North west transport network

Environmental Assessment Chapter 14
North West Transport Corridor

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14. Environmental assessment

14.1 Chapter purpose

This chapter summarises key findings of the environmental assessment undertaken on the NWTN program. The assessment examined the NWTN program's potential environmental impacts and actions for future phases to meet relevant policy, regulatory and legislative requirements, and issues of community concern. **Appendix K - Environmental Scoping Report** details investigations into environmental base line, impacts and recommendations for further investigations in future planning stages.

14.2 Approach

Table 14-1 summarises assessment methodologies applied for each environmental factor. The assessment includes desktop assessment with site investigations conducted for ecological field studies, cultural heritage assessment and preliminary modelling for noise and vibration. This is appropriate with the level of design of proposed projects and the project development and assessment requirements associated with future detailed business case(s).

The assessment considers the NWTN program variations which are made up of active transport, BRT, motorway and rail alignments. The assessment of each proposed project alignment has an assumed 10 m buffer for the construction footprint that is considered a direct impact on the local receiving environment.

Table 14-1: Environmental factors and associated assessment approach

Environmental factor	Assessment methods
Topography, geology and soils	Review of available desktop mapping, including identification of areas of potential contamination based on land use, and potential occurrence of acid sulphate soils within the NWTN Business Case Area.
Waterways and wetlands	Desktop review of publicly available mapping; including identification of watercourse classification, coastal districts and erosion prone areas, Queensland waterways, and wetland data mapping intersecting the NWTN Business Case Area.
Flora and fauna	Desktop review of publicly available reports and spatial data for terrestrial and aquatic flora and fauna. Field assessments of the NWTC competed in February 2021 (stage 2) and NWTN program completed in August 2021 (NWTN program business case). The field survey for Stage 2 assessed floristic composition structure health of vegetation communities, and potential habitat for threatened flora and fauna within the NWTC, particularly in the Chermside Hills Reserve and nearby area. The field survey assessed presence of threatened flora and threatened ecological communities, existing vegetation communities, made observations of threatened/colonial breeding fauna species, determined habitat suitability of threatened fauna species, and evaluated habitat connectivity in the area outside the NWTC. 'Likelihood of occurrence' assessment of flora and fauna species, based on field survey findings and database searches of the *Environment Protection and Biodiversity and Conservation Act 1999* Protected Matters Search Tool and Queensland Government's WildNet database. Observations of threatened fauna habitat and suitability. Calculations of estimated impact areas based on alignments with a 10m buffer for direct impact areas (impact areas are based on a calculation of the hectares and is an approximate figure subject to refinement once the extent of vegetation and clearing are confirmed).

Environmental factor	Assessment methods
Sensitive receptors	Desktop review of sensitive receivers in the vicinity of program 4a and program 4b for air quality and noise and vibration.
Air quality	Consideration of available climate information, including rainfall patterns, air temperatures, humidity, and wind (direction and speed) and other factors that may affect management for program 4a and program 4b. See **Chapter 15 - Sustainability and social value assessment** for information in relation to climate change.
Noise and vibration	Preliminary noise level and vibration modelling of airborne noise, groundborne noise, and groundborne vibration. Identification of potential impacts and mitigation measures generated from the noise level and vibration assessments.
Resources use and management (including waste)	Identification of responsible resource use and potential waste streams, the sources required for construction and relevant protocols required. Review of construction methods and the associated waste that can potentially occur. Consideration of raw material consumption and incorporation of circular economy principles for disposal. This is assessment is complemented by the assessments in **Chapter 15 - Sustainability and social value assessment**.
Landscape and visual amenity	Desktop assessment of existing landscape and visual values within and adjacent to the NWTN Business Case Area, including consideration of landscape elements, zoning, open space, character, value and sensitivity. This is assessment is complemented by the assessments in **Chapter 12 - Land use planning and placemaking** and **Chapter - 13 Social impact evaluation**.
Cultural heritage	Desktop searches and reviews of statutory and non-statutory registers and databases for Aboriginal and non-Aboriginal cultural heritage, and traditional owner identification. Cultural heritage site inspections undertaken from public vantage points to confirm identified of any known cultural heritage places and potential places. Assessment of risk associated with the Reference Projects with a 10m buffer for direct impact areas and 150m buffer for the buffer area, based on outcomes of desktop review and cultural heritage inspections.

14.2.1 Limitations and assumptions

The environmental assessment has been largely a desktop assessment of the business case area, which covers approximately 40km² of north-west Brisbane. The designs of the alignments within program 4a and program 4b included approximate lengths of tunnel sections, cut and cover areas (dive structures and tunnel portals), surface areas, railway stations, car parks, and construction footprints. At this stage design has not progressed to details such as bridge types, land crossings, tunnel ventilation types and locations, and the network integration into existing infrastructure. The designs included approximate lengths of sections of at-grade, cut, tunnels and these are summarised in **Chapter 9 – Preferred program**. For the purposes of this assessment, the footprint of the network option alignments was assessed.

Given the limits in the design details, only preliminary modelling and assessments were completed for air quality, ecology, acoustic, and Aboriginal cultural heritage at this stage. Visual impact assessments have not been undertaken at this stage. These assessments will be undertaken in future phases of the project.

Due to the current detail of the designs and the fact that two network combinations are being considered, the assessment has not allowed for the potential for positive benefits such as revegetation or reinstatement of habitat, adopting a precautionary principle of 'worst case scenario' approach. Potential mitigation measures will be investigated in future detailed business cases for proposed projects.

Similarly, the assessment has not considered specifics of crossings at waterways, such as the exact location of bridge piers and piles.

The assessment considered direct impacts on mapped environmental and heritage elements to the specific NWTN network. However, there are areas considered that are the same for either program variation (4a or 4b). Where this is the case, these are described prior to network specific assessment. The evaluation criteria and performance measures are discussed in more detail in **Section 14.4**.

14.2.1.1 Active transport and network enhancement projects

This environmental assessment focuses on BRT, motorway and rail infrastructure proposed as part of the NWTN program. These projects are the focus due to their scale and level of potential impact to environmental factors. Active transport shared paths are identified within North West Motorway (western alignment) (program 4a) and North West Rail with at surface Bridgeman Downs station (program 4b) and are included in the assessment as they assumed to be delivered with these large scale projects.

The prioritised list of active transport projects and the potential network enhancements outlined in **Chapter 10 - Transport analysis** would also have potential environmental impacts that will require management during planning, construction and delivery. These will be addressed through established investigation and project assessment processes relevant to the agency (State or local government) delivering.

14.3 Legislative and policy context

Appendix K - Environmental Scoping Report provides a summary of the legislation, policies and plans that are expected to be applicable to the project. The recommendations in this report are based on the interpretation of available information at the time of writing. Approval requirements may vary depending on the final design and construction methodology, and future changes in statutory requirements prior to project implementation.

14.4 Identification of environmental impacts

14.4.1 Topography, geology and soils

14.4.1.1 Topography

The topography across Brisbane is generally flat, with areas of localised varied topography. The elevation at the coast is sea level, rising to around 500 m Australian Height Datum (AHD) at Mount Nebo. The average elevation of Brisbane is 48 m AHD. **Table 14-2** summarises topography associated with each NWTN network proposed project.

Table 14-2: Program 4a and 4b topography

Proposed project	Topography	4a	4b
North West Rail (both variations)	The topography in the area is relatively flat, ranging from around 10m AHD to the north, to 30m AHD in the central and southern section the southern area around 10m AHD.	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	The topography in the area is relatively flat, with the elevation for the northern section around 20m AHD, the central section ranging from 40-60m AHD, and the southern section ranging from 20–40m AHD.	✓	
Active transport with motorway		✓	

Proposed project	Topography	4a	4b
BRT	The topography in the area is relatively flat, with the elevation from the north to south sections ranging from 20-40m AHD.	✓	✓
North West Motorway (eastern alignment)	The topography in the area is relatively flat, ranging from 20m AHD in the north, and the central and southern section ranging from 20-40m AHD.		✓

14.4.1.2 Acid sulfate soils

Mapping indicates that except for the coastal areas, much of the NWTN Business Case Area is mapped as negligible likelihood of containing acid sulphate soils (ASS). There are areas of high probability (moderate confidence) of ASS occurring at South Pine River and Breakfast Creek and their immediate surrounding environments.

14.4.1.3 Unexploded ordnance

This mapping indicates an area of 'other' associated with Mount Strathpine/Petrie (this was a site of Encampment and Training Area during the Second World War) intersecting the program 4a and 4b rail alignments along the Caboolture/Sunshine Coast railway line.

14.4.1.4 Contamination

As the design is refined, a search of the EMR/CLR will be undertaken to determine whether any lots are recorded as containing potential contamination. Rail corridors, associated rail infrastructure, and Council open spaces are commonly listed on the CLR. The NWTN Business Case Area intersects these land zones which may generate potential risks to the NWTN program. Consideration of contamination within NWTN Business Case Area will be untaken as part of future project stages.

14.4.1.5 Geology

The geology related to the NWTN was investigated through consideration of the Queensland 'MinesOnline' Website 1:250 000 scale Geological Map. Details of this assessment is included in **Appendix K - Environmental Scoping Report**. During future project stages, it is recommended that geological conditions are considered in further detail to inform design development particularly in relation to proposed projects involving tunnelling.

14.4.1.6 Soils

Geotechnical considerations will inform design refinement, including consideration of soft soils in alluvial areas, which could require ground improvement, potential shrinkage/swelling of reactive clays, and slope stability of cuttings and embankments. **Table 14-3** provides a summary of the soils within the alignments of program 4a and 4b.

Table 14-3: Program 4a and 4b soils

Proposed project	Soils present	4a	4b
North West Rail (both variations)	• Soils are classified as hydrosols to the north, which are distributed to low lying narrow coastal plains and seepage areas on lower slopes. These soils are found in very poorly drained sites with rainfall between 40mm and 220mm. They are primarily found on flat to gently sloping alluvial plains with a firm surface condition. • Soils are classified as sodosols to the south, which are a texture-contrast soil which is strongly sodic. These soils are found in very poorly drained sites with rainfall between 290mm and 580mm. The soils have low permeability and dispersible subsoils contributing to soil erosion if exposed. • Southern, central and northern sections of the alignment are mapped as having extremely low probability of ASS (very low confidence) • Northern sections (aligned with South Pine River and Conflagration Creek) and southern sections mapped as high probability (moderate confidence) with sections in the north of high probability (very low confidence) (Source: ASRIS).	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• Soils are classified as hydrosols to the north. • Soils are classified as sodosols to the south. • Alignment is mapped as extremely low probability of ASS (very low confidence) (Source: ASRIS)	✓	
Active transport with motorway		✓	
BRT	• Soils are classified as sodosols along the whole alignment. • Alignment is mapped as extremely low probability of ASS (very low confidence) (Source: ASRIS)	✓	✓
North West Motorway (eastern alignment)	• Soils are classified as hydrosols to the north. • Soils are classified as sodosols to the south. • Alignment is mapped as extremely low probability of ASS (very low confidence) (Source: ASRIS)		✓

14.4.1.7 Potential impacts and approvals

Soils

Construction activities with potential geology and soils impacts include ground disturbance activities such as vegetation clearing and earthworks for the construction of new infrastructure.

During construction, there is a risk that sediment will be transported from exposed soils in surface water runoff. Construction at or adjacent to the waterways within the Business Case Area may pose a risk of sediment entering the waterways, resulting in localised reduction in water quality and impacts to aquatic habitat.

A detailed erosion and sediment control plan should be developed as part of the project Environmental Management Plan (EMP) and implemented during construction to divert clean water around the Business Case Area and to capture construction sediment within the Business Case Area to prevent transport to waterways.

Acid sulfate soils

The mapping indicates there is a high risk of encountering ASS associated with the rail programs 4a and 4b, specifically in the northern area associated with the South Pine River and the southern area with Breakfast Creek. Throughout the other direct impact areas of the programs there is low risk of encountering acid sulfate soils.

Sampling should be undertaken to establish the presence or absence of ASS. If ASS or potential ASS (PASS) are present, an Acid Sulphate Soil Management Plan should be prepared to minimise the possibility of environmental damage from the mishandling or mistreatment of soils.

Topography

Steeper slopes may be more susceptible to localised instability and surface erosion depending on the vegetation cover, geometry of existing slopes, discontinuity state of the rockmass, state of weathering, properties of superficial deposits and potential for overland or channelised flow during storm or flood events.

Where the proposed design has encountered areas of undulation, it has responded with a suitable vertical alignment (such as areas of cut at Gympie Road, Webster road, Albany Creek Road, Linkfield Road, and tunnel at Gympie Road, Albany Creek Road, Linkfield Road).

Geotechnical considerations

Geotechnical considerations include soft soils in alluvial areas, which could require ground improvement, potential shrinkage/swelling of reactive clays, and slope stability of cuttings and embankments.

Geotechnical investigations should be undertaken to inform the design including boreholes and test pits with appropriate in-situ and laboratory testing.

14.4.2 Waterways and wetlands

14.4.2.1 Catchments

The NWTN Business Case Area sits within the Pine River and Lower Brisbane River catchment areas.

- **Pine River:** The freshwater waterways within this catchment are in a 'good' condition (conditions meet guidelines for most of the reporting area, most key processes are slightly impacted, and most critical habitats are intact).
- **Lower Brisbane River:** In the last 12 months, the condition of this catchment has declined slightly from fair to poor condition (where conditions meet few of the guidelines in most of the reporting area, many key processes are not functional and most critical habitats are impacted).

14.4.2.2 Wetlands

The NWTN Business Case Area includes wetlands that are part of the Moreton Bay Ramsar site, which are recorded on the Directory of Important Wetlands in Australia (DIWA) as a Nationally Important Wetland, as well as wetland reserves managed by Council.

Table 14-4 identifies the wetlands potentially directly or indirectly impacted by the alignment options where network programs are proposed above ground. These are also shown in **Figure 14-1**.

