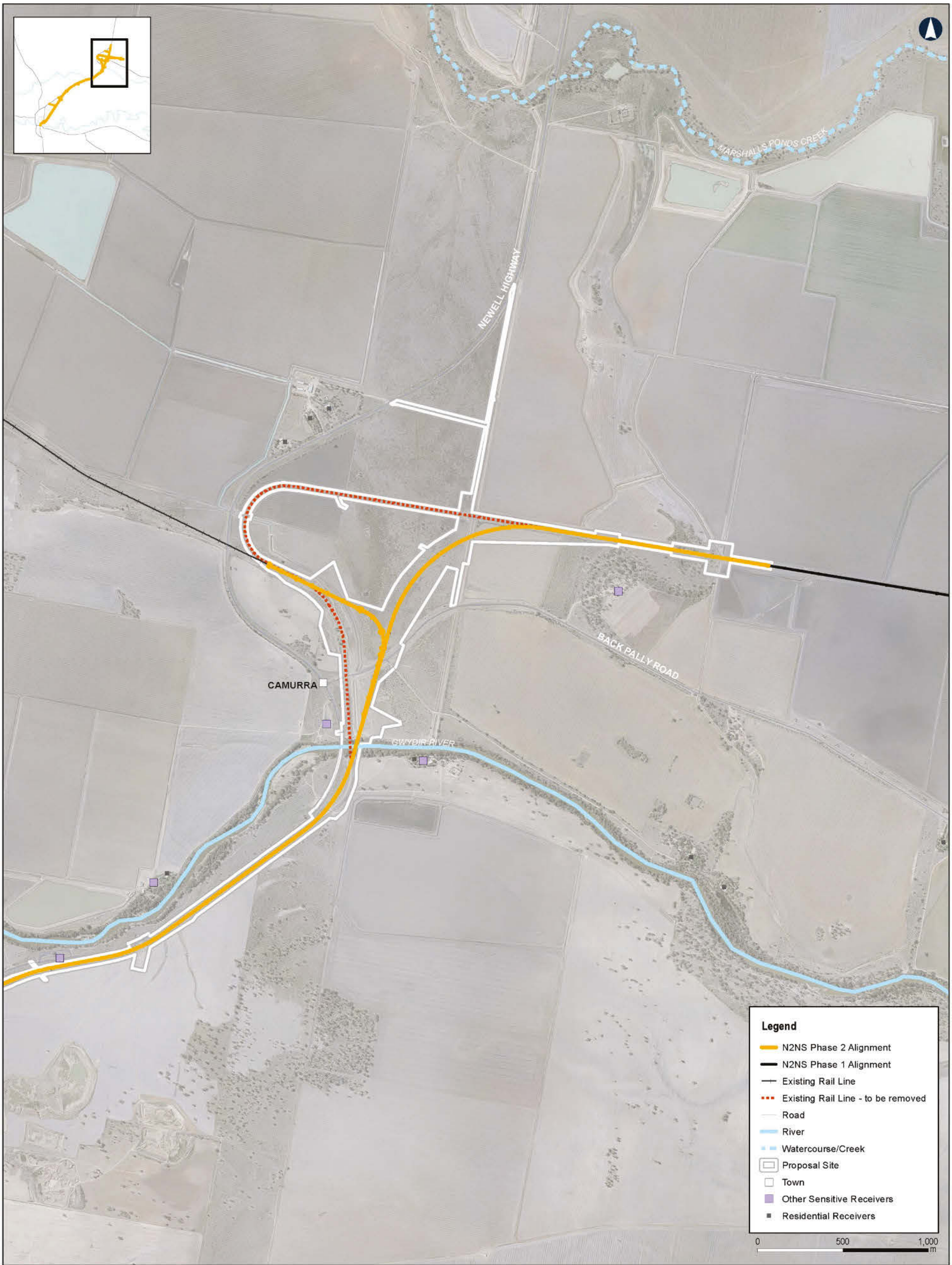


Figure 24-1 Location of sensitive receivers

Data Sources: ARTC, IRDJV, LPI

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:400,000
Paper size: A3
Date: 9/22/2021
Map 3 of 3

N2NS_SP2_EIS_F24_01_SensitiveReceivers_r3v2.mxd

24.2.3.2 Local meteorology

Meteorology is fundamental to the dispersion of pollutants; therefore, in assessing air quality impacts, it is necessary to carefully assess project-specific meteorological data. Key meteorological parameters governing the atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability, as described below:

- Wind direction governs the direction of pollutant transport.
- Wind speed influences the distance from the pollutant source that will be travelled by the emitted pollutants atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion, and therefore it affects the spread of pollutants as they travel away from the source.
- Climate data recorded at the Bureau of Meteorology (BoM) Moree Aero site (site number 053115) is most representative for the study area. This site is located approximately 2 kilometres (km) south of the study area's southern extent (refer to Figure 24-2). Key climate statistics established from historic observations are summarised in Figure 24-3, Figure 24-4 and Figure 24-5. It is evident that temperature, rainfall and wind speeds are increased during summer months. Rainfall is lowest during April and August, with temperatures and wind speeds lowest during winter months.
- While the data presented in Figure 24-3, Figure 24-4 and Figure 24-5 provides an indication of local meteorology, it is important to understand that due to spatial variation in topography, land use, vegetation and watercourses along the study area, meteorological conditions will also vary.