Table 14-4: Program 4a and 4b wetlands

Proposed project	Proximity to wetlands	4a	4b
North West Rail (both variations)	• Area of Lacustrine wetland approximately 130m south of the Caboolture/Sunshine Coast rail line between Strathpine Station and Bald Hills • Area of Riverine wetland associated with South Pine River approximately 250 m south of the Caboolture/Sunshine Coast rail line between Strathpine Station and Bald Hills • Area of Palustrine wetland associated with the unnamed tributary of South Pine River approximately 615m south of the Caboolture/Sunshine Coast rail line between Strathpine Station and Bald Hills • Area of Palustrine wetlands approximately 100m north-west of the Linkfield Road/Gympie Road intersection • Area of Estuarine wetland associated with Breakfast Creek intersects the existing Caboolture/Sunshine Coast rail line between Albion Station and Mayne Yard • Wetland regional ecosystem mapped at Four Mile Creek • Wetland regional ecosystem mapped at Cabbage Tree Creek • Wetland regional ecosystem mapped at South Pine River • Area of high ecological significance wetland at South Pine River	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• Wetlands regional ecosystem associated with the unnamed tributary of Cabbage Tree Creek approximately 270m north-east of Gympie Road/ Beams Road Carseldine • Area of wetland regional ecosystem approximately 90m north-west of Hamilton Road/ Trouts Road Chermside West • Area of wetland regional ecosystem at Cabbage Tree Creek	✓	
Active transport with motorway		✓	
BRT	• Wetland regional ecosystem mapped approximately 680m north-west of Hamilton Road/Gympie Road Chermside.	✓	✓
North West Motorway (eastern alignment)	• Wetland regional ecosystem associated with the unnamed tributary of Cabbage Tree Creek approximately 70m north-east of Gympie Rd/ Beams Road Carseldine • Wetland regional ecosystem associated with the unnamed tributary of Cabbage Tree Creek approximately 500m north of Gympie Road/ Beams Road Carseldine • Area of Riverine Wetland associated with Downfall Creek at Hamilton Road/ Webster Road Chermside.		✓

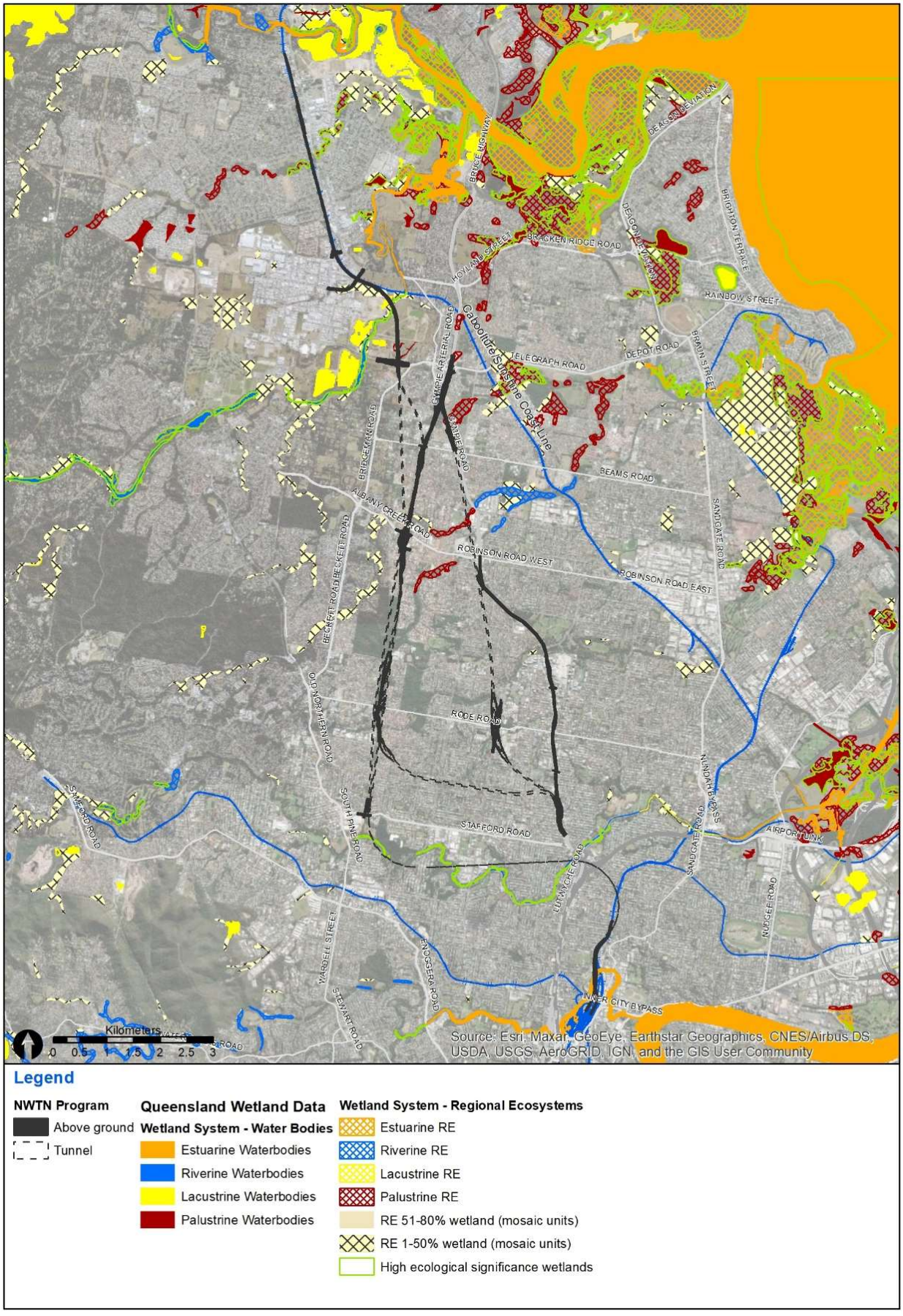

Figure 14-1: Wetlands mapping

14.4.2.3 Moreton Bay Marine Park

The Moreton Bay Marine Park extends from Caloundra South to the southern tip of South Stradbroke Island, with the border extending up to the highest tidal mark. The Moreton Bay Marine Park is recognised as an internationally significant wetland under the Ramsar convention. Ramsar wetlands are recognised as a matter of national environmental significance (MNES) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). An action that has, will have, or is likely to have, a significant impact on the ecological character of a Ramsar wetland must be referred to the Minister of Environment and undergo an environmental assessment and approval process.

14.4.2.4 Waterways

The Department of Agriculture and Fisheries (DAF) has mapped all waterways in Queensland according to their level of risk for impacts to fish movement and aquatic habitat. The mapping defines whether the site of proposed waterway barrier works requires assessment and approval under the *Fisheries Act 1994*. These coloured zones indicate if waterway barrier works can proceed under the relevant DAF Accepted Development code or if the works require an Operational Works permit, that is, constructing or raising a waterway barrier, with green being the least risk and purple being highest risk of adverse impact on fish movement.

Council also maps waterways under the City Plan 2014, considering both city-wide waterways and local waterways. While the city-wide waterways generally align with the DAF waterways, the local waterways include minor waterways not covered by the DAF mapping. These features are generally mapped as drainage features under the *Water Act 2000* and have biodiversity significance which would need to be considered during project design.

Table 14-5 lists waterways and watercourses intersected the program options where proposed projects are above ground.

Table 14-5: Program 4a and 4b waterways and watercourses

Proposed project		4a	4b
North West Rail (both variations)	• Four Mile Creek mapped as an amber (moderate risk of impact) waterway crossing the existing Caboolture/Sunshine Coast rail line between Bray Station and Lawnton Station • South Pine River mapped as a purple (major risk of impact) waterway crossing approximately 180m south of the Caboolture/Sunshine Coast rail line between Strathpine Station and Bald Hills Station • Conflagration Creek (drainage feature) crossing approximately 35m south of the Caboolture/Sunshine Coast rail line • An unmapped tributary of South Pine River mapped as a green (low risk of impact) waterway crossing rail alignment approximately 550m south of the Caboolture/Sunshine Coast rail line between Strathpine Station and Bald Hills • An unmapped tributary of South Pine River mapped as a green (low risk of impact) waterway crossing the rail alignment approximately 615m south of the Caboolture/Sunshine Coast rail line between Strathpine Station and Bald Hills Station • An unmapped tributary of South Pine River mapped as a green (low risk of impact) waterway crossing the rail alignment approximately 40m north of Linkfield Road • Breakfast Creek mapped as a tidal waterway (major risk of impact) crossing the existing Caboolture/Sunshine Coast rail line.	✓	✓
Active transport with rail			✓

Proposed project		4a	4b
North West Motorway (western alignment)	• Cabbage Tree Creek mapped as an amber (moderate risk of impact) waterway crossing approximately 320m north of Albany Creek Road, Aspley • An unnamed tributary of Cabbage Tree Creek (Drainage feature) crossing approximately 230m west of Gympie Road Carseldine • Little Cabbage Tree Creek mapped as a green (low risk of impact) waterway crossing approximately 30m north of Hamilton Road, Chermside West • Downfall Creek mapped as a green (low risk of impact) waterway crossing approximately 30m north of Trouts Road, McDowall.	✓	
Active transport with motorway		✓	
BRT	• Downfall Creek mapped as an amber (moderate risk of impact) waterway crossing approximately 750m north of the intersection of Gympie Road/Hamilton Road Chermside	✓	✓
North West Motorway (eastern alignment)	• Downfall Creek mapped as an amber (moderate risk of impact) waterway crossing approximately 600m north-west of the intersection of Rode Road and Webster Road Chermside • An unnamed tributary of Downfall Creek mapped as a green (low risk of impact) waterway crossing approximately 180m south of the intersection of Rode Road/Webster Road Chermside		✓

14.4.2.5 Fish habitat areas

A declared fish habitat area is protected against physical disturbance from coastal development. All habitats within these areas (including marine plants, sand flats, riverbanks and rocky shores) are protected, and limited development is permitted.

There is an area of fish habitat associated with the Tinchi Tamba wetlands and Hayes inlet, these areas are outside of the NWTN Business Case Area.

14.4.2.6 Coastal management district

Coastal management districts are areas that have the potential to be influenced by coastal hazards such as erosion, storm tide inundation and sea level rise. Coastal management districts are declared under the *Coastal Protection and Management Act 1995* (Coastal Act).

Storm tide inundation areas are defined by areas of land temporarily inundated by a defined storm-tide event, by default the measurement of 1.5m above the highest astronomical tide is used to identify the area of inundation for South East Queensland.

Table 14-6 identifies North West Rail as the only proposed project within the NWTN program intersecting with areas of coastal management districts or storm-tide inundation.

Table 14-6: Program 4a and 4b Coastal Management Areas

Proposed project		4a	4b
North West Rail (both variations)	• Mapped Coastal Management District where Breakfast Creek intersects the rail alignment. • Storm tide inundation associated with South Pine River • Storm tide inundation associated with Breakfast Creek	✓	✓

14.4.2.7 Potential impacts and approvals

The NWTN Business Case Area contains waterways and wetlands of significance, and there is potential that construction works, and future operation of infrastructure may have a detrimental effect on these sites. Soils in the north of Brisbane are generally fragile and prone to erosion. Waterway crossings will need to be designed to minimise erosion and increase of velocity in streams to manage impacts to water quality and aquatic biota. Construction of the project will need to consider appropriate mitigation through the implementation of an Erosion and Sediment Control Plan.

Moreton Bay is a Ramsar Wetland and is recognised as a MNES under the EPBC Act. If the project is likely to have a significant impact on the ecological character of the Moreton Bay Wetlands, it would need to be referred to the Minister of Environment under the EPBC Act.

Works within or adjacent to waterways may cause impacts on riparian vegetation, water quality and ecological processes. Works that involve the destruction of vegetation, excavation or placing of fill within the bed and banks of a watercourse, lake or spring or any other water-related development may require approval under the Water Act.

Earthworks which are carried out within the channel of these creeks may require a Riverine Protection Permit unless the works can be carried out in accordance with certain exemption requirements. Government departments (including Council) are considered authorised entities under the guidelines and can operate under the exemption requirements provided they can achieve the minimum requirements specified in Section 4 of the exemption document.

It is dependent on what works will be undertaken within waterways as to whether a permit will be required, both for temporary waterway barriers (i.e. during construction) and permanent barriers such as bridges and culverts.

If a project is likely to extend into a fish habitat area or coastal management district, a development application will need to be sought if the project cannot comply with the accepted development requirements under the Planning Act.

14.4.2.8 Summary of potential impacts

Table 14-7 provides a summary of the main points of difference between program 4a and program 4b.

Table 14-7: Program 4a an 4b Primary waterway and wetland impacts

Proposed project	Waterway and wetland impacts	4a	4b
North West Rail (both variations)	• Bridges are proposed where the rail alignment crosses Conflagration Creek, South Pine River, and the several unnamed tributaries of South Pine River. The bridges will need to be designed in accordance with the Accepted Development Requirements (ADR) for operational work that is constructing or raising waterway barrier works (DAF October 2018), or alternatively will require a permit for raising or constructing a waterway barrier. • The extension of the existing railway line at Four Mile Creek and Breakfast Creek the design will need to be in accordance with the ADR (DAF October 2018), or alternatively will require a permit for raising or constructing a waterway barrier. • Should the extension of the existing railway line be required at Breakfast Creek, a development assessment for prescribed tidal works will be required. Depending on the extent of works, an assessment for potential impacts to marine plants will also be required.	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• Crossings of Cabbage Tree Creek, Little Cabbage Tree Creek and Downfall Creek are to be designed in accordance with the Accepted Development Requirements for operational work that is constructing or raising waterway barrier works (DAF October 2018). If design cannot comply with these requirements, a permit for raising or constructing a waterway barrier will be required.	✓	
Active transport with motorway		✓	
BRT	• Th extension of the crossing at Downfall Creek and the unnamed tributary of Downfall Creek will need to be undertaken in accordance the Accepted Development Requirements for operational work that is constructing or raising waterway barrier works (DAF October 2018), or seek a permit for raising or constructing a waterway barrier.	✓	✓
North West Motorway (eastern alignment)	• Crossings of Cabbage Tree Creek and the unnamed tributary Downfall Creek are to be designed in accordance with the Accepted Development Requirements for operational work that is constructing or raising waterway barrier works (DAF October 2018), or seek a permit for raising or constructing a waterway barrier.		✓

14.4.3 Flora

14.4.3.1 Restricted and prohibited invasive plants

Landholders have a general biosecurity obligation under the Biosecurity Act to take all reasonable and practical steps to minimise the risks associated with invasive plants.

Given the predominantly urban location and the likely degrading processes on natural vegetation communities, there are likely to be several invasive species present. The location and extent of any restricted invasive plant infestations should be confirmed prior to any vegetation clearing works and appropriate measures included to control the spread of seeds or plant material into environmentally significant areas.

14.4.3.2 Remnant vegetation

A review of the Queensland Regional Ecosystem (RE) mapping, where NWTN program options are proposed above ground, identified potential impacts on remnant vegetation. **Table 14-8** identifies remnant vegetation intersected by the proposed projects and potential level of impact assessment. Impact assessment is based on a calculation of the hectares that will be subject to direct impact and is an approximate figure subject to refinement once the extent of vegetation and clearing are confirmed. **Figure 14-2** maps RE areas in relation to proposed project alignments.

Table 14-8: Program 4a and 4b Queensland Regional Ecosystem

Proposed project	Regional ecosystems intersected	4a	4b
North West Rail (both variations)	RE 12.1.3, described as the 'least concern' mangrove shrubland to low closed forest on marine clay plains and estuaries – Impacting 0.51ha of 'Endangered' RE.	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• RE 12.3.7, described as the 'least concern' Eucalyptus tereticornis, Casuarina cunninghamiana subsp. cunninghamiana +/- Melaleuca spp. fringing woodland. • RE 12.3.11, described as the 'of concern' Eucalyptus tereticornis +/- Eucalyptus siderophloia, Corymbia intermedia open forest on alluvial plains usually near coast. • RE 12.5.2a, described as the 'endangered' Corymbia intermedia, Eucalyptus tereticornis open forest on remnant Tertiary surfaces, usually near coast and on deep red soils. • RE 12.11.5, described as the 'least concern' Corymbia citriodora subsp. variegata woodland to open forest +/- Eucalyptus siderophloia/E. crebra, E. carnea, E. acmenoides, E. propinqua on metamorphics +/- interbedded volcanics. • RE 12.11.24 described as the 'least concern' Eucalyptus carnea or E. tindaliae, Corymbia intermedia +/- E. siderophloia or E. crebra woodland on metamorphics +/- interbedded volcanics. • RE 12.11.25, described as the 'least concern' Corymbia henryi and/or Eucalyptus fibrosa subsp. fibrosa +/- E. crebra, E. carnea, E. tindaliae woodland on metamorphics +/- interbedded volcanics. – Impacting 6.56ha 'Least concern' RE. – Impacting 0.52ha 'Of concern' RE. – Impacting 1.21ha 'Endangered' RE.	✓	
Active transport with motorway		✓	

Proposed project	Regional ecosystems intersected	4a	4b
BRT	• RE 12.3.11, described as the 'of concern' *Eucalyptus tereticornis +/- Eucalyptus siderophloia*, *Corymbia intermedia* open forest on alluvial plains usually near coast. – Impacting 0.003ha 'Of concern' RE.	✓	✓
North West Motorway (eastern alignment)	• RE 12.9-10.17a, described as the 'least concern' *Eucalyptus acmenoides*, *E. major, E. siderophloia +/- Corymbia citriodora* subsp. *variegata* open forest on sedimentary rocks. • RE 12.12.3, described as the 'least concern' open forest complex with *Corymbia citriodora* subsp. *variegata*, *Eucalyptus siderophloia* or *E. crebra* or *E. decolor, E. major* and/or *E. longirostrata, E. acmenoides* or *E. portuensis* on Mesozoic to Proterozoic igneous rocks. – Impacting 1.15ha 'Least concern' RE		✓

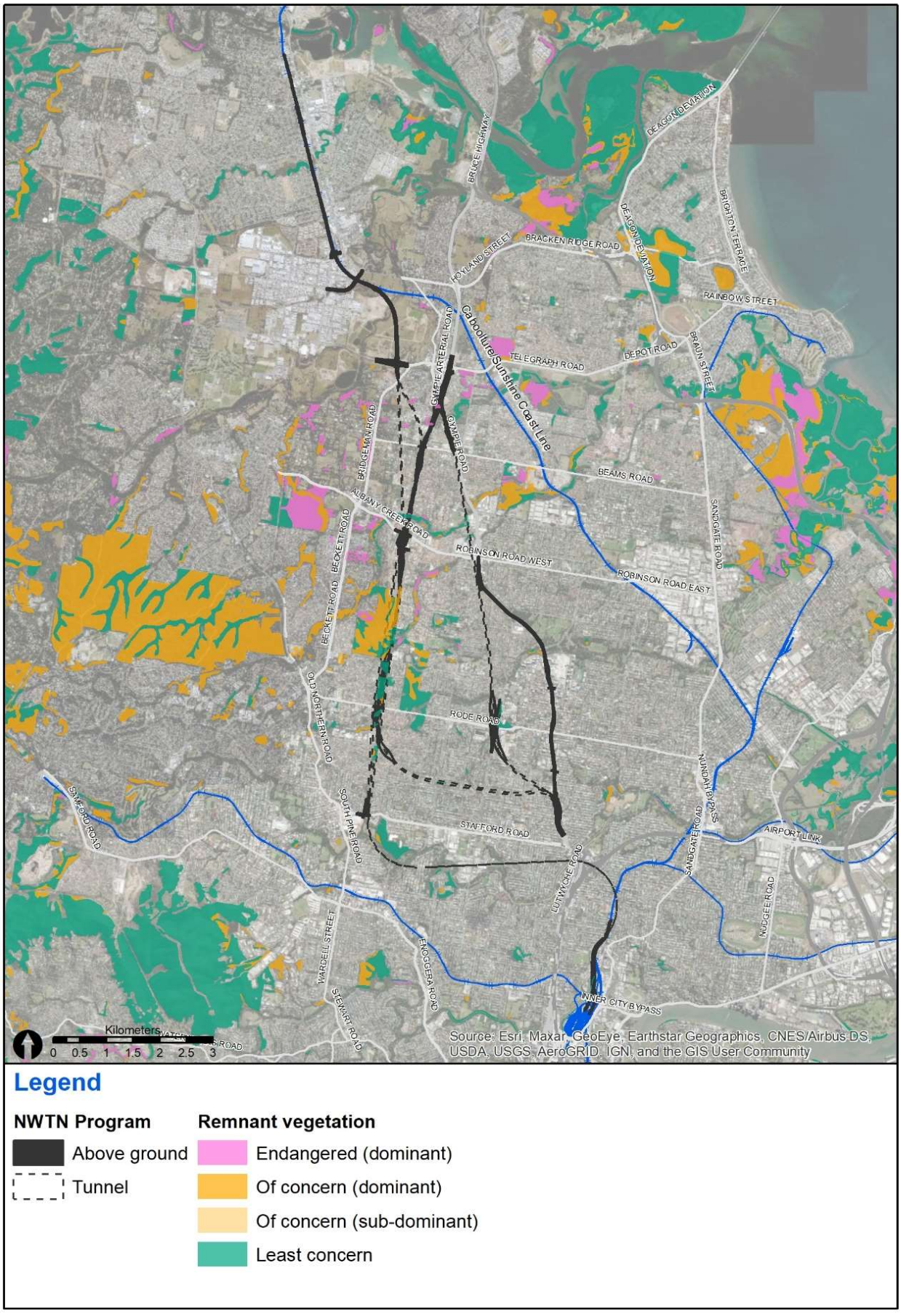

Figure 14-2: Queensland Regional Ecosystem Mapping

14.4.3.3 Native vegetation

The Brisbane City Council *Natural Assets Local Law 2003* (NALL) was created to protect the biodiversity values, preserve natural landforms, and facilitate the retention of landscape character of Brisbane City. These environmental matters are protected due to the presence of significant vegetation. This law defines seven categories of significant vegetation, including:

- Council Controlled Vegetation
- Vegetation Protection Order
- Significant Native Vegetation
- Valued Urban Vegetation
- Waterway Vegetation
- Wetland Vegetation
- Significant Landscape Trees.

Much of the NWTN Business Case Area includes areas mapped as containing significant vegetation.

Brisbane. Clean, Green Sustainable 2017-2031 strategy establishes that protection of the green spaces, trees and bushland through the City is a priority. To achieve this, Council has a goal that developments result in no net loss of open space. Healthy and well-connected ecosystems are essential in maintaining a diversity of plants and animals. Threats to ecosystem health such as invasive species, habitat clearing and fragmentation, decline in water quality and changes to water flow must be closely managed. The *Brisbane. Clean, Green Sustainable 2017-2031* strategy identifies that Council currently has 35% natural habitat cover within the Brisbane City Council LGA, with a target of 40% natural habitat cover by 2031. Natural habitat cover (NHC) is identified by remnant and non-remnant vegetation within the Habitat Area Ecological Corridor map as well as areas of high ecological significance and general ecological significance. Any reduction in natural habitat which is not otherwise offset may impact Council's ability to achieve the target of 40% NHC by 2031.

Significant flora species

Significant flora species are those listed in the *Nature Conservation Act 1992* (NC Act) as critically endangered, endangered, vulnerable or near-threatened and/or listed in the EPBC Act as vulnerable, endangered, or critically endangered. These species are defined as species that have conservation significance, due to their rarity or high levels of endemism (a species being native to a single defined geographic location).

A search of the EPBC Act Protected Matters Search Tool (PMST) database (accessed 24 August 2021, see **Appendix K - Environmental Scoping Report**), identified a total of 19 significant flora species with potential to occur within the NWTN Business Case Area. The EPBC Act PMST carries out a predictive modelling exercise, based on the species' known range and does not take account of known records or the habitat features present within the search area.

To support the PMST results, the Wildlife Online Database (accessed 24 August 2021, see **Appendix K - Environmental Scoping Report**) contains historical observations of flora and fauna. A search of this database for the NWTN Business Case Area identified 21 threatened flora species as having been recorded since 1980. Based on the February 2021 and August 2021 field assessments of vegetation and habitats within program 4a and program 4b, it has been determined that all 18 threatened flora species identified in the EPBC PMST have a low possibility of occurring for program 4a and program 4b.

Appendix K - Environmental Scoping Report includes Likelihood of Occurrence assessment for threatened flora species.

14.4.3.4 Threatened ecological communities

The EPBC Act lists threatened ecological communities (TEC) as MNES. TECs identified as potentially occurring within the NWTN Business Case Area include:

- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (Endangered)
- Lowland Rainforest of Subtropical Australia (Critically endangered)
- Poplar Box Grassy Woodland on Alluvial (Endangered)
- Subtropical and Temperate Coastal Saltmarsh (Vulnerable).

The results of the ecological field survey did not identify any TECs within the survey area. The field survey was of sufficient coverage and effort to identify any TECs in the NWTN Business Case Area so at this stage their absence can be reported with a high level of confidence.

14.4.3.4.1 Protected plants high risk trigger area

The NC Act protected plants flora survey trigger map shows high risk areas for protected plants and is used to determine flora survey and clearing permit requirements for a particular location. North West Motorway options intersect these areas with the western alignment (within program 4a) impacting 6.88 ha and the eastern alignment (within program 4b) impacts 0.29 ha. These impacts occur near the northern portal of each North West Motorway option on the eastern side of where the Gympie Road corridor connects to Gympie Arterial Road, and the Rode Road interchange for the western alignment (within program 4a).

14.4.3.4.2 Site-based vegetation communities and flora species

Field surveys were undertaken by ecologists in February 2021 and August 2021 within the NWTN Business Case Area to identify and map vegetation communities. The initial survey in February 2021 informed design development in the vicinity of the NWTC, in particular through Chermside Hills Reserve. During Stage 2, it was noted that an area of RE 12.11.28 *Eucalyptus helidonica* occurred within the NWTC, associated with the Chermside Hills Reserve. This RE is known to occur only in the Chermside Hills Reserve area of Brisbane, and there is no suitable offset area within Brisbane for this ecosystem. The rail and motorway alignments using the NWTC are largely within tunnel to avoid impact on this important ecosystem.

During future design stages, refinements to the proposed design should be identified to reduce or minimise potential impacts on areas of RE.

Table 14-9 provides a summary of the vegetation community results from the field survey and aerial photography interpretations that intersect the network program alignments.

Table 14-9: Program 4a and 4b site-based communities

Proposed project	Site-based communities	4a	4b
North West Rail (both variations)	• Exotic dominant riparian vegetation • Mixed eucalypt open forest to woodland with disturbed understorey • Native dominant riparian vegetation - degraded • Regrowth wattle dominant • Low mangrove open forest • Urban parkland • Cleared areas.	✓	✓
Active transport with rail			✓

Proposed project	Site-based communities	4a	4b
North West Motorway (western alignment)	• Exotic dominant riparian vegetation • Mixed eucalypt open forest to woodland with disturbed understorey • Native dominant riparian vegetation - degraded • Regrowth wattle dominant • Cleared areas. • The mixed eucalypt open forest with native understorey vegetation community was identified associated with the Chermside Hills Reserve associated with the mapped RE 12.3.11, RE 12.11.24 and RE 12.11.25. The RE 12.11.28, which is present within the Chermside Hills Reserve was assessed as part of the works undertaken for the NWTC as being of high conservation value (North West Transport Network Business Case Stage 2 Ecological Assessment Report (Arup, 2021)). The NWTN program business case design avoids the mapped extent of RE 12.11.28.	✓	
Active transport with motorway		✓	
BRT	• Mixed eucalypt open forest to woodland with disturbed understorey • Cleared areas.	✓	✓
North West Motorway (eastern alignment)	• Mixed eucalypt open forest to woodland with disturbed understorey • Cleared areas.		✓

The Ecological Assessment Report (**Appendix K - Environmental Scoping Report**) provides further detail of site-based communities definitions.

14.4.3.5 Potential impacts and approvals

The NWTC performs an important function as one of the few north-south biodiversity corridors through Brisbane, and it crosses biodiversity corridors associated with Cabbage Tree Creek, Downfall Creek and Kedron Brook, and other smaller corridors. Program 4a and program 4b would require construction within this corridor which would likely result in direct impacts to species and their habitat, but also result in indirect effects such as severance of a biodiversity corridor and isolation of species. These potential impacts have been significantly reduced through placing the network options in tunnel for large sections, however there are still sections above ground that would result in impacts.