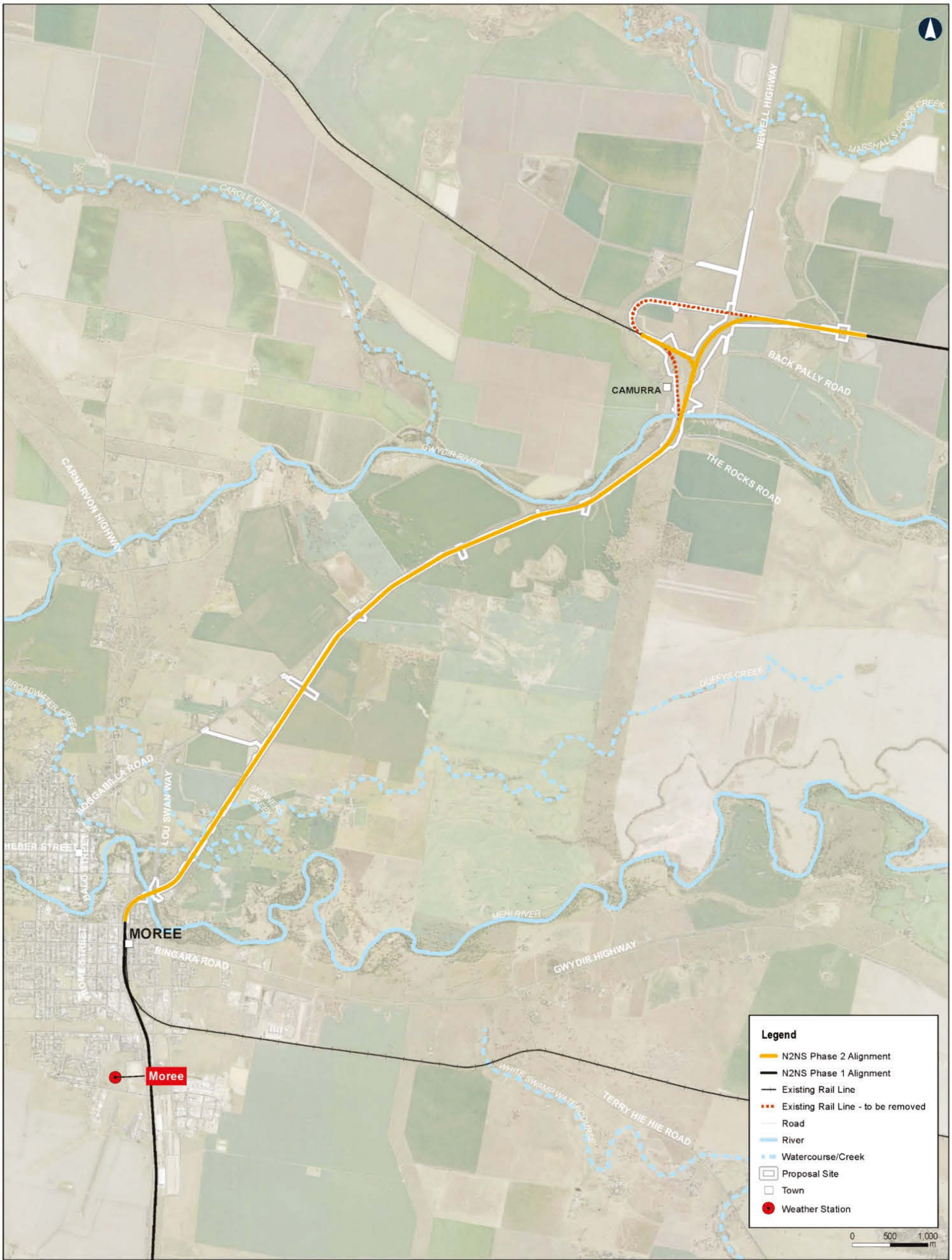
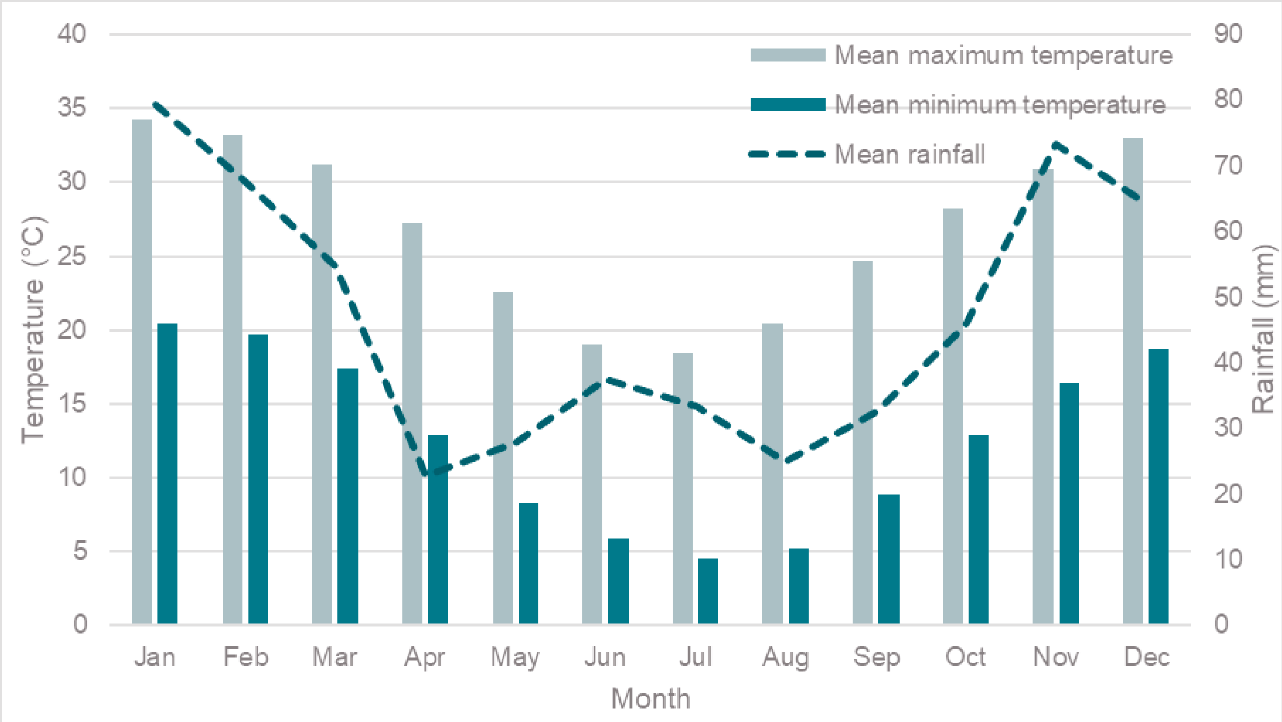


Figure 24-2 Meteorological monitoring location

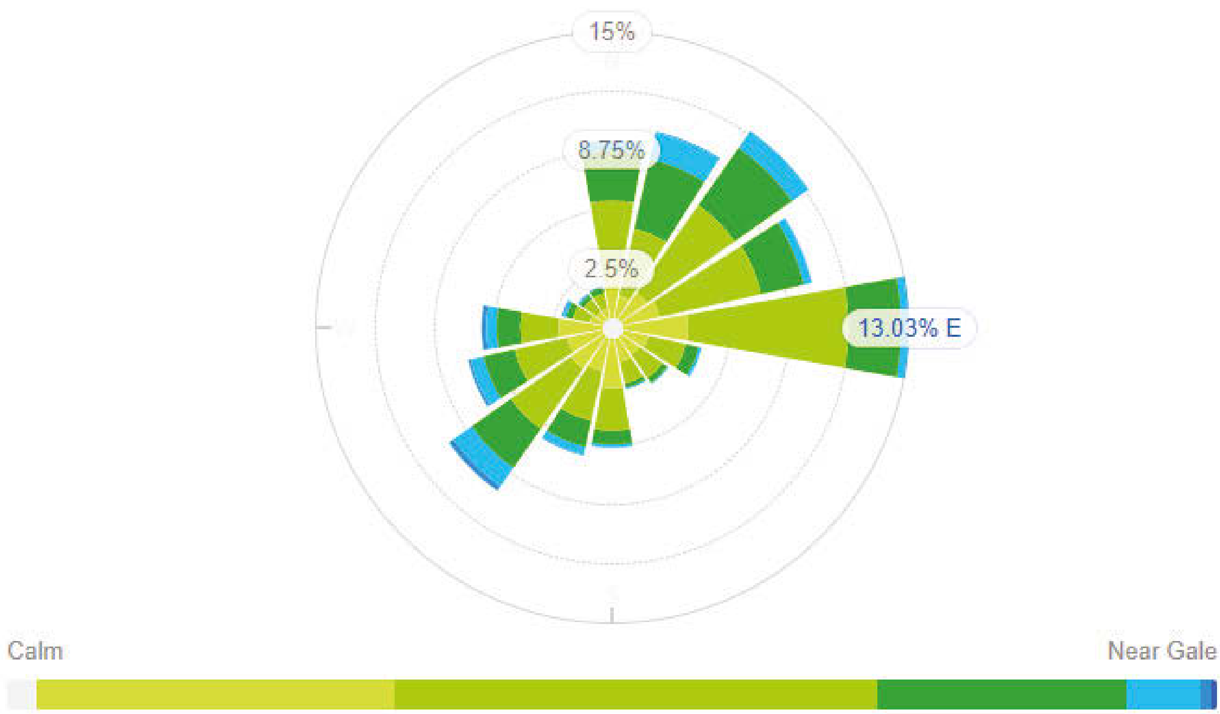
Data Sources: ARTC, IRDJV, LPI

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:45,000
Paper size: A3
Date: 9/22/2021
Map 1 of 1