Clearing of remnant RE is currently regulated under the *Vegetation Management Act 1999* (VM Act) and the *Planning Act 2016 (*Planning Act). Under the Planning Regulation 2016, clearing of remnant vegetation for the purpose of government supported transport infrastructure is defined as exempt clearing work, and therefore not subject to permits for clearing vegetation under Section 74 of the VM Act.

Although clearing of remnant vegetation is considered exempt for the purposes of government supported infrastructure, these vegetation communities perform important ecological services, such as the provision of habitat for flora and fauna or maintaining ecological connectivity, and impacts should be minimised and mitigated where possible. Proposed projects in the NWTN program were refined to limit potential impacts on remnant RE's, particularly the area of RE 12.11.28 *Eucalyptus helidonica* associated with the Chermside Hills Reserve, which cannot be suitably offset within Brisbane.

Queensland Government mapping is prepared at a relatively coarse scale and the boundaries of vegetation communities can be inaccurate on the ground. The mapping also does not reflect the on-

ground structure and condition of the vegetation communities present. The field survey undertaken in August 2021 confirmed the site-based vegetation groups and boundaries and identified areas directly impacted by proposed program projects. Targeted ecological site investigations will be necessary in future detailed business cases and closer to the construction period.

Where a threatened plant is identified and the project will impact the threatened plant, a Clearing Permit (Protected Plants) will be required. The Clearing Permit (Protected Plants) application is required to be accompanied by a Flora Survey Report, an Impact Management Plan and (where land-based offset/mitigation measures are proposed) an Offset Site Management Plan. The *Environment Offset Act 2014* is triggered by a Clearing Permit application; however, where propagation and planting of threatened plants is proposed in an Impact Management Plan, the propagation and planting are viewed as mitigation measures, allowing the project to avoid a significant residual impact and so the propagation and planting are technically not an offset (as they are not being provided to compensate for a significant residual impact).

Under the NALL, a permit must be acquired prior to clearing any protected vegetation that is not covered by an exemption.

Under the NC Act, development located within a high risk area on the Protected Plants Flora Survey Trigger Map Version 7.1 (Department of Environment and Science (DES) 2019) triggers additional requirements under the Flora Survey Guidelines – Protected Plants (DES 2020). Any high risk areas located within the Business Case Area will need to be assessed in accordance with those guidelines. A Flora Survey Report will be required to be prepared and submitted to DES for any clearing activities proposed within high risk areas, to either support a permit to clear protected plants or an exempt clearing notification.

In addition, in accordance with the Environmental Offsets Act 2014, an environmental offset may be required as a condition of approval where a prescribed activity is likely to result in a significant residual impact on prescribed environmental matters following consideration of avoidance and mitigation measures. Prescribed environmental matters, or matters of state environmental significance (MSES) include:

- regulated vegetation
- connectivity areas
- wetlands and watercourses of high ecological significance
- protected wildlife habitat
- state marine parks
- fish habitat areas
- waterways providing fish passage
- marine plants
- legally secured offset areas.

In future stages of the project, when a preferred option has been identified, an assessment against the Significant Residual Impact Guidelines (Department of Environment and Heritage Protection, 2014) would be undertaken to determine whether an offset will be required. This guideline outlines when offsets are required, the minimum acceptable offset to achieve a conservation outcome, the appropriate delivery mechanisms (direct or indirect) and long-term protection.

Where an environmental offset is required, the environmental offsets framework provides options as to how this can be delivered: through a financial settlement, proponent-driven (such as land-based offsets and/or delivery of actions in Direct Benefit Management Plan) or a combination of both. There are some environmental matters which cannot be offset through land-based offsets as no suitable habitat area exists.

Any opportunities to preserve or protect areas of remnant vegetation, or habitat for significant flora species should be considered where possible, in accordance with the *Brisbane. Clean, Green Sustainable 2017-2031* Strategy. Any reduction to the extent of native vegetation cover (which comprises natural habitat cover) may impact the ability of council to achieve their target of 40% natural habitat cover by 2031.

14.4.3.6 Summary of potential impacts

Table 14-10 provides a summary of the main points of difference between program 4a and program 4b, showing program 4a presenting potential impacts over a larger area than program 4b.

Table 14-10: Program 4a and 4b potential flora impacts summary

Proposed project	Potential flora impacts	4a	4b
North West Rail (both variations)	• 4a potential impact on 0.51 ha of 'Least concern' RE (4a). • 4b potential impacts to: – 1.10 ha 'Least concern' RE – 0.15 ha 'Endangered' RE.	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• Potential impacts to: – 6.56 ha 'Least concern' RE – 0.52 ha 'Of concern' RE – 1.21 ha on 'Endangered' RE. • 6.88 ha mapped within the protected plants high risk trigger areas.	✓	
Active transport with motorway		✓	
BRT	• There is one mapped 'Least concern' regional ecosystem intersecting the BRT alignment resulting in a total impact of 0.003 ha.	✓	✓
North West Motorway (eastern alignment)	• Potential impact on 1.15 ha on 'Least concern' RE • 0.29 ha mapped within the protected plants high risk trigger areas.		✓

14.4.4 Fauna

14.4.4.1 Restricted invasive species

There is a general biosecurity obligation under the Biosecurity Act and *Biosecurity Regulation 2016*, which means that all people are responsible for taking reasonable and practical steps to prevent or minimise biosecurity risks.

Fire ants are considered Category 1 restricted matter under the Biosecurity Act and under the Act, Council has an obligation to take all reasonable steps to prevent the spread of fire ants. DAF has defined fire ant biosecurity zones to help manage the movement of materials that could spread fire ants (such as soil, hay, turf etc). The NWTN Business Case Area does not intersect any mapped Fire Ant Biosecurity zones.

14.4.4.2 Essential habitat

Essential habitat is habitat for any significant fauna species (critically endangered, endangered, vulnerable or near-threatened) under the NC Act. Essential habitat is protected under the VM Act. The essential habitat layer is based on the vegetation communities in the remnant RE mapping and historical records of significant fauna species. It does not consider recent surveys or current, site-specific fauna habitat requirements of populations. **Table 14-11** provides a summary of the area of essential habitat that will be directly impacted by the above ground alignment options, which are also shown in **Figure 14-3**.

Table 14-11: Program 4a and Program 4b Essential Habitat mapping

Proposed project	Essential habitat	4a	4b
North West Rail (both variations)	• No essential habitat mapped	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• 8.29 ha mapped for Koala (Phascolarctos cinereus)	✓	
Active transport with motorway		✓	
BRT	• No essential habitat mapped	✓	✓
North West Motorway (eastern alignment)	• 1.15 ha mapped for Koala (Phascolarctos cinereus)		✓

Figure 14-3: Essential Habitat mapping

14.4.4.3 Koalas

Koalas are listed as vulnerable under the EPBC Act and as such are considered MNES. They are also listed as vulnerable under the Queensland NC Act.

14.4.4.3.1 Commonwealth

Under the EPBC Act, if an action is likely to have a significant impact on an MNES, it must be referred to the Minister of Environment. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population[26] of a species
- Reduce the area of occupancy of an important population
- Fragment an existing important population into two or more population
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of an important population
- Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- Introduce disease that may cause the species to decline, or
- Interfere substantially with the recovery of the species.

14.4.4.3.2 Queensland

The *South East Queensland Koala Conservation Strategy 2020-2025* increases both the area and level of protection given to koalas. The Strategy outlines critical actions that are necessary to halt the decline in SEQ koala populations and preserve and restore key koala habitat, while working towards increasing koala populations over the long term. Under the Strategy, clearing habitat areas within a Koala Priority Area is prohibited. However, under the Planning Regulation, clearing of koala habitat for the purpose of government supported transport infrastructure is defined as exempt clearing work, and therefore not prohibited.

Northern sections of North West Rail (both variations) intersects areas shown within current Koala Habitat mapping for Queensland (see **Figure 14-4**) and with the classification of areas intersected including areas of high value to low value areas suitable of rehabilitation habitat.

14.4.4.3.3 Potential impacts to koala

The assessment of Koala Habitat Mapping and Essential Habitat Mapping (see **Section 14.4.4.2**) have identified impacts to areas of koala habitat, further design development proposed projects should minimise these impacts where feasible. Despite the project being exempt clearing work under State legislation, any impact on koala habitat will need to be assessed against the EPBC Act Significant Impact Guidelines to determine whether the project may have a significant impact on the koala.

In addition, an environmental offset may be required as a condition of approval where – following consideration of avoidance and mitigation measures – a prescribed activity is likely to result in a significant residual impact on prescribed environmental matters. The policy outlines when offsets are required using a hierarchy of mitigation to avoid impacts being the top priority, and at a minimum, acceptable offset to achieve a conservation outcome, the appropriate delivery mechanisms (direct or indirect) and long-term protection. The incorporation of tunnels for the network programs has reduced the impacts to koala habitat areas.

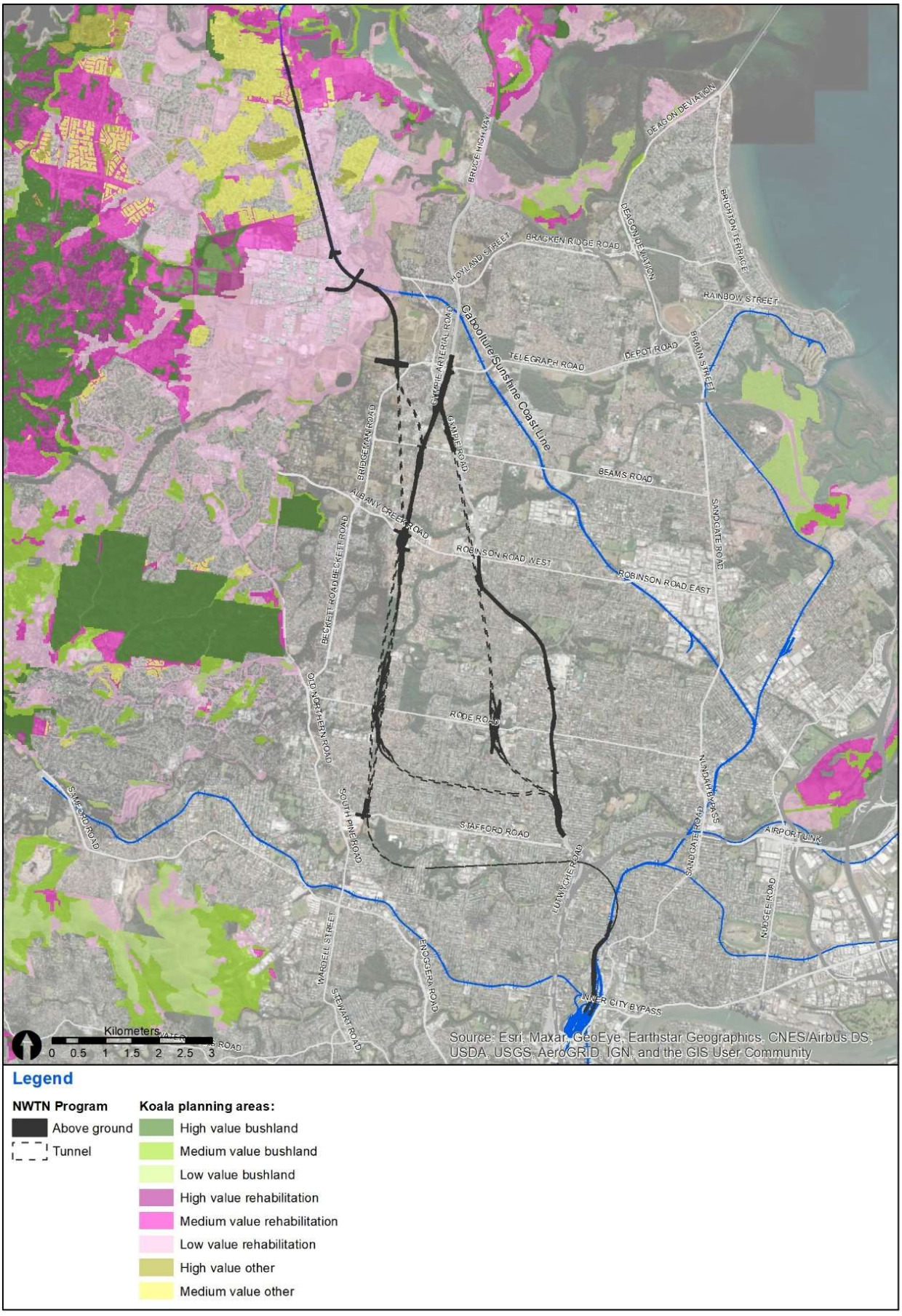

Figure 14-4: Koala Habitat mapping

14.4.4.4 Site-based fauna and habitat values

The field survey completed in August 2021 collected information on the quality of habitat for native fauna and its suitability for threatened or special least concern fauna species (see **Appendix K - Environmental Scoping Report**). Throughout the NWTN Business Case Area the NWTC is the most significant biodiversity corridor, providing a vegetated link between Kedron Brook in the south, through to Chermside Hills Reserve and Raven Street Reserve and connecting into Cabbage Tree Creek. This area would provide habitat for native fauna, as well as contributing to the wider ecological connectivity in the surrounding area as part of the Mountains to Mangroves ecological corridor.

Table 14-12 lists the species observed during the field survey. Based on the assessment of previous records and habitats identified within the NWTN Business Case Area other species not observed but likely to occur include:

- *Adelotus brevis* (Tusked frog) (listed as vulnerable under the NC Act)
- *Hirundapus caudacutus* (White-throated needletail) (listed as vulnerable, migratory and marine under the EPBC Act and vulnerable under the NC Act)
- *Ninos strenua (*Powerful Owl) (listed as vulnerable under the NC Act)
- *Petaurus norfolcensis* (Squirrel glider) (listed as least concern under the NC Act)
- Petaurus breviceps (Sugar glider) (listed as least concern under the NC Act)
- *Pterauroides armillatus (*Grey-headed flying-fox) (listed as vulnerable under the EPBC Act)
- *Tachyglossus aculeatus* (Short-beaked echidna) (listed as special least concern under the NC Act).