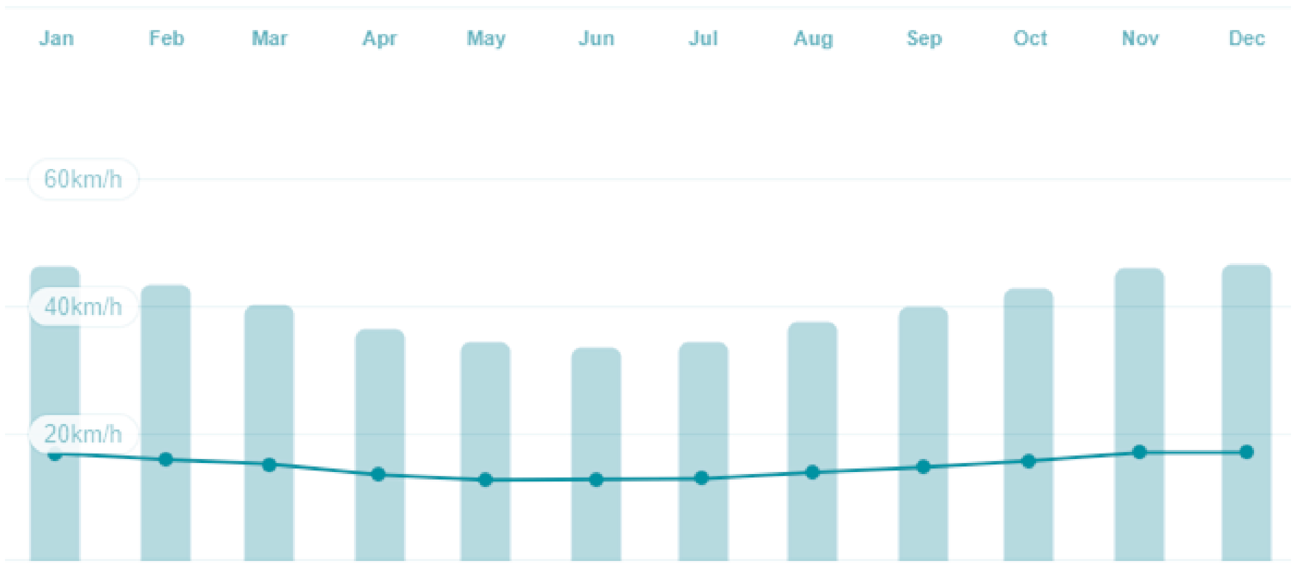
Source: bom.gov.au

FIGURE 24-3 ANNUAL VARIATION IN TEMPERATURE AND RAINFALL BASED ON HISTORIC OBSERVATIONS AT MOREE AERO (1995–2020)



Source: willyweather.com.au

FIGURE 24-4 ANNUAL WIND ROSE BASED ON HISTORIC OBSERVATIONS AT MOREE AERO (2015–2020)



Source: willyweather.com.au

FIGURE 24-5 ANNUAL VARIATION IN WIND SPEED BASED ON HISTORIC OBSERVATIONS AT MOREE AERO (1995–2020)

24.2.3.3 Existing air quality

To enable assessment of potential air quality impacts from the proposal against assessment criteria, it is necessary to establish background concentrations of pollutants so that the cumulative impact (sum of impacts from the proposal and ambient/background concentrations) can be assessed.

In accordance with the Approved Methods, background concentrations of air pollutants are ideally obtained from ambient monitoring data collected at the site of the proposal; however, the Approved Methods recognises that site-specific ambient data is rare and that data is typically obtained from monitoring sites as close as possible to a proposal site, where sources of air pollution are representative of the proposal site.

The NSW Government Department of Planning and Environment (DPE) operates a network of air quality monitoring stations across the state. There are 12 monitoring stations currently operating in the Greater NSW region, with the closest station to the study area located approximately 94 km to the south at Narrabri Airport. The Narrabri station monitors concentrations of PM_{10} and $PM_{2.5}$, and wind speed and wind direction, and commenced operation in December 2017.

None of the regional air quality monitoring stations measure concentrations of NOx or benzene; however, due to the inland location of the study area and the lack of concentrated emission sources (Department of Environment and Energy (DEE), 2019a), it is suitable to assume negligible background levels for gaseous pollutants such as NO_2 and benzene.

A summary of measured PM_{10} and $PM_{2.5}$ concentrations at the Narrabri Airport station are summarised in Table 24-4.

Adopting maximum values for background levels is not appropriate as these are overly conservative and not representative of typical ambient conditions, often attributed to extreme events. For the study area and monitoring site, exceedances of short-term limits for particulates are particularly sensitive to occurrences of dust storms and agricultural activities. For this reason, it was considered suitably conservative for this assessment to adopt the highest 70th percentile concentration, which is 20.7 $\mu g/m^3$ for PM_{10} and 6.4 $\mu g/m^3$ for $PM_{2.5}$. Both values are below the assessment criteria, accounting for 41 per cent and 26 per cent of the criterion, respectively.

TABLE 24-4 PARTICULATE MATTER CONCENTRATIONS MEASURED AT NARRABRI AIRPORT—REPRESENTATIVE OF BACKGROUND LEVELS FOR THE PROPOSAL

	Pollutant	Data capture rate[1]	24-hour average Concentration (µg/m³) [1]					24-hr averaging period exceedances
			Average	70th percentile	90th percentile	95th percentile	99th percentile	
2018	PM10 [2]	98.7%	14.3	14.0	21.5	26.5	98.9	10
	PM2.5 [3]	97.8%	4.9	5.2	7.6	9.3	15.7	1
2019	PM10	98.0%	23.3	20.7	46.1	77.6	155	33
	PM2.5	98.0%	7.9	6.4	16.6	26.0	64.4	22

1. Determined from 1-hour average recorded concentrations
2. Annual averaging period criterion is 50 µg/m³, 24-hour averaging period is 25 µg/m³
3. Annual averaging period criterion is 25 µg/m³, 24-hour averaging period is 8 µg/m³

Source: dpie.nsw.gov.au/air-quality/air-quality-data-services

Analysis of measured concentrations of PM_{10} at Narrabri Airport provide an indication of particulate matter concentrations in the vicinity of the study area. As such, Figure 24-6 provides an understanding of the months of the year when concentrations of fine particles are typically highest. It is evident that exceedances of the PM_{10} 24-hour averaging period are most frequent during summer months. Correlating this with our understanding of local meteorology (refer to section 24.2.3.2), it appears that while summer months experience increased rainfall, the increased temperatures and wind speeds result in increased ambient dust concentrations during summer.