Appendix K - Environmental Scoping Report includes a Likelihood of occurrence of the full list of threatened species

Table 14-12: Program 4a and 4b Threatened fauna observed

Proposed project		4a	4b
North West Rail (both variations)	• Fairy martins (*Petrochelidon ariel*) and Welcome swallows (*Hirundo neoxena*), were observed actively nesting under two bridges (observed for both program 4a and 4b) • Koalas (*Phascolarctos cinereus*) were indirectly observed in the form of faecal pellets at multiple locations within the rail alignment	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• Koalas were indirectly observed in the form of faecal pellets at multiple locations within the rail alignment • Grey-headed flying-fox - suitable habitat including possible roosting sites in eucalypt forest and wetlands	✓	
Active transport with motorway		✓	
BRT	• No threatened fauna species were directly or indirectly observed within the proposed bus alignment	✓	✓
North West Motorway (eastern alignment)	• No threatened fauna species were directly or indirectly observed within the motorway alignment		✓

14.4.4.5 Potential impacts and approvals

Construction of the project is likely to result in direct impacts to areas of fauna habitat through clearing of native vegetation and impacts to ecological and waterway corridors. Given the length of the proposed projects, there is potential for direct loss of habitat as well as indirect impacts through loss of ecological connectivity, increased noise and light or introduction of weed species. Mitigation measures to avoid impacts to fauna include design refinements such as the incorporation of tunnels into the project,

construction of bridges over areas of riparian vegetation and waterways, and selection of options to avoid or minimise impacts on areas of habitat. All proposed projects being considered involve a tunnel under the Chermside Hills Reserve to avoid direct impact on this area which has been identified as a high value environment for koalas, a remnant RE, the local community and the broader Brisbane area as an ecological corridor.

Any impact on koala habitat will also need to be assessed against the EPBC Significant Impact Guidelines to determine whether the project may have a significant impact on the koala. In addition, an environmental offset may be required as a condition of approval where a prescribed activity is likely to result in a significant residual impact on prescribed environmental matters. An environmental offset may also be required for any impacts to MSES in accordance with the *Environmental Offsets Act 2014*.

Soil originating from Fire Ant Biosecurity Zone 2 can be moved within Zone 2 without a Biosecurity Instrument Permit (BIP). A BIP is required if moving the soil to a place within Zone 1. Soil can be moved from its original place in Zone 2 directly to a waste facility within the same zone, or a BIP would be required to move the soil to a waste facility in Zone 1.

Additional investigations will need to be undertaken to inform the extent of potential impacts as a result of the project, and to inform potential mitigation measures. If any breeding places for any significant fauna species, or special least concern, colonial breeders or least concern species are to be disturbed as part of the construction works, a Species Management Program will need to be prepared and submitted to DES for approval.

14.4.4.6 Summary of potential impacts

Both program 4a and 4b have similar impacts on fauna species considered likely around at-surface sections along proposed project alignments. It has been determined that due to the North West Rail intersecting mapped koala habitats and both networks and having similar northern section alignments the potential impacts will not change in significance. The essential habitat mapped for koala habitat intersected by programs 4a and 4b are primarily impacted by the North West motorway. The eastern alignment of the North West motorway having a significantly larger impacted area in comparison to the western alignment.

14.4.5 Sensitive receptors

Proposed projects within the NWTN program are located near a number of sensitive receptors, including hospitals and medical facilities, schools and day care facilities, and aged care facilities. Air quality (see **Section 14.4.6.3**) and noise and vibration (see **Section 14.4.7**) impacts associated with construction and operation of motorway, rail and BRT projects were considered.

Table 14-13 lists sensitive receptors related to each proposed project indicating which were considered in the air quality or noise and vibration assessments undertaken. **Figure 14-5** overviews the location of sensitive receptors in relation to proposed NWTN program projects.

See **Chapter 12 – Land use planning and placemaking** for sensitive receptors of high community value including open space and recreation, neighbourhood parks, larger district parks, and reserve areas.

Table 14-13: Sensitive receptors identified by program and proposed projects and air quality and noise/vibration assessment

Proposed project	Program 4a	Program 4b	Sensitive receptor	Air quality	Noise/ vibration
North West Rail (both variations)	✓	✓	• Pine Rivers Community Health Centre (568 Gympie Road, Strathpine) • Bald Hills State School (2156 Gympie Road, Bald Hills) • Goodstart Child Care Centre (97 Flockton Street, McDowall) • North West Private Hospital (137 Flockton Street, Everton Park) • Qscan Radiology Clinic (456 South Pine Road, Everton Park) • Stafford State School (314 Stafford Road, Stafford) • Queen of Apostles Stafford (10 Thuruba Street, Stafford) • Hoyts Cinema (400 Stafford Road, Stafford) • Brisbane Academy of Musical Theatre (57 Hayward Street, Stafford) • Kedron Wavell Medical Centre (232 Gympie Road, Kedron) • Kedron Medical Centre (136 Gympie Road Kedron).		✓
North West Motorway (western alignment)	✓		• Carseldine Greens Care Community (40 Raynbird Place, Carseldine) • Little Village Bridgeman Downs (207 Ridley Road, Bridgeman Downs) • Aveo Bridgeman Downs (42 Ridley Road, Bridgeman Downs) • Flutterbys Childcare (234 Albany Creek Road, Bridgeman Downs) • Aspley Gardens Independent Retirement Village (743 Trouts Road, Aspley) • Goodstart Child Care Centre (97 Flockton Street, McDowall) • McDowall Family Medical Centre (2/97 Flockton Street, McDowall) • Stafford Heights State School (95 Redwood Street, Stafford Heights) • Stafford Heights Kindergarten (12 Dorkay Street, Stafford Heights) • Little Flower Church (134 Somerset Road, Kedron) • St Anthony's School (121 Somerset Road, Kedron) • Padua College (80 Turner Road, Kedron)	✓	✓

Proposed project	Program 4a	Program 4b	Sensitive receptor	Air quality	Noise/ vibration
			• Mount Alvernia College (134 Somerset Road, Kedron) • Molly's House (139 Turner Road, Kedron) • C&K Kedron childcare centre (26 Emerald Street, Kedron) • Kedron Wavell Medical Centre (232 Gympie Road, Kedron) • Kedron Medical Centre (136 Gympie Road Kedron)		
BRT	✓	✓	• Aspley Medical Centre (1311 Gympie Road) • Avenue Early Learning Centre (24A Riordan Street, Aspley) • Wheller on the Park Retirement Village (25 The Boulevard, Chermside) • Carinya Early Learning Centre (10 Banfield Street, Chermside) • Chermside Medical Centre (956 Gympie Road, Chermside) • Kids Club Child Care Kedron Centre (26-30 Lawley Street Kedron) • Kedron Wavell Medical Centre (232 Gympie Road, Kedron) • Kedron Medical Centre (136 Gympie Road Kedron)	✓	✓
North West Motorway (eastern alignment)		✓	• Aspley family day care (66 Pie Street, Aspley) • Carseldine family clinic (735 Beams Road, Carseldine) • St Vincent's care services (736 Beams Road, Carseldine) • Tricare Stafford lakes aged care (682 Rode Road, Chermside West) • Prince Charles hospital (627 Rode Road, Chermside) • Avenue Early Learning Centre (24A Riordan Street, Aspley) • Somerset hills state school (233 Kitchener Road, Stafford Heights) • C&K Kedron childcare centre (26 Emerald Street, Kedron) • Kedron Wavell Medical Centre (232 Gympie Road, Kedron) • Kedron Medical Centre (136 Gympie Road Kedron)	✓	✓

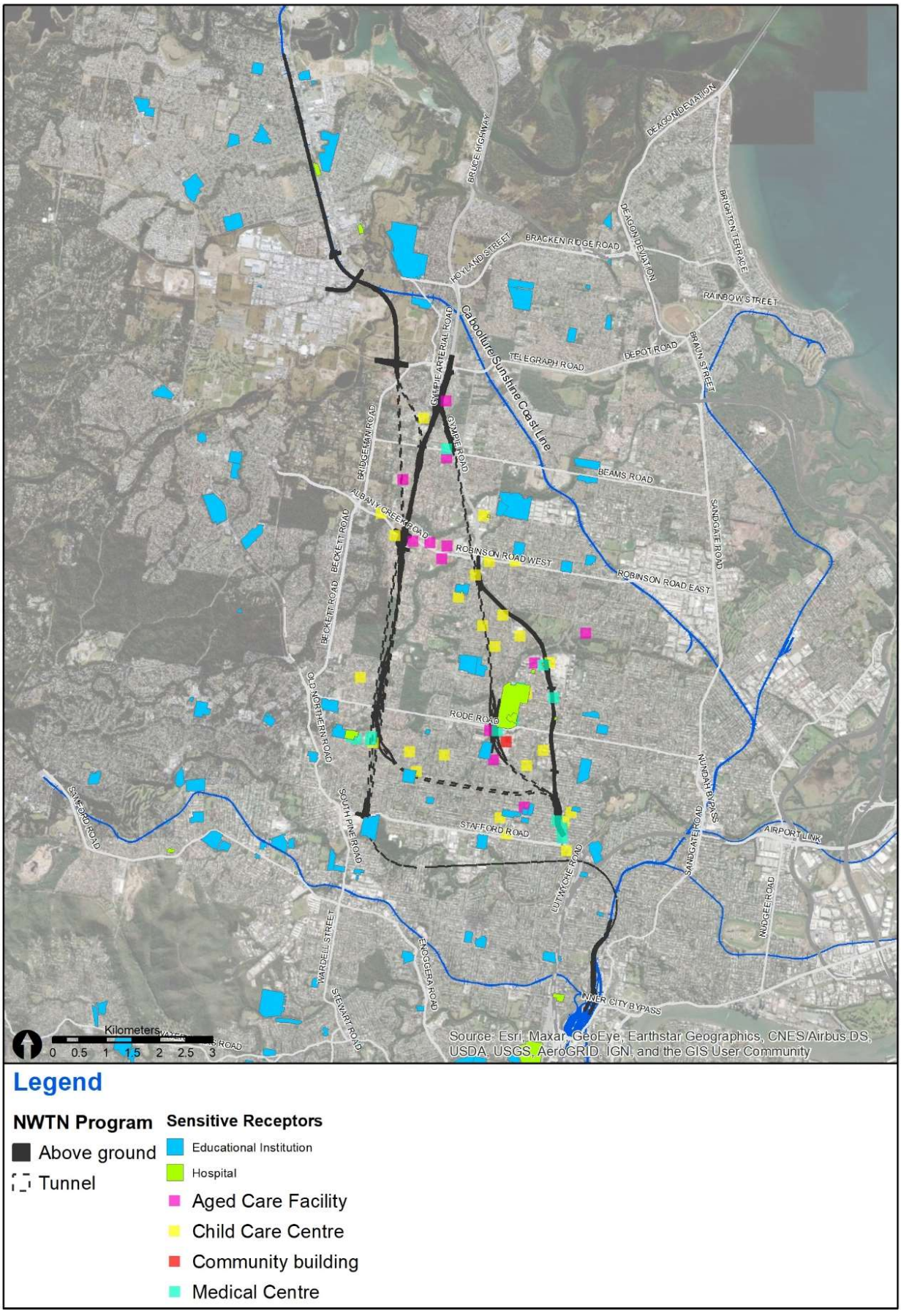

Figure 14-5: Sensitive receptor mapping

14.4.6 Air quality

A Preliminary Air Quality Assessment has been undertaken for program 4a and 4b (see **Appendix K - Environmental Scoping Report**). The assessment included the following:

- Description of the existing environments including sensitive receptors, local air emissions, ambient air monitoring data, meteorology
- Bureau of meteorology (BOM) climate statistics
- National pollutant inventory (NPI) data
- Aerial photography and cadastral mapping to review existing land uses and identify sensitive receptors
- Identification and comparison of key air quality issues
- Recommendations for future air quality investigations.

Due to the current assumption that North West Rail will be utilised for electric trains only, air quality impacts for the rail options were not assessed. Similarly, active transport has not be considered from an air quality perspective.

14.4.6.1 Climate

The mean monthly minimum and maximum temperatures as recorded by the Bureau of Meteorology at the Brisbane Aero Station and the average rainfall as recorded at the Toombul Bowls Club Station (closest station to the Business Case Area) are shown in **Figure 14-6**. The highest temperatures are experienced in the summer months from November to March with the same period experiencing higher recorded average rainfall.

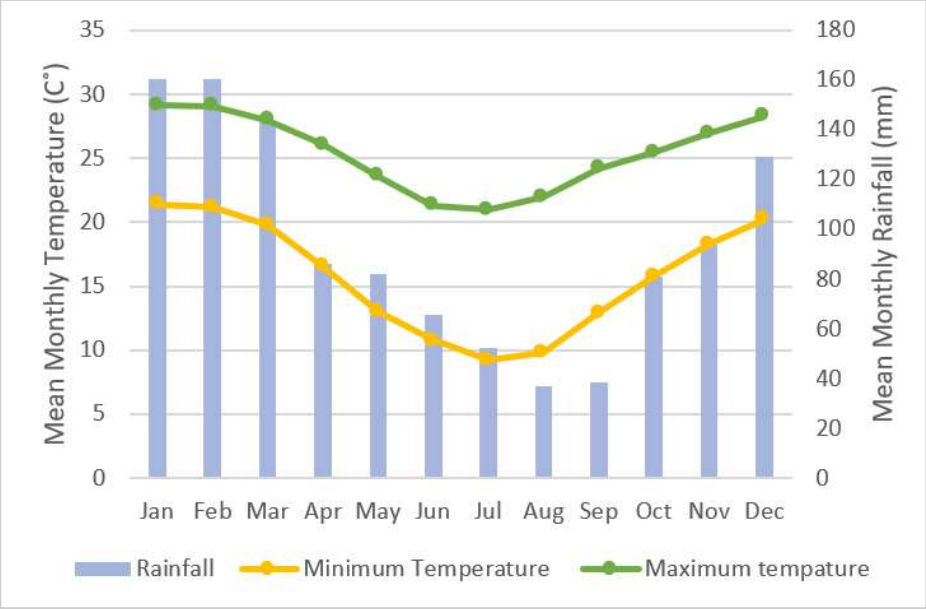

Figure 14-6: Climate data for the NWTN Business Case Area

The predominant wind direction recorded at Brisbane airport BOM is south-south-westerly and at Brisbane BOM south-westerly. Wind speeds at Brisbane Airport BOM are higher due to its proximity to the coastline with high proportions of wind being above 4 m/s and exceeding 8 m/s in some components (westerly, northerly and north-north-easterly). The Brisbane BOM station wind speeds are typically below 4 m/s and below 2 m/s for a high proportion of the time. The Brisbane BOM station presented much higher proportions of calms at 13.9% in comparison to Brisbane Airport BOM station at 2.1% (**Table** 14-14).

Table 14-14: BOM Stations wind speed statistics

Wind speed class (m/s)	Brisbane Airport BOM	Brisbane BOM
Calms	13.0%	2.1%
0.5-2.0	51.1%	6.0%
2.0-4.0	30.8%	43.2%
4.0-6.0	4.0%	32.3%
6.0-8.0	0.1%	11.4%
8.0-10.0	0.0%	3.9%

14.4.6.2 Air quality monitoring data

The neatest air quality monitoring station from DES is, situated at Deagon, approximately 4 km east of the NWTN Business Case Area. The station measures meteorological data, ozone and nitrogen dioxide. The most recent hourly data from the Deagon station (September 2021) indicated ozone and nitrogen dioxide levels are 'very good' with reference to the National Environment Protection Measures for Ambient Air Quality (Air NEPM) standard or the Environmental Protection (Air) Policy 2008 objectives. Further information is available in the Preliminary Air Quality Assessment (**Appendix K - Environmental Scoping Report**).

14.4.6.3 Sensitive receptors

Sensitive receptors include places that will be sensitive to changes in air quality that may result from the operation of the above-ground and portal sections or the construction works. This includes residential areas, hospitals and medical facilities, schools and day care facilities, and aged care facilities. **Section 14.4.5** lists the sensitive receptors that are in close proximity to proposed projects.

14.4.6.4 Potential impacts

Proposed motorway tunnels require a mechanical ventilation system to maintain acceptable levels of in-tunnel air quality. These are generally located at either end of the tunnel within a few hundred metres of the portal. For both NWTN program 4a and 4b, the potential northern section of the motorway tunnel ventilation system would be near residential areas with the topography rising to 15m either side of the tunnel portals which would require the vent to be greater in height to reduce the local air quality impacts. For program 4a and 4b the southern section of the road tunnel ventilation system at Gympie Road would be near residential and commercial zones and may have possible cumulative impacts with the existing Airport Link ventilation outlet.

Ambient air quality may be temporarily impacted during construction works as a result of dust generation and exhaust emissions with the potential for localised reduction in air quality and nuisance to the surrounding residents. High wind speeds and dry conditions may increase the potential for dust impacts during construction. The main construction activities likely to have a risk of dust generation include vegetation clearing and earthworks.

Pollutants produced by vehicles may include carbon monoxide, nitrogen oxides, particulates, volatile organic compounds and sulfur dioxide. As electric vehicles become more popular, the pollutants are likely to reduce and/or change. There is an opportunity through this project to reduce potential carbon emissions resulting from our transport system.

Local impacts may occur from construction of new roads and resultant redistribution of traffic. The improved road and rail infrastructure may result in a reduction in traffic congestion, which would likely result in localised improvements to air quality. The provision of improved active transport infrastructure which integrates with the existing network has the potential reduce car dependency for residents in the NWTN Business Case Area with the benefit of reduced emissions, increase pedestrianisation, decarbonisation of our transport network and health and wellbeing benefits.

14.4.6.5 Summary of potential impacts

The main impacts associated with air quality relate to temporary construction and permanent infrastructure. There are identified sensitive receptors in the NWTN Business Case Area that have potential to experience air quality impacts associated with vehicle centric infrastructure. The assessment of air quality impacts presented negligible differences in the potential impacts between program 4a and 4b. Tunnel and ventilation design will be a key factor in potential air quality impacts for the NWTN program and should be considered for future stages to mitigate impacts on the identified sensitive receptors.

14.4.7 Noise and vibration

14.4.7.1 Sensitive receptors

Existing sources of noise vibration within the NWTN Business Case Area would likely include existing traffic noise from roads and motorways, as well as train noise near the railway. Some properties, including medical facilities, may be more sensitive to impacts to groundborne vibrations due to vibration sensitive equipment such as CT-scanners, X-rays, and endoscopies. **Section 14.4.5** lists the sensitive receptors that are in close proximity to proposed projects.

14.4.7.2 Potential impacts and approvals

Table 14-15 overviews the noise and vibration assessments undertaken as they relate to proposed road, rail and BRT projects (see **Appendix K – Environmental Scoping Report)**.

Table 14-15: Noise and vibration assessments and key findings

Project component	Noise and vibration assessment key findings
Road Traffic	The assessment of road traffic identified portals and interchanges as sources of major noise which have been assessed under the TMR Community of Practice (CoP) for Transport Noise Management Volume 1 – Road Traffic Noise criteria. This criterion outlines the impacts for new roads, upgrades of existing roads, and existing roads (no-roadworks) against three receiver categories (residences, sensitive educational/community/health buildings, and outdoor passive recreational areas) The major noise sources for program 4a include the southern portal at Gympie Road, Rode Road interchange, and the northern portal at Albany Creek Road. Program 4b has major noise sources generated from the southern portal at Gympie Road, Webster Road interchange, and the northern portal at Beams Road.
BRT	The assessment for BRT is the same as for road traffic. The results have identified that overall the noise generated from the BRT will generally increase by 1-2 db(A), although there are some locations where noise levels are forecast to decrease due to road alignment changes. Across the entire corridor significance of change is considered negligible (<3dB)
Surface rail noise	Airborne noise impact modelling for the rail alignments forecast impact to sensitive receivers at the southern portal area including Mayne Yard, Bridgeman Downs Station (program 4b only), and the northern portal area at Bald Hills. The assessment criteria for surface rail noise is based on the TMR *Interim Guidelines Operational Railway and Vibration (Interim Guideline).*
Underground Rail	The assessment of groundborne noise (GBN) and groundborne vibration (GBV) from the underground railways and portals has been conducted using the Interim Guideline assessing impacts for New Railways or Upgrading Existing Railway. Underground rail noise modelling (using a hybrid empirical/analytical method) identified exceedance of GBN and GBV for 4275 properties intersecting program 4a and 4731 properties intersecting program 4b.

14.4.7.3 Potential mitigation measures

14.4.7.3.1 Road noise mitigation

Options for mitigation of potential impacts from road noise include elements such as:

- Low noise pavement surfaces
- Noise mounds
- Noise barriers (noise walls)
- At-property treatment (such as double-glazing windows).

During future stages, these potential mitigation measures will be investigated and modelled to understand the extent of reduction of impact.

Gympie Road within the Business Case Area is non-access controlled with most receivers having driveway access to Gympie Road. Noise mitigation via noise barriers is not considered feasible for the Southern Portal area. Noise mitigation via pavement surface treatments is not considered feasible due to the traffic speed within the Business Case Area.

The program 4a motorway within the Business Case Area is access controlled. This means that noise barriers may be feasible and could be considered as a mitigation measure along the new motorway corridor during future design stages.

Noise mitigation via pavement surface treatments may be considered feasible for the surface motorway sections since the design speed is above 60km/h. This could be considered as part of future design stages.

14.4.7.3.2 Surface rail noise mitigation

There is a predicted exceedance of the airborne noise criteria at Bald Hills State School however the exceedance is due to maximum noise levels from freight trains running on existing NCL tracks and is not directly due to the project changes associated with NWTN. Mitigation options for airborne noise would consist of noise barriers to provide shielding. This is because the exceedance is resulting from airborne noise from freight locomotives. Mitigation via rail dampers would not be effective because the dominant noise source is engine noise rather than noise from the wheel/rail interface.

14.4.7.3.3 Underground rail noise mitigation

GBN and vibration from railways is controlled by introducing resilient components to lower the fundamental track resonance and decouple the track from the ground. In general terms, the higher the mass that is isolated, the lower the resulting natural frequency (and, generally, the greater effectiveness of isolation) but also the higher the cost of the treatment.

An assessment of North West Rail with highly resilient rail fasteners in place indicates no residential properties or sensitive receptors will be affected by GBN with the current rail alignment options and so additional mitigation measures have not been considered.

14.4.7.3.4 Summary of potential impacts

Table 14-16 provides a summary of impacts from the noise and vibration assessment indicating program 4b has lower impact on sensitive receivers due to program 4a's motorway alignment (western alignment).

Table 14-16: Noise and vibration summary of impacts

Proposed project		4a	4b
North West Rail (both variations)	• Surface noise modelling assessed against the Interim Guidelines identified exceedance for noise level at 12 sensitive receivers in the southern portal area and one sensitive receiver in the northern portal area. • The results from the modelling presented exceedance of GBN and GBV for 4275 properties assessed against the Interim Guidelines. • These potential impacts can be entirely mitigated through the installation of highly resilient rail fasteners for 100% of the tunnel alignment.	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• Through CoRTN 1988 noise modelling the road alignment is expected to generate moderate to high impact to 70 sensitive receptors. • The large portions of new road segments and new road corridor has increased the potential impacts for noise.	✓	
Active transport with motorway		✓	
BRT	• The noise levels throughout the busway generally increase by 1-2 db(A), although due to road alignment changes there are some locations where noise levels were forecast to decrease. Throughout the sectioned road segments the significance of change is considered negligible.	✓	✓
North West Motorway (eastern alignment)	• Through CoRTN 1988 noise modelling the road alignment is expected to generate moderate impacts to ten sensitive receptors. • The large portions of work on existing road segments and upgrading road segments has reduced the potential impacts on sensitive receptors		✓

14.4.8 Resource use and management (including waste)

Program 4a and 4b rail alignment intersects with Key Resource Area (KRA) 60 – Pine Rivers South. The resource is located south of the NCL bridge crossing of the South Pine River flats west of Bald Hills within the alluvial plain of the South Pine River. The western extent is upstream of Scouts Crossing Road in Brendale. This is a sand and gravel extractive resource.

Significant extractive resources are generally protected from development that could impact on their long-term availability because of their economic importance to the state. Consultation with the Geological Survey of Queensland (GSQ) should be undertaken to discuss potential impacts on the KRA. Any proposed amendments or removal of KRAs must undergo a consultation process that includes affected property owners, local government and the extractive industry proponent.

Waste that is not managed appropriately could have adverse impacts on the environment as well as public health and amenity (e.g. contamination, odour, visual impact, increase spread of disease and encouragement of pests).

Opportunities to optimise resource efficiency and reduce resource consumption of construction materials will be undertaken during future design phases, including:

- Consideration of locally sourced materials
- Prioritisation of prefabricated assets where possible
- Avoiding unnecessary resource consumption during construction by making accurate predictions of the required quantities of resources
- Maximising the use of resources with low environmental impact
- Minimising the use of non-renewable resources
- Requiring certified products in project delivery contracts.

Construction of the project could generate a number of waste streams:

- Excavation material - consisting of virgin excavated natural material (VENM) and excavated natural material. As far as practicable, earthworks material generated from the project would be reused for construction of the project.
- Green waste - which would be produced from the removal of vegetation. Opportunities to reuse green waste on site (such as for landscaping, fauna connectivity structures and habitat enhancement) will be investigated.
- Demolition waste - generated from the demolition of existing structures such as buildings, road pavement, utilities, and redundant services.

Hazardous waste is to be handled, transported and disposed of in accordance with legislative requirements. A complete list of trackable regulated wastes can be found in Schedule 2E of the Environmental Protection Regulation 2019.

Council requires submission of a Waste and Recycling Management Plan prior to the commencement of works. The Waste and Recycling Management Plan must provide full details of how the site will be serviced, including waste and recycling collection and waste minimisation. The Waste and Recycling Management Plan will provide predicted waste and recycling volumes, path for collection vehicle access, ongoing strategy for managing waste, and how local stakeholders will be communicated for waste management.

Construction of the project is likely to result in a large quantity of excavated natural material from construction of the tunnels. As far as practicable, this material should be reused for construction of elements of the project, such as embankments, noise barriers, subgrade pavement layers and verge materials. During detailed design, the earthworks balance should be refined to reduce potential excess spoil material. Spoil would be managed according to the following hierarchy where feasible:

- Review alignment and profile refinements during detailed design
- Assess opportunities to reuse excess spoil in works such as landscaping and noise barriers within the construction footprint or in adjacent land
- Disposal at an approved materials recycling or licensed waste disposal facility.

The EMP(C) is to include waste management measures such as provision of appropriate receptacles provided for various waste streams, conducting routine checks for litter and rubbish and disposal of waste to appropriate licensed facilities.

Energy, water and construction materials will be used during the construction phase of the project. The construction contractor for the works will be responsible for managing resource use, such as identifying sources of construction water and complying with the relevant protocols or permits required.

See **Chapter 15 - Sustainability and social value assessment** for additional information.

14.4.8.1 Summary of potential impacts

Currently at this stage of the NWTN project there are no distinguishable differences in waste and resource management for program 4a and 4b. Specific waste management methods and impacts to program 4a and 4b may be identified when searches of contaminated land registers/ environmental management registers and preliminary site investigations for contaminated land are undertaken.

14.4.9 Landscape and visual amenity

Existing amenity across the NWTN Business Case Area varies considerably. Areas along Gympie Road are impacted by the existing operations of an arterial road, and have lower levels of air, acoustic, and visual amenity. Areas in the vicinity of the NCL would be subject to noise from passenger and freight trains. South Pine Road carries less traffic compared to Gympie Road; however, it varies in topography and its use by heavy vehicles may generate acceleration and brake noise.

Areas in the north-west, particularly where adjoining environmental and recreation reserves and waterways (such as the NWTC) would have a higher level of amenity, with lower exposure to noise and air emissions from vehicles and commercial activities, and emissions. These areas contain native vegetation and wildlife and natural landforms, offer views to and from surrounding areas, and provide opportunity for enjoyment of nature.