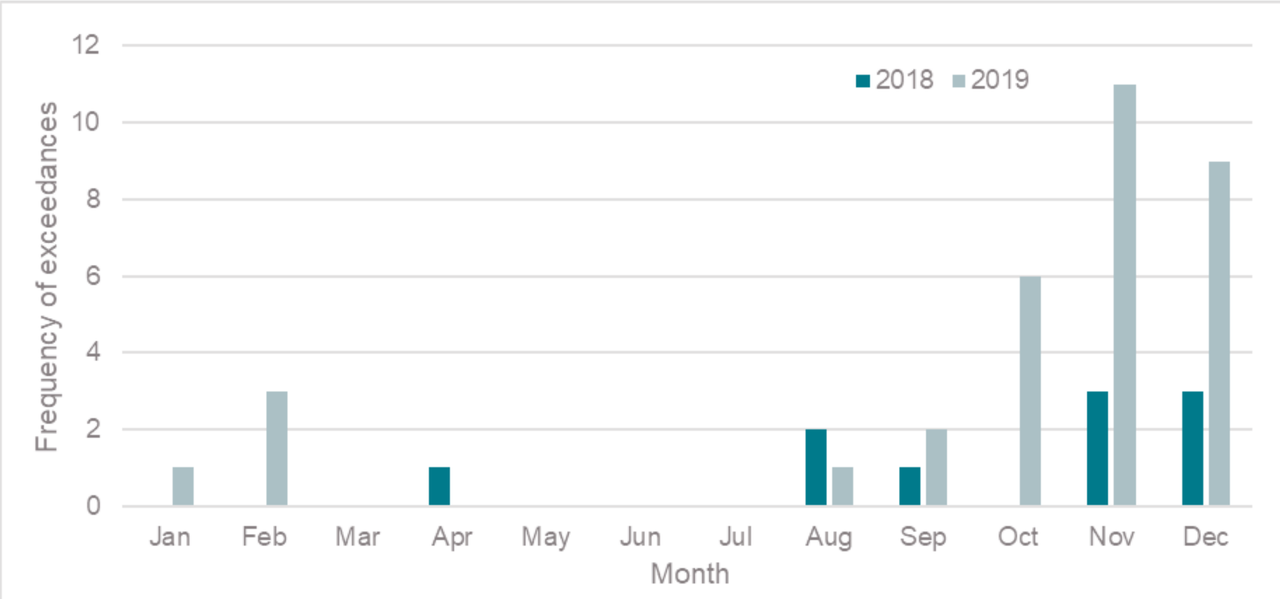


FIGURE 24-6 DISTRIBUTION OF EXCEEDANCES FOR THE PM_{10} 24-HOUR AVERAGING PERIOD RECORDED AT NARRABRI AIRPORT

According to the National Pollutant Inventory (NPI), for the 2018/2019 financial year, there were three facilities located within three kilometres of the study area that produced emissions exceeding the reporting threshold (DEE, 2019a). As the main activities for all three facilities are categorised as petroleum product wholesaling, these facilities do not produce reportable emissions of particles or NO_2, meaning cumulative impacts for these pollutants are not expected. While emissions of benzene from these facilities are more significant, cumulative impacts of benzene are not expected as these facilities are located more than 500 m from the study area.

24.2.4 Impact assessment

This section details the identification and assessment of potential construction and operation phase air quality risks. These risks are detailed in Appendix C: Environmental risk assessment. Risks assessed with a medium or greater level of risk include:

- impacts to local air quality during construction due to:
  - lime treatment
  - dust generation from bulk earthworks, exposed soil/stockpiles, vehicle movements on unsealed roads

- operation of construction plant and equipment
- construction workforce vehicle movements
- increased vehicle movements associated with transport of construction materials.

24.2.4.1 Construction

Several air quality risks were identified relating to construction of the proposal. Impacts to local air quality during construction may result due to PM, odour and combustion emissions. Specific activities may include:

- dust generation from bulk earthwork, exposed soil, and temporary stockpiles and vehicle movement on unsealed roads
- operation of construction plant, equipment and machinery
- increased vehicle movements associated with transport of construction materials, resulting in increased emissions
- odour and emissions from disturbance of contaminated soils if present
- relocation of utility services
- construction and installation of infrastructure (e.g. new tracks, roads, culverts and bridges)
- demolition and removal of existing track, culverts and bridges
- combustion of fuel in both light and heavy commercial vehicles (HCVs), and mobile plant.

Of these potential construction air quality impacts, the potential for PM (dust) generation is considered the highest risk. Exhaust emissions produced by construction vehicles and plant are expected to be less significant due to their nature (discontinuous, transient and mobile). Potential impacts from contaminated soil, including emissions and odour, are considered in Chapter 20: Soils and contamination.

Generation of particulate matter

During construction, exceedances of assessment criteria for dust at sensitive receiver locations could result from either (or a combination) of the following:

- high background levels of dust that are close to, or exceeding, the criteria
- high concentrations of dust, produced from construction activities, experienced at sensitive receiver locations due to:
  - generation of excessive emissions/insufficient use of dust control measures
  - unfavourable meteorological conditions, particularly dry, hot and windy conditions
  - close proximity of sensitive receivers to the study area.

Based on the specific land uses in the existing environment (refer to section 24.2.3), infrequent exceedances of assessment criteria due to high background concentrations are expected and are most likely to occur during summer months due to farming activities such as harvest and planting. During this time of year, the risk of dust impacts resulting from construction activities is also expected to be heightened due to increased wind speeds and temperatures. As such, the risk of construction dust impacts at sensitive receivers is expected to be highest during the summer months, with the lowest risk expected to be during June and July.

The density of sensitive receivers at a given location, and the distance separating sensitive receivers from the study area, also affects the level of risk for construction dust impacts. As both density and distance vary along the preferred corridor, the level of risk also varies. Construction works in and near the town of Moree pose the highest risk for construction dust impacts at sensitive receiver locations due to the high density of sensitive receivers located in proximity to the study area (within 20 m at some locations). While there are sensitive receivers located in the vicinity of the study area (within 200 m) along the remainder of the preferred corridor, the risk of construction dust impacts at these locations is significantly reduced due to increased separation distance and reduced density.

While construction works in and near the town of Moree during summer months pose the highest risk for construction dust impacts, it is important to note that any impacts from construction would be short-term only as construction works would move along the study area, limiting the duration of potential impacts at any one location.

The proximity of material haul routes to sensitive receivers also poses a significant risk due to dust generation on mainly unsealed or temporary access roads.

Emissions

Emissions (CO, NOx, SO_2, PM (PM_{10} and $PM_{2.5}$), VOCs and semi-volatile organic compounds from plant and equipment would occur through the combustion of diesel and petrol fuel.

Construction emission impacts generated by plant and machinery would depend on the quantity and power output of the relevant engines, as well as the quality of fuel and condition of the engine. It is unlikely that combustion emissions would be significant, and the associated impacts would be negligible, due to the intermittent and mobile nature of the construction works, as well as the geographical extent over which emissions would occur and the low number of sensitive receptors that may be directly impacted.

Odour

Odour emissions for some of the activities (e.g. excavation of potentially contaminated soil) may occur. It is anticipated, however, that any such occurrence would be localised and unlikely to impact sensitive receivers offsite. Potential impacts from contaminated soil, including emissions and odour, are considered in Chapter 20: Soils and contamination.

24.2.4.2 Operation

The primary air quality risk identified relating to operation of the proposal, potentially resulting in local air quality impacts, is increased train operations and railway maintenance works.

It is estimated that operation of the Inland Rail will increase the number of trains operating between Camurra and Moree, with 11 trains per day in 2027 increasing to 20 trains per day in 2040. Locomotives operating in the corridor will be diesel-fuelled, potentially generating the following air emissions:

- PM_{10} and $PM_{2.5}$
- NOx, CO and SO_2
- VOCs and SVOCs.

Emissions of NOx and fine particles are likely to be the most significant emissions associated with the proposal during operation, due to rail exhaust emissions.

Air quality impacts from busy rail corridors are generally only an issue in densely populated areas, with poor outdoor air circulation. *Development near rail corridors and busy roads*—interim guideline (Department of Planning, 2008), suggests that air quality should be a design consideration within 20 m of a freeway or main road with moderate congestion levels. The guideline provides no specific reference to a distance from rail corridors.

The majority of the study area traverses a rural area with few sensitive receivers and low background emission levels compared to other transport corridors in NSW. The potential for air quality impacts would be greater in the town of Moree, which has the greatest density of housing close to the alignment.

As part of the EIS assessment completed for N2NS Phase 1 (ARTC, 2017) the results of the *Northern Sydney Freight Corridor Strathfield Rail Underpass Air Quality Assessment* (Parsons Brinckerhoff, 2012) were reviewed with respect to the potential impacts of the operation of freight trains. The assessment included air quality modelling of 81 class diesel locomotives undertaking a minimum of 35 movements per day at 75 km per hour. The results of modelling indicated that for all assessed pollutants (NO_2, sulphur dioxide (SO_2), carbon monoxide (CO), PM_{10}, $PM_{2.5}$ and benzene) the predicted levels were significantly below the assessment criteria at a distance of 50 m from the track. The maximum predicted incremental impacts for PM_{10} and $PM_{2.5}$ as a 24-hour average were 0.06 $\mu g/m^3$ and 2 $\mu g/m^3$, respectively, which complied with the assessment criteria at all sensitive receivers. For benzene and NO_2, the maximum predicted incremental impacts were 3.2 $\mu g/m^3$ and 103 $\mu g/m^3$, respectively.

N2NS Phase 2 is currently forecast to operate at a rate of 11 trains per day in 2027 and up to 20 trains per day in 2040.The levels of operational rail traffic along the proposal would be considerably lower than for the Northern Sydney Freight Corridor. As such, operational air quality impacts for N2NS Phase 2 are also expected to be much lower. While these impacts would be increased compared to existing conditions, impacts are still expected to be well below the relevant impact assessment criteria for all key pollutants at both 2027 and 2040 operating capacities.

As there are no identified significant sources of air pollutants within 20 m of the proposal (e.g. factories or industries likely to emit significant quantities of air pollution, or facilities producing emissions exceeding the reporting threshold) cumulative impacts from operational activities are not expected.

24.2.5 Mitigation and management

This section details mitigation and management measures required to reduce the level of risk for potential construction and operation air quality impacts.

24.2.5.1 Approach to mitigation and management

An air quality and dust management sub-plan would be prepared as part of the CEMP and implemented during construction to ensure air quality impacts do not exceed relevant air quality criteria. The air quality and dust management sub-plan would help ensure that dust and emissions are managed in an environmentally sound manner, and in accordance with statutory requirements.

During construction, monitoring of construction dust as PM_{10} and/or $PM_{2.5}$ would be undertaken at sensitive receiver locations. To establish whether a measured exceedance was caused by construction activities or elevated background dust levels, it would be necessary to also measure local background dust concentrations. Air quality goals for the proposal during construction relate to the measured exceedance of criteria due to construction activities, when background levels for the same period are below and not close to the criteria. A measured exceedance due to elevated background levels would not constitute a breach of the air quality goals for the proposal. Assessment of measured wind conditions at Moree Airport could also be considered for this purpose.

During operation, air quality would be managed to achieve compliance with the operational EPL.

24.2.5.2 Consideration of the interactions between mitigation measures

Mitigation measures to control air quality impacts may overlap with the measures proposed for the control of erosion and sedimentation (described in Chapter 13: Surface water quality impact assessment and Chapter 20: Soils and contamination), as the major pollutant of concern is dust. All mitigation measures for the proposal would be consolidated and described in the CEMP. The CEMP would identify measures that are common between different aspects. Common impacts and common mitigation measures would be consolidated to ensure consistency and implementation.

Mitigation and management measures expected to be included in the CEMP and implemented during operation are summarised in Table 24-7.

24.3 Greenhouse gas

A GHG is any gas that has the property of absorbing energy emitted from the Earth's surface and re-radiating it back as heat. This heating effect increases with increased concentrations of GHG emissions, which are produced from natural events and anthropogenic activities, resulting in climatic changes. Potential climate change impacts on the proposal are addressed in Chapter 22: Climate change, and the reporting and management of GHG emissions are also covered in Chapter 23: Sustainability.

The latest *National Greenhouse Gas Inventory* (Department of Industry, Science, Energy and Resources, 2019) report showed that the transport sector emitted 102 million tonnes (Mt) of carbon dioxide equivalent in the 12 months prior to September 2019. This was equivalent to 18.9 per cent of Australia's GHG emissions.

As both construction and operation of the proposed N2NS Phase 2 would result in generation of GHG emissions, contributing to global warming and climatic changes, it is important to establish expected GHG emission impacts for N2NS Phase 2 and identify suitable mitigation measures.

24.3.1 Assessment approach

24.3.1.1 Legislative and policy context

In 2015, the Australian Government announced a commitment to target a reduction in GHG emissions by 26 to 28 per cent below 2005 levels by 2030. This target was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) at the 21st Conference of the Parties (COP21) that was held in Paris in December 2015. The Australian Government ratified the Paris Agreement on 9 November 2016. The Australian Government's *Direct Action Plan* (DEE, 2015) outlines policies that provide positive incentives for businesses and communities to reduce emissions, including the Emissions Reduction Fund and the Safeguard Mechanism to ensure that the 2030 emissions reduction target will be achieved.

The National Greenhouse and Energy Reporting Act (NGER Act) 2007 (Cth) provides a national framework for corporations to report on GHG emissions. Annual threshold values are specified for both facilities and corporations, where emissions must be reported if estimated emissions exceed the thresholds.

The National Greenhouse and Energy Reporting (Measurement) Determination (Clean Energy Regulator, 2008) provides methods for quantifying GHG emissions from production and consumption of energy by a facility, and from the operation of that facility.

In NSW, the *NSW Climate Change Policy Framework* (Office of Environment and Heritage (OEH), 2016) commits NSW to the aspirational objectives of achieving net zero emissions by 2050 and helping NSW to become more resilient to a changing climate.

24.3.1.2 Assessment approach

The Greenhouse Gas Protocol (WRI, 2004) establishes an international standard for accounting and reporting of GHG emissions. The protocol describes a project's GHG emissions as being either direct or indirect, and that can be delineated into the following three scopes for reporting purposes (also depicted in Figure 24-7):

- Scope 1 emissions are direct GHG emissions. These emissions are produced from sources that are owned or controlled by the company.
- Scope 2 emissions are electricity related indirect GHG emissions. These emissions are created from offsite generation of electricity, which is purchased and consumed by the reporting company. The Scope 2 emissions are physically produced offsite, at the electricity generation facility.
- Scope 3 emissions are other indirect greenhouse gas emissions. These emissions are produced by sources that are not owned or controlled by the reporting company but are a result of the company's activities.

GHG emissions are reported in terms of tonnes of carbon dioxide equivalent (t CO2-e), where a Global Warming Potential (GWP) index is applied to non-CO_2 gases to determine the equivalence. Some of the most commonly assessed GHGs are carbon dioxide (CO2), sulphur hexafluoride (SF6), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs).