As the design progresses, consideration should be given to *the City Plan 2014* LGIP desired standards of service and design values listed in Council's *Design-led City – A design strategy for Brisbane*. Public Park Networks are designed to provide a diverse, well-connected, accessible, and equitable network that needs community needs across Brisbane, the desired standards outlined in Council's *City Plan 2014* accommodate both recreation and natural areas. Council's *Design-led City – A design strategy for Brisbane* values have been identified based on what people value most about Brisbane, and include:

- **Green:** Enhance and connect to green infrastructure and provide greenspace for people, wildlife, and biodiversity
- **Responsive:** Designed to make a positive contribution to the community and place by responding to the site and context
- **Sense of place:** Designed to have an identity that reflects the context, heritage and culture of people and place
- **Subtropical:** Designed to celebrate our subtropical climate and outdoor lifestyle.

Implementation of Council's design standards and values for public park networks should collectively aim to ensure the 'no net loss of public open space' target from the *Brisbane's, Clean, Green, Sustainable 2017-2031 strategy*. Further information on opportunities for land use planning and placemaking is provided in **Chapter 12 – Land use planning and placemaking**. Impacts on open space and recreation areas are further discussed in **Chapter 13 – Social impact evaluation**.

14.4.9.1 Potential impacts and approvals

The main impacts associated with landscape and visual amenity will be experienced during construction changing the landscape for the residential and commercial zones. The BRT will result in minor alterations to the key landscape elements of Gympie Road.

The NWTC currently acts as a green wedge in the surrounding urban environment. For the North West Motorway (western alignment) and North West Rail (both alignments), infrastructure proposed within the NWTC (particularly around Rode Road and Albany Creek Road for program 4a North West Motorway (western alignment) and Bridgeman Downs Station at Albany Creek Road for program 4b North West Rail), will potentially result in physical disconnect of existing landscapes for local communities and loss of the established character values. Required clearing of existing vegetation and property resumption in order to construct transport infrastructure will likely expose local residents to visual impedance from

sound barrier walls, loss of existing open space, reduced presence of fauna, light pollution associated with the infrastructure, and increase in traffic for surrounding roads.

The program projects have proposed tunnelling sections which will assist in mitigating loss of landscape and visual qualities for local communities. With the exception of the tunnel portals, the proposed tunnels will avoid landscape impacts on areas that have not been subject to extensive urbanisation. The areas subject to tunnel portals for North West Rail at Linkfield Road in Bald Hills will present small impacts with the introduction of uncharacteristic features in relation to the existing landscape. However, the surrounding area is primarily low density and rural zoning which reduces the quantity of impacts on local communities. There will be major landscape impacts where there are proposed tunnel portals for new rail stations and the southern portal in Albion. These are more isolated in comparison to the major impacts which will be brought on from the North West Motorway (western alignment) which has an extensive footprint for the majority of the NWTC northern section through Carseldine and central sections associated with Rode Road interchange. Where there are tunnel portals proposed within residential areas such as Albany Creek Road for motorway network 4a, there is the potential for significant impacts resulting in diminished landscape and visual quality. The North West Motorway (eastern alignment) will see major landscape impacts isolated to specific segments along the tunnel alignment including the Gympie Road northern portal and South portals and Webster road interchange. The program 4b landscape impact areas being surrounded by existing major infrastructure and urban precincts resulting will only result in a partial loss of landscape characteristics however will amplify lowering of amenity values due to increases in infrastructure footprint.

The active transport network 4a and 4b will primarily reside within their existing co-infrastructure alignments. The active transport network 4b will require some partial property resumption which can potentially cause minor loss to key landscape elements such as vegetation where the alignment meets the NWTC. This will affect a small quantity of residence, however, may result in a moderate impact due to visual disturbance from vegetation clearing and active transport traffic. This is discussed in more detail in **Chapter 10 - Transport Analysis**.

14.4.9.2 Summary of potential impacts

Landscape and visual amenity experience major impacts from North West Motorway (western alignment) through the northern and central sections of the NWTC, North West Rail (program 4b) station at Bridgeman Downs in the central section of the NWTC, and program 4a and 4b BRT along Gympie Road. Landscape disturbance is avoided with the use of tunnel sections. All of these major impacts will require property resumption, however the works within the NWTC will see more significant landscape changes and loss of amenity value, particularly for the North-West Motorway (western alignment). **Chapter 13 - Social impact evaluation** provides further analysis to changes in landscape and amenity and the impacts on local communities and receivers.

14.4.10 Cultural heritage

A Cultural Heritage Assessment (CHA) was undertaken to identify the potential Aboriginal and historic heritage risks related to the NWTN Business Case Area.

14.4.10.1 Native Title

The Cultural Heritage Body for the NWTN Business Case Area is the Turrbal Association. According to the National Native Title Tribunal Native Title Vision, native title no longer exists for the Turrbal People within the NWTN Business Case Area.

14.4.10.2 Aboriginal heritage

Archaeological evidence shows that Aboriginal people have inhabited mainland Australia for at least 65,000 years, and South East Queensland for at least 20,000 years; however, it is expected that their occupation extends earlier than this date.

The identity and extent of groups who claimed the Brisbane area is a heavily debated topic. It is generally believed that the Turrbal language was spoken within the area of Brisbane and its immediate surrounds, and that a 'Brisbane Tribe' known as the Turrbul extended as far south as the Logan River and as far north as the North Pine River.

Brisbane and its surrounds provided a rich cultural landscape, where Aboriginal people lived, hunted, fished, held ceremonies, travelled, and buried their dead. The landscape itself held cultural significance, both as important resource locations, and as spiritually significant places. Waterways and wetlands contain a diverse variety of food species as well as fresh water for drinking.

Interactions between the Aboriginal people and Europeans gradually led to increasing altercations and there are several records of hostile encounters, including at Victoria Park in 1849, and Nundah in 1838. By the 1870s, the conflict had mainly subsided. Aboriginal people continue to live in the greater Brisbane area, carrying with them their traditional knowledge of culture and their connection to country.

The Aboriginal Cultural Heritage Database and Register, maintained by the Department Seniors, Disability Services and of Aboriginal and Torres Strait Islander Partnerships (DSDSATSIP) records known Aboriginal sites, places and objects for Queensland. DSDSATSIP advises that where there are no recorded sites, it is probably that the absence reflects a lack of previous cultural heritage surveys of the area, and the records are not likely to reflect a true picture of the Aboriginal cultural heritage values of the area.

The NWTN business case area includes many landscape features, including waterways, wetlands, hills and ridges. These landscape features coupled with the known occupation of the wider area by Aboriginal people, can indicate a moderate to high potential for further tangible and intangible sites, places, and objects of Aboriginal cultural heritage significance to exist within the NWTN business case area.

Through the Cultural Heritage Assessment investigation, impacts on Aboriginal cultural heritage assessed the above ground impacts of remnant vegetation and watercourse areas. **Table 14-17** provides a summary of the number of aboriginal cultural heritage sites that will be intersected by the network programs.

Appendix K - Environmental Scoping Report includes figures of Aboriginal Cultural Heritage sites and the program alignments.

Table 14-17: Program 4a and 4b Aboriginal Cultural Heritage Summary

Proposed project		4a	4b
North West Rail (both variations)	• **4a** Five remnant vegetation sites and four watercourses (Four Mile Creek, South Pine River, Conflagration Creek, Kedron Brook) • **4b** Ten remnant vegetation sites and six watercourses (Four Mile Creek, South Pine River, Conflagration Creek, Cabbage Tree Creek, Downfall Creek, Kedron Brook)	✓	✓
Active transport with rail			✓
North West Motorway (western alignment)	• Five remnant vegetation sites and one watercourse (Cabbage Tree Creek)	✓	
Active transport with motorway		✓	
BRT	• One Remnant vegetation and watercourse (Downfall Creek).	✓	✓
North West Motorway (eastern alignment)	• Five remnant vegetation sites and two watercourses (Cabbage Tree Creek and Downfall Creek)		✓

14.4.10.3 Historic heritage

14.4.10.3.1 Inner city localities

John Petrie and his family purchase land in the Albion area in 1858 and established a quarry in 1860. Although close to the city, urbanisation in Albion north of Breakfast Creek was slow, with the lower-lying area of Albion becoming more frequently visited.

14.4.10.3.2 North-west region of Brisbane

Brisbane's north-west region largely began as pastoral and agricultural communities in the 1850s and 1860s. The opening of the Gympie goldfields in 1867 meant that Gympie Road was further cemented as one of Brisbane's most important roadways. The route allowed European prospectors to travel and access mining areas north of the growing colony and resulted in townships adjacent to the road developing. This road continues to provide access to several of the suburbs within the NWTN business case area.

By the 1880s, Brisbane's railway network was developing. Railways within the NWTN Business Case Area have historically been characterised as suburban rail routes, serving the growing suburbs and connecting them with Brisbane city proper. These routes eventually connected directly into the NCL, allowing the transport of goods and people into the northern towns and cities of Queensland.

With transport infrastructure in place such as railways and electric trams, the north-west districts flourished into the 20th century. These transport corridors, such as Gympie Road, also made adjoining suburbs key locations of military camps and operations during the First and Second World War, providing ease of access to and from the inner-city.

Many of the early settlements in the north-west were developed around key transport corridors such as Gympie Road and the railway line, the use of these corridors for future upgrades would therefore result in a higher volume of heritage places in the vicinity of works.

Brisbane's north-west region remained predominantly a farming area until the late 1950s when many of the earlier farms were subdivided for residential settlements, with various places flourishing from immigration and the post-war baby boom.

Appendix K - Environmental Scoping Report includes a breakdown of historic heritage sites (local, state and federal) within the NWTN network buffer areas and mapping of these sites. Impacts are summarised in **Table 14-18.**

14.4.10.4 Potential impacts and approvals

14.4.10.4.1 Aboriginal heritage

Through the investigation of Aboriginal cultural heritage sites within the NWTN Business Case Area there are a total of 12 sites directly impacted and 3 sites within the buffer area for program 4a, and a total of 18 sites directly impacted and two sites within buffer area for program 4b.

There is a rich Aboriginal history within the NWTN business case area, and significant potential exists for known and unknown sites, places and objects to exist in the NWTN business case area. In addition, any areas of disturbance in proximity to creeks and waterways are considered high risk for discovery of Aboriginal cultural heritage material.

Given the scale of the project, it is recommended that consultation is undertaken with the Aboriginal Party(s) to confirm if cultural heritage is present and seek advice on how to proceed. This may be achieved through the development of a Cultural Heritage Management Plan, Cultural Heritage Study, or a Cultural Heritage Management Agreement.

14.4.10.4.2 Historic heritage

Through the investigation of historic heritage sites within the NWTN Business Case Area there are a total of 23 sites directly impacted and 84 sites within the buffer area for program 4a, and a total of 26 sites directly impacted and 82 sites within the buffer area for program 4b.

Where impacts on local and state heritage places are likely, a Conservation Management Plan should be developed, including consideration of any impacts likely to result from vibration and settlement if located above a tunnel. A development application will be required for any state heritage place in which impacts are expected. A Heritage Risk Assessment should be developed where there are potential impacts to character places through surface level works and tunnelling works (including portals).

A detailed assessment, including field survey should be undertaken for subsequent phases of the project, which considers further potential places of historic heritage significance. The CHA should consider built, landscape and archaeological values and a framework for their protection, conservation and interpretation where required.

Development on a local heritage place (not State listed) where undertaken by the State or a public sector entity (including Council) is not assessable development and can proceed without a permit, however where possible impacts on local heritage places should be avoided.

14.4.10.5 Summary of potential impacts

Table 14-18 provides a summary of the main points of difference between program 4a and program 4b. Due to program 4a and 4b occupying similar alignments particularly for the North West Rail, BRT, and southern portal for the North-West Motorway there have been small differences in the impacts on Aboriginal cultural heritage and historic heritage.

Table 14-18: Program 4a and 4b Cultural Heritage summary of potential impacts

<table>
<tr><th>Proposed project</th><th></th><th>4a</th><th>4b</th></tr>
<tr><td>North West Rail (both variations)</td><td rowspan="2">4a Potential Aboriginal cultural heritage impacts:
6 direct impacts
2 indirect impact
4b Potential Aboriginal cultural heritage impacts:
11 direct impacts
1 indirect impact
4a and 4b potential Historic heritage impacts:
Queensland Heritage Register: 4 indirect impacts
Local Heritage Register: 5 direct impacts; 22 indirect impacts
Pre-1911 buildings: 4 direct impacts; 9 indirect impacts (8 for 4b)
Commercial character buildings: 4 direct impacts; 6 indirect impacts
Traditional character precincts: 3 direct impacts; 1 indirect impact
Known significant trees: 6 indirect impacts (9 for 4b)
Potential historic heritage sites: 8 indirect impacts (7 for 4b)</td><td>✓</td><td>✓</td></tr>
<tr><td>Active transport with rail</td><td></td><td>✓</td></tr>
<tr><td>North West Motorway (western alignment)</td><td rowspan="2">Potential Aboriginal cultural heritage impacts:
4 direct impacts
1 indirect impact</td><td>✓</td><td></td></tr>
<tr><td>Active transport with motorway</td><td>✓</td><td></td></tr>
</table>

Proposed project		4a	4b
	Potential Historic heritage impacts: • Local Heritage Register: 1 direct impacts; 2 indirect impacts • Commercial character buildings: 1 direct impacts; 2 indirect impacts • Potential historic heritage sites: 1 direct impact; 2 indirect impacts		
BRT	Potential Aboriginal cultural heritage impacts: • 1 direct impact Potential Historic heritage impacts: • Local Heritage Register: 4 direct impacts; 6 indirect impacts • Pre-1911 buildings: 1 indirect impact • Commercial character buildings: 3 direct impacts; 2 indirect impacts • Traditional character precincts: 1 direct impact; 1 indirect impact • Potential historic heritage sites: 2 indirect impacts	✓	✓
North West Motorway (eastern alignment)	Potential Aboriginal cultural heritage impacts: • 6 direct impacts • 1 indirect impact Potential Historic heritage impacts: • Local Heritage Register: 2 direct impacts; 2 indirect impacts • Pre-1911 buildings: 2 indirect impacts • Commercial character buildings: 4 direct impacts; 3 indirect impacts • Traditional character precincts: 1 direct impact • Potential historic heritage sites: 2 indirect impacts • Potential significant trees: 1 indirect impact.		✓

14.4.11 Legislation and permit requirements

Table 14-19 summarises the approvals and compliance requirements likely to be applicable to the NWTN program. With this being a program business case and proposed projects (preferred alignment and design details) are not yet known, required approvals or permits listed are indicative. As the proposed projects progress into detailed business case and further design stages, there will be greater clarity on design details, including mitigation measures, and likely construction methodology, approval and compliance requirements will be confirmed.