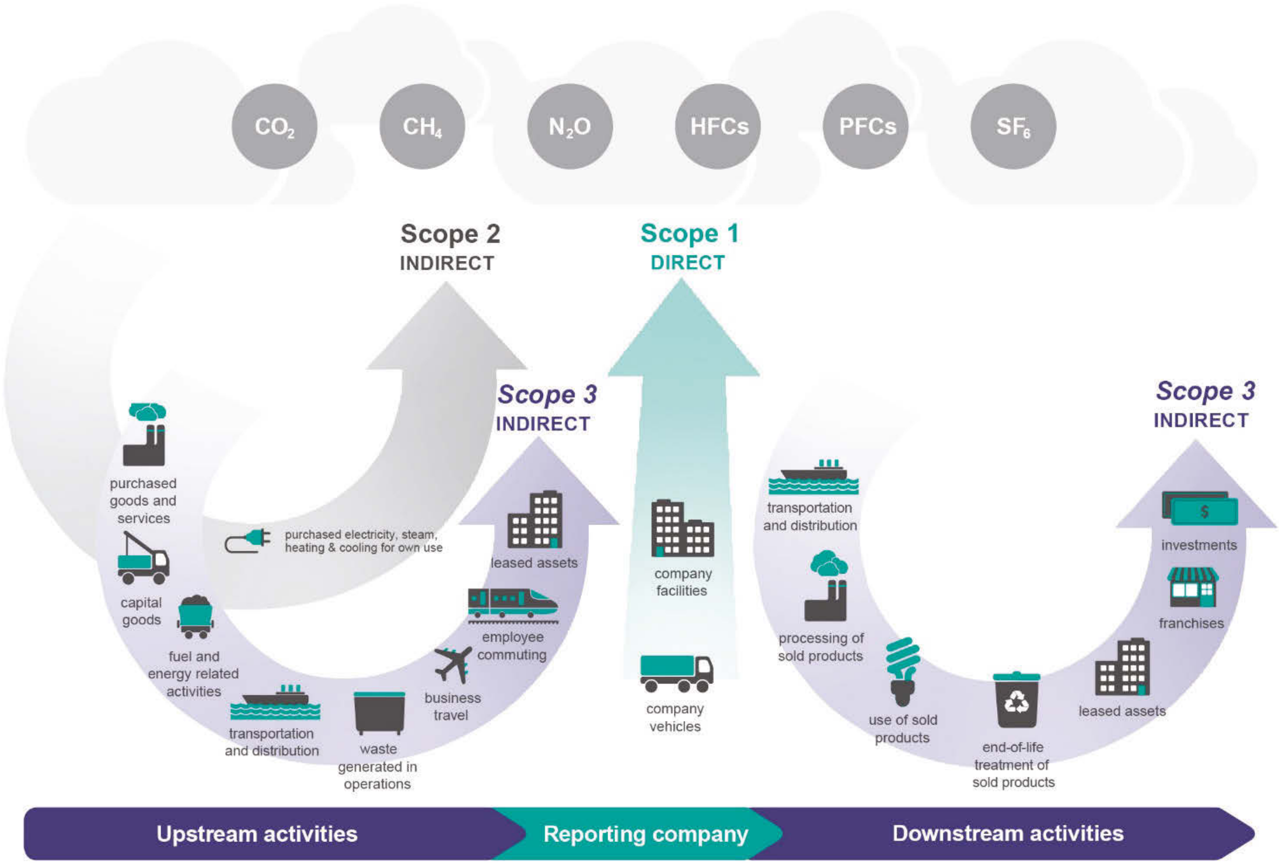


FIGURE 24-7 OVERVIEW OF SCOPES AND EMISSIONS (WRI, 2004)

The following items have been excluded from the GHG assessment due to either limited project information at the time the GHG assessment was completed, or due to being outside the scope of this GHG assessment:

- maintenance activities
- embodied GHG emissions from materials
- waste removal from site
- all other scope 3 emission sources, except for those associated with electricity use and material transport to site.

Of the excluded scope 3 emissions, embodied GHG emissions from construction and maintenance materials use and emissions associated with diesel fuel combusted by locomotives are expected to be significant sources of GHG emissions for N2NS Phase 2.

Emission factors were sourced from the *National Greenhouse Accounts Factors* (DEE, 2019b).

24.3.2 Impact assessment

This section details the identification and impact assessment of whole-of-life GHG emissions for N2NS Phase 2, including site preparation, construction and operation phases. Appendix C: Environmental risk assessment provides a risk rating for the risks associated with GHG emissions. Risks were either assessed as high or very high and included:

- emissions of GHGs from construction energy use and embodied energy in construction materials
- emissions of GHGs from operational energy use of trains and maintenance vehicles.

24.3.2.1 Construction

Construction GHG emissions include all sources of fuel and electricity use associated with both preparation of the proposal site and construction of N2NS Phase 2. Estimates of construction phase energy use and associated GHG emissions are indicative only, based on current project information (including construction methodology information detailed in Chapter 8: Construction of the proposal), specialist advice, industry experience and best practice. GHG emissions for the following sources were estimated:

- loss of carbon sequestration (vegetation clearance)
- combustion of diesel fuel (construction plant, equipment and vehicles)
- electricity use (largely site compounds).

Estimated construction phase GHG emissions for N2NS Phase 2 are summarised in Table 24-5. Combustion of diesel fuel is expected to be the most significant construction phase source of GHG emissions. The following provides an indicative understanding of activities most significantly contributing to this diesel consumption:

- transport of pre-cast concrete, bulk materials and deliveries (approximately 20 per cent)
- enabling works, bridge demolition and construction (approximately 25 per cent)
- culverts installation, earthworks and track formation construction (approximately 50 per cent)
- site rehabilitation works (approximately 5 per cent).

TABLE 24-5 SUMMARY OF ESTIMATED CONSTRUCTION PHASE GREENHOUSE GAS EMISSIONS FOR N2NS PHASE 2

Construction activity	Scope 1 emissions (t CO2-e)	Scope 2 emissions (t CO2-e)	Scope 3 emissions (t CO2-e)	Total emissions (t CO2-e)
Site office		199	22	221
Construction: Transport of pre-cast concrete units, bulk materials and deliveries to site			1,633	1,633
Construction: Stages (1, 2 and 3) enabling works, bridge demolition and construction	2,041		104	2,145
Construction: Stages (4, 5 and 6) culverts installation, earthworks and track formation construction	4,082		208	4,290
Construction: Stage (7) site rehabilitation works	408		21	429
Vegetation clearance (lost carbon sink)—Mehi River	184			184
Vegetation clearance (lost carbon sink)—Within construction impact zone (CIZ)	132			132
Vegetation clearance (lost carbon sink)—Gwydir River	184			184
Total	**7,032**	**199**	**1,988**	**9,218**

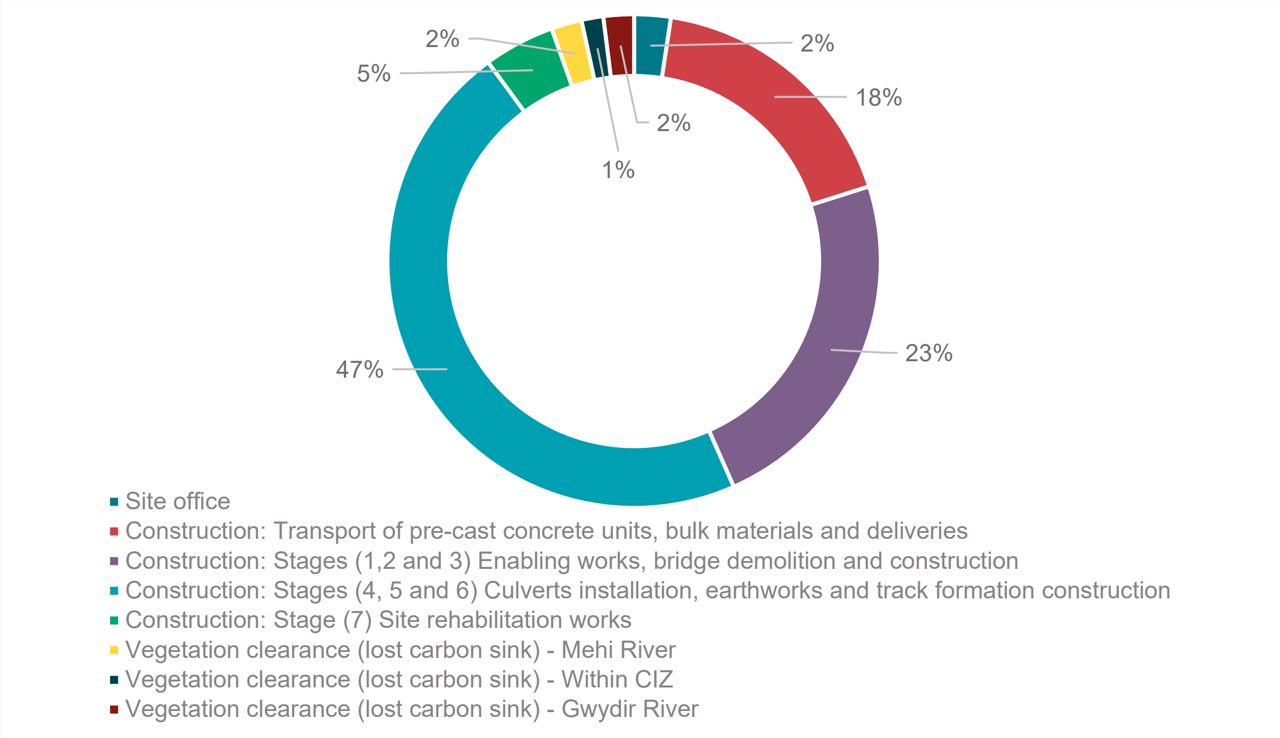


FIGURE 24-8 ESTIMATED CONSTRUCTION STAGE GREENHOUSE GAS EMISSIONS (TCO2-E) FOR N2NS PHASE 2

Key data inputs and assumptions for the construction GHG emission calculations include:

- NSW electricity grid GHG factor: Scope 2 = 0.81 kilograms (kg) CO2-e/kWh, Scope 3 = 0.09 kg CO2-e/kilowatt-hour (kWh) (NPI, 2019a)
- site office area = 360 square metres (m2)
- annual office electricity use = 314.72 kWh/m2 per annum (based on 3-star NABERS, using NABERS reverse calculator)
- diesel use for construction: transport of pre-cast concrete units, bulk materials and deliveries = 600 kilolitres (kL)
- diesel use for construction: sequences (1, 2 and 3) enabling works, bridge demolition and construction = 750 kL
- diesel use for construction: sequences (4, 5 and 6) culverts installation, earthworks and track formation construction = 1,500 kL
- diesel use for construction: sequences (7) site rehabilitation works = 150 kL
- vegetation clearing for Mehi River = 6,000 m2, vegetation class C, maximum biomass class 3
- vegetation clearing for within CIZ = 12,000 m2, vegetation class I, maximum biomass class 3
- vegetation clearing for Gwydir River = 6,000 m2, vegetation class C, maximum biomass class 3
- diesel use GHG factor: Scope 1 = 2.72 kg CO2-e/L, Scope 3 = 0.14 kg CO2-e/L (DEE, 2019a).

24.3.2.2 Operation

Once operational, the Inland Rail Program as a whole is predicted to reduce current carbon emissions by 750,000 tonnes (t) per year, as a result of transferring road freight to rail. Notwithstanding this, GHG emissions would be produced by the operation of the proposal.

Operational GHG emissions include all sources of fuel and electricity use associated with operation of N2NS Phase 2. Estimates of operational phase energy use and associated GHG emissions are indicative only, based on current project information (contained in other EIS chapters), specialist advice, industry experience and best practice. At the time of completing this assessment, only limited design detail was available.

Based on the information available, operation of active level crossings, including signals, boom gates and associated systems, along the study area were identified as operational phase energy uses. The assessment of operational energy use and associated GHG emissions was based on a 120-year design life and is summarised in Table 24-6 (in accordance with Transport for NSW's (TfNSW) *T HR CI 12002 ST Durability Requirements for Civil Infrastructure Standard (2017)* for design life of bridges, track slabs, rail corridor retaining walls and drainage systems). Level crossings are expected to be the only energy use and source of GHG emissions in operation.

TABLE 24-6 SUMMARY OF ESTIMATED OPERATIONAL PHASE GREENHOUSE GAS EMISSIONS FOR N2NS PHASE 2

Operational activity	Scope 1 emissions (t CO2-e)	Scope 2 emissions (t CO2-e)	Scope 3 emissions (t CO2-e)	Total emissions (t CO2-e)
LX-562—Gwydirfield Road	–	27	3	30
LX-563—The Rocks Road	–	27	3	30
LX-564—River Road (Pallamallawa Road)	–	27	3	30
Total	**–**	**81**	**9**	**90**

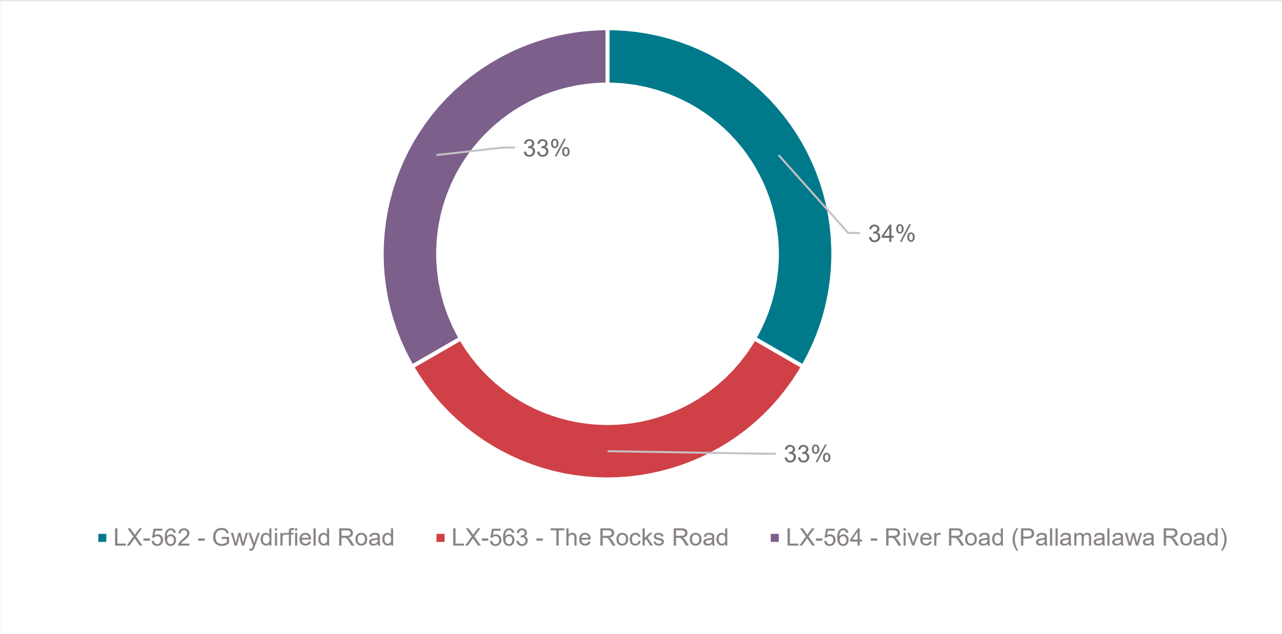


FIGURE 24-9 ESTIMATED OPERATIONAL STAGE GREENHOUSE GAS EMISSIONS (TCO2-E) FOR N2NS PHASE 2

Key data inputs and assumptions for the operational GHG emission calculations include:

- NSW electricity grid greenhouse gas factor: Scope 2 = 0.81 kg CO2-e/kWh, Scope 3 = 0.09 kg CO2-e/kWh (DEE, 2019a)
- LX-562: Gwydirfield Road lifetime electricity use = 33,257 kWh
- LX-563: The Rocks Road lifetime electricity use = 33,257 kWh
- LX-564: River Road (Pallamallawa Road) lifetime electricity use = 33,257 kWh.

24.3.2.3 Whole-of-life greenhouse gas emissions

Whole-of-life emissions are the sum of those estimated for construction and operation phases of N2NS Phase 2. The distribution by project phase is graphically presented in Figure 24-10, where construction phase emissions account for 99 per cent of the whole-of-life GHG emissions.

The whole-of-life GHG emissions for the proposal is 9,309 t of carbon dioxide equivalent.