Early engagement with relevant approval authorities is recommended in future detailed business cases to gauge the acceptance of the project and to understand the required studies expected to support any permit application. Agencies that will have an interest in the project and may have a role in the assessment of permit applications include but are not limited to:

- Commonwealth Department of Agriculture, Water and the Environment (DAWE)
- Department of State Development, Infrastructure, Local Government and Planning
- Department of Resources
- Department of Regional Development, Manufacturing and Water
- Department of Environment and Science
- Department of Agriculture and Fisheries.

Table 14-19: Summary of potential identified permit triggers for the project

Legislation/ Regulation/ Policy	Agency	Approval or permit	Trigger	Project applicability and actions	Applicable program/ proposed project
Commonwealth legislation					
EPBC Act and *Environmental Offsets Policy 2012*	DAWE	EPBC Act referral of proposed action to DAWE for determination on whether the proposal is a *Controlled Action*, *Controlled Action – Particular Manner* or *Not a Controlled Action*	EPBC Referral: undertaking an action that results or will result in a significant impact on MNES or other protected matters Offset: where a significant residual impact to MNES is determined for projects requiring assessment and approval under the EPBC Act	**Likely to be required** Further investigations required to determine whether option(s) would result in a significant impact on MNES MNES potentially impacted by the project include: • Koala • Grey-headed flying-fox • White-throated needletail	Program 4a – Rail, Motorway and active transport Program 4b – Rail and active transport, Motorway
Native Title Act 1993 (NT Act)	Attorney General's Department	Where an interest is required on land where native title has not been extinguished, the requirements of the NT Act must be met before tenure can be granted	Works within areas where native title exists	**Not currently required** According to the National Native Title Tribunal Native Title Vision, native title no longer exists for the Turrbal People within the NWTN Business Case Area, who are the Cultural Heritage Body for the Business Case Area This should be reassessed as project progresses	All applicable programs
Policy on the Management of Land in Australia Affected by Unexploded Ordnance	Department of Defence	Risk assessment Land remediation	Development of land within an area of substantial unexploded ordnance (UXO) potential	**Further assessment required** As options are refined, further assessment of UXO mapping to be undertaken to inform future stages	Program 4a – Rail Program 4b – Rail and active transport

Legislation/ Regulation/ Policy	Agency	Approval or permit	Trigger	Project applicability and actions	Applicable program/ proposed project
Queensland legislation					
Aboriginal Cultural Heritage Act 2003 (ACH Act)	DSDSATSIP	Duty of care to take all reasonable and practical measures not to harm Aboriginal cultural heritage	An activity with the potential for impact to Aboriginal cultural heritage	**Likely to be required** A Cultural Heritage Risk Assessment for the preferred option(s) will be undertaken in future stages of the project, to determine next steps Consultation with Aboriginal Party(s) to be undertaken to seek advice on how to proceed, which may include Cultural Heritage Management Plan, Cultural Heritage Study or a Cultural Heritage Management Agreement	All applicable programs
Biosecurity Act	DAF	The Act provides biosecurity measures for the management of restricted and invasive plants or animals, such as wild dogs and weeds	There is a general biosecurity obligation under the Act which means that all people are responsible for taking reasonable and practical steps to prevent or minimise biosecurity risks	**Will be required** Ecological investigations should be undertaken to identify presence of restricted or invasive species	All applicable programs
Coastal Protection and Management Act 1995	DAF	The Act supports the protection of the coast and coastal resources through the provision of technical information to inform planning decisions. This includes the declaration of erosion prone areas and coastal management districts	Works undertaken within a coastal management district, including clearing marine plants, prescribed tidal works, interfering with quarry material.	**Possible – further assessment required** The rail alignments for program 4a and program 4b both intersect a coastal management district at Breakfast Creek If construction cannot be undertaken in accordance with the Accepted Development Requirements of the Planning Act, approval will be required	Program 4a – Rail Program 4b – Rail and active transport

Legislation/ Regulation/ Policy	Agency	Approval or permit	Trigger	Project applicability and actions	Applicable program/ proposed project
EP Act	DES	Soil disposal permit	Removal/disposal of potentially contaminated soil or site recorded on EMR/CLR	**Possible – further assessment required** A search of the EMR/CLR to be undertaken for intersecting lots and plans for the alignments Contamination investigations may be required in future stages	All applicable programs
		Management hierarchy for air emissions that affect, or may affect, an environmental value	Impacts to qualities of the air environment conducive to protecting health and biodiversity of ecosystems, human health and wellbeing, aesthetics of the environment,	**Possible – further assessment required** As the design of the preferred option is refined, assessment for air quality impacts can be refined and verified.	Program 4a Motorway and active transport, and bus Program 4b Motorway and bus
Environmental Offsets Act and *Queensland Environmental Offsets Policy 2020*	DES	Offsets Management Plan	An environmental offset may be required as a condition of approval where – following consideration of avoidance and mitigation measures – a prescribed activity is likely to result in a significant residual impact on prescribed environmental matters	**Possible – further assessment required** As design of the project is refined this will need to be assessed	All applicable programs
Fisheries Act	DAF	Permit for constructing or raising a waterway barrier	Construction of a waterway barrier (such as culvert or bridge) across a mapped waterway	**Likely to be required** Designs currently intersect multiple waterways. Bridges should be considered where feasible to reduce potential barriers to waterways. If construction of the waterway crossing cannot be in accordance	Program 4a Rail, Motorway and active transport and Bus Program 4b Rail and active transport, Bus

Legislation/ Regulation/ Policy	Agency	Approval or permit	Trigger	Project applicability and actions	Applicable program/ proposed project
				with the Accepted Development Requirements of the Planning Act then a permit will be required	
NC Act	DES	Clearing Permit (Protected Plants) Protected Plant Exempt Clearing Notification	Clearing of vegetation within area mapped as high-risk flora trigger area	**Likely to be required** Both network options have been identified to intersect Protected Plants flora trigger survey mapping. Flora surveys will need to be undertaken in areas mapped within the high-risk flora trigger area	Program 4a Motorway and active transport Program 4b Motorway
		Species Management Program (SMP) for tampering with animal breeding places	Clearing vegetation that contains nests, hollows, or other animal breeding places. Tampering with a breeding place used by a least concern species can be carried out using the DES low risk SMP. Any breeding place used by colonial breeding, endangered, vulnerable or near threatened fauna will require an SMP to be prepared for approval by DES	**Likely to be required** As design of the project is refined this will need to be assessed. Ecological investigations should be undertaken to identify presence of animal breeding places (such as nests and hollows)	All applicable programs
Planning Act and Planning Regulation	Department of State Development, Infrastructure, Local	Development approval under Schedule 10 of the Planning Regulation (associated with other legislation such as the Fisheries Act).	Assessable development under the Planning Regulation that is not accepted development or otherwise exempt	**Likely to be required** As design of the project is refined this will need to be assessed	All applicable programs

Legislation/ Regulation/ Policy	Agency	Approval or permit	Trigger	Project applicability and actions	Applicable program/ proposed project
	Government and Planning	Assessment against relevant State Development Assessment Provisions codes			
Queensland Heritage Register	DES	General Exemption Certificate Exemption Certificate Development Approval	Regular maintenance or low minor works may be authorised through an exemption certificate, however development activities that will impact the significance of a site will require a Development Application	**Not likely to be required** Designs for both programs have avoided direct impacts on sites register as Queensland Heritage There are potential indirect impacts for each rail option (i.e. within 150m buffer) which would need to be considered during future design stages	Program 4a Rail Program 4b Rail and active transport
VM Act	Department of Resources	Operational works permit for clearing remnant native vegetation.	Clearing of regulated vegetation	**Exempt clearing works** Under Schedule 21 of the Planning Regulation, clearing vegetation for the construction or maintenance of government supported transport infrastructure is 'exempt clearing work' and development approval is not required	All applicable programs
Water Act	Department of Regional Development, Manufacturing and Water	Riverine Protection Permit (or exemption)	Earthworks within a watercourse	**Possible – further assessment required** As the design of the preferred option is refined, an assessment against the Riverine Protection permit Exemption Guidelines should be undertaken to determine whether construction can proceed in accordance with the guidelines, or a permit will be required	All applicable programs

Legislation/ Regulation/ Policy	Agency	Approval or permit	Trigger	Project applicability and actions	Applicable program/ proposed project
Local legislation					
City Plan	Council	Exemption Certificate Development Approval	Regular maintenance or low minor works may be authorised through an exemption certificate, however development activities that will impact the significance of a site will require a Development Application	**Likely to be required** As design of the project is refined this will need to be assessed. Currently all alignments under both programs include potential impacts on potential heritage sites Where design impacts on local heritage places, a Conservation Management Plan should be developed and a Development Application is required where impacts are expected.	All applicable programs
		Air quality impact report Licence or approval limits where required	A development that poses potential impacts to air quality, odour and health risk	**Possible – further assessment required** As the design of the preferred option is refined, assessment for air quality impacts can be refined and verified.	Program 4a Motorway and active transport, and bus Program 4b Motorway and bus
NALL	Council	Permit to work on protected vegetation	Clearing or development that would impact significant vegetation under the NALL requires a permit	**Likely to be required** As design of the project is refined this will need to be assessed	All applicable programs

14.5 Further detailed investigations in detailed business case(s)

Recommendations and further actions to be implemented as the project progresses include:

- Undertake targeted fauna surveys in accordance with relevant species-specific survey guidelines (where available) for all fauna species identified as having the potential to occur or assessed as having a 'high' or 'moderate' likelihood of occurring in the vegetation communities which have been identified as providing suitable habitat.
- Undertake targeted surveys for RE validation in the mapped RE areas and flora survey in accordance with the Flora Survey Guidelines – Protected Plants (DES, 2020) in all mapped high-risk areas impacted by the project to confirm if protected plants are present. This would need to be undertaken within the 12 months prior the commencement of clearing activities.
- Undertake aquatic surveys in all waterways impacted by each network to confirm the aquatic species assemblages, aquatic habitat values, and fish passage requirements.
- Incorporate fauna sensitive design measures into the design of all network alignments including:
  - fauna exclusion fencing where there is a risk of fauna entering an alignment
  - bridges at waterway crossings which provide a dry ledge to maintain terrestrial fauna passage along waterways
  - rope bridges to maintain fauna passage for arboreal fauna species.
- Undertake targeted koala surveys to confirm koala utilisation of the vegetation to inform appropriate mitigation measures.
- Develop a Fauna Movement Strategy (or similar) to assess current fauna movement opportunities and restrictions in the landscape and to identify how the current project can maintain or enhance fauna movement requirements and identify fauna movement infrastructure required by the project.
- Minimise the design footprint in the mixed eucalypt open forest with native understorey and the Mixed eucalypt open forest to woodland with disturbed understorey.
- Conduct searches of the contaminated land/environmental management registers of the Lots and Plans that intersect the network alignments.
- Undertake a preliminary site investigation to inform the potential presence of contaminated soils for the network alignments.
- Undertake a detailed review of ventilation outlet locations considering potential ventilation system requirements, off-site air quality as well as other deciding factors.
- Undertake air dispersion modelling for each option to quantify pollutant concentrations at the nearest sensitive receptors. The modelling should include with and without project scenarios to determine the potential for exceedance of ambient air quality goals and to understand the change in pollutant concentrations as a result of the network alignments.
- Undertake air dispersion modelling for each option to quantify pollutant concentrations at the areas that absorb traffic as a result of on and off ramp and tunnel portal locations.
- Obtain long-term background air monitoring data for the Airport Link project, the data will assist in establishing existing levels and assessing cumulative impacts associated with the Airport Link ventilation outlet.
- Establish a baseline air quality scenario that models projections on a 30-year horizon, assessing local and regional impacts, and total tonnes of emissions for each of the program options.
- Undertake noise survey along the route of the selected options for airborne noise model calibration and establishment of construction noise criteria.
- Undertake calibration and refinement of airborne noise models as design progresses.

- Refine groundborne noise assessment as design progresses, considering design progression, local variations in lithology.
- Undertake detailed busway noise assessment along Gympie Road.
- Develop noise mitigation design for the selected options and construction noise and vibration assessment.
- Commence consultation with the Turrbal People.
- Undertake a heritage impact assessment to assess any potential impacts of vibrational or settlement effects.

14.6 Conclusion and recommendations

Of the two programs that have been developed, the assessment has highlighted environmental factors that presented similarities and key differences, including:

- topography, geology, and soils assessment having negligible differences, with high risk of acid sulfate soils present for both of the network program rail alignments
- waterways and wetlands assessment for both network alignments have minor differences in quantities of features intersected, but presented similar high risk features such as high ecological significance (HES) wetlands and High Risk waterways at South Pine River and Breakfast Creek
- remnant vegetation and protected plants trigger survey area mapping will have significantly higher impacts from program 4a as a result of rail and motorway alignment above ground sections through the NWTC from Gympie Road through to Albany Creek Road, and Hamilton Road through to Rode Road
- potential impacts on essential habitat being significantly higher for program 4a due to the rail and motorway alignment through the NWTC
- program 4a footprint within the NWTC for rail and motorway creating significant amenity value loss and altering the landscape features
- program 4b would result in more airborne noise and GBN impacts in comparison to program 4a
- program 4a and 4b both having potential impacts on a large number of local heritage sites.

It is clear that the motorway alignments for program 4a and 4b have resulted in significant differences in impacts to the existing environments. Program 4a's use of the NWTC results in potential impacts to flora and fauna which can potentially diminish the ecological corridor function of the NWTC. Program 4b has clear high potential impacts to sensitive receivers in urban areas in which can have negative impacts on the health and wellbeing of the local communities (see **Chapter 13 - Social impact evaluation**).

There are opportunities through the progression of detailed design to further refine alignments to mitigate environmental impacts. Key potential environmental impacts that need to be investigated further are identified in **Section 14.5**.