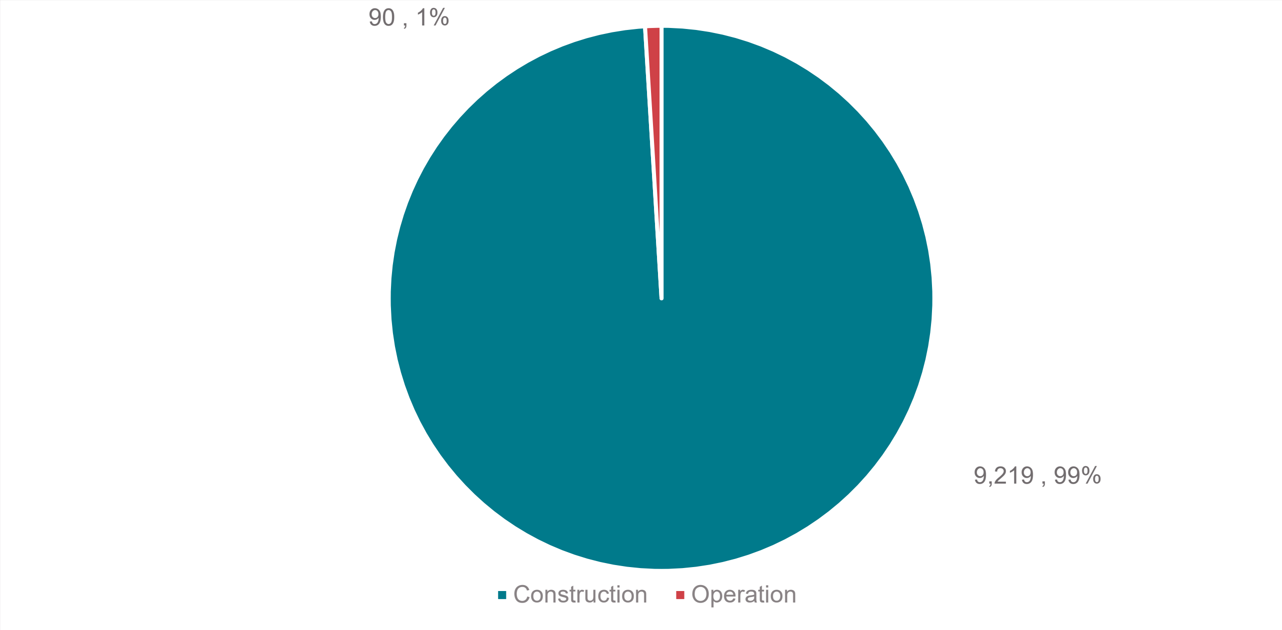


FIGURE 24-10 GRAPHICAL REPRESENTATION OF DISTRIBUTION OF ESTIMATED WHOLE-OF-LIFE GREENHOUSE GAS EMISSIONS (TCO2-E)

24.3.3 Mitigation and management

This section details mitigation and management measures required to reduce GHG emissions in construction and operation for the proposal.

24.3.3.1 Approach to mitigation and management

The carbon management principles (Environment Protection Authority Victoria, 2020) are detailed in this section and would be considered during detailed design and construction to reduce the GHG emissions impacts:

- **Measure**: What are you emitting?
- **Set objectives**: What do you want to achieve?
- **Avoid:** Can you avoid generating emissions?
- **Reduce** (modify–recover): Can you change your activities to reduce emissions?
- **Switch** (renew–exchange): Can you switch energy sources, so they are less greenhouse intensive?
- **Sequester**: Should you consider sequestering your emissions?
- **Assess**: What are your residual GHG emissions?
- **Offset**: Can you offset your residual GHG emissions?

24.4 Summary of mitigation measures of air quality and greenhouse gas emissions

The mitigation and management measures for N2NS Phase 2 are expected to reduce dust and GHG emission impacts in construction and operation if implemented. The measures outlined in Table 24-7 would be implemented to mitigate the potential impacts.

TABLE 24-7 SUMMARY OF MITIGATION MEASURES

Ref	Impact	Mitigation Measures	Timing
AQ-1	General air quality impacts	An air quality management plan (AQMP) would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for air quality impacts on the local community and environment. The air quality and dust management sub-plan would address all aspects of construction, including: - spoil handling - machinery operating procedures - soil treatments (lime)	Pre-construction and construction

Ref	Impact	Mitigation Measures	Timing
		▸ stockpile management ▸ haulage ▸ dust suppression ▸ dust monitoring.	
AQ-2	Dust control	▸ Controls would be implemented to prevent or minimise dust generation during activities involving excavation or disturbance of soils or vegetation, or handling ballast (e.g. use of water sprays or water carts for dust suppression as required).	Construction
AQ-3	Dust control	▸ A protocol would be established and implemented notifying relevant stakeholders when potential dust-generating activities are planned to be carried out. ▸ Where sensitive receivers are located within 150 m of construction works, or visible dust is generated, additional dust suppression measures (such as water carts, sealing haulage routes, and use of enclosures and wind breaks) would be implemented.	Pre-construction and construction

AQ-4	Dust monitoring	▸ Dust monitoring would be conducted at sensitive receiver locations and would move along the corridor with the progression of construction works. Any exceedances of assessment criteria would be investigated:
		  ▸ to enable prompt identification and mitigation of activities producing excessive dust levels. For amenity issues, a 1-hour monitoring period would occur. For an assessment against the standards, a 24-hour average would be undertaken
		  ▸ to establish the cause of any measured exceedances of assessment criteria, particularly during instances of region-wide dust events, a monitoring station at a location not expected to be impacted by construction activities would be used for the purpose of establishing local background concentrations.
			Construction

AQ-5	Dust control for stockpiles	▸ Long-term stockpiles would be avoided wherever possible; however, where necessary, long-term stockpiles would be established in locations with suitable separation from sensitive receptors. Long-term stockpiles would be stabilised and protected from erosive processes while not in use.	Construction
AQ-6	Rail vehicle emissions	Operations would be managed in accordance with the air quality management requirements specified in the relevant EPLs, which would likely cover air emissions from: ▸ locomotive idling and accelerating in the vicinity of Moree ▸ activities that generate dust.	Operation
AQ-7	Impacts during maintenance	▸ Maintenance service vehicles and equipment would be maintained and operated in accordance with the manufacturer's specifications.	Operation
AQ-8	Air quality	▸ Timely, meaningful responses to air quality or dust complaints would be provided. This may include investigations, corrective actions, monitoring or notification to relevant authorities.	Construction
AQ-9	Dust control	▸ Water and any additives (where required) used in dust suppression would be of suitable quality and would not result in environmental or human health risks, or impact rehabilitation outcomes.	Construction
GHG-1	Construction GHG emissions targets	▸ Targets to reduce GHG emissions during construction would be included in the proposal's sustainability management plan in line with Inland Rail's Sustainability Policy. ▸ As part of the ISCA IS rating, a GHG assessment would be undertaken based on the detailed design for the project and the final project when built.	Pre-construction and construction
GHG-2	Materials handling	▸ Construction and operational works would be planned to reduce the construction program, avoid double handling of materials and minimise haulage distances, thereby minimising the use of fuel.	Construction
GHG-3	Energy efficiency	▸ Energy efficiency design aspects would be incorporated into site offices wherever possible to reduce energy demand. Examples could include energy efficient lighting systems, natural ventilation, insulation and solar PV systems.	Pre-construction and construction
GHG-4	Procurement	▸ The procurement of renewable energy, low carbon intensive fuel or carbon emission offsets would be investigated if feasible.	Pre-construction and construction

Ref	Impact	Mitigation Measures	Timing
		The procurement of materials, goods and services would consider if they: - are from local suppliers - make use of recycled materials or materials with a low embodied energy content - are energy efficient or have low embodied energy - minimise the generation of waste.	
GHG-5	Operational GHG emissions of signalling and lighting	As part of the ISCA IS rating, a GHG assessment, which covers the operational phase emissions, would be undertaken based on the detailed design for the project and the final project when built.	Operation