

9 Assessment of other issues

This chapter provides an assessment of the project's other potential impacts. These are potential impacts that were not identified as key issues by either the Director-General's environmental assessment requirements or the environmental risk analysis (see Chapter 11). Notwithstanding, the issues discussed in this chapter have either been directly identified by the project team or have emerged through the consultation process (see Chapter 7). The level of assessment reflects that these are issues commonly associated with road projects and have been addressed through the design process and best practice management. Mitigation measures for these issues would be implemented during project construction and operation.

9.1 Greenhouse gases

This section provides a desktop assessment of the greenhouse gas emissions that would be generated during the construction of the project and an assessment of the emissions generated once the project is operational.

9.1.1 Background

Greenhouse gases absorb outgoing infra-red radiation reflected from the earth which in turn generates heat. This heat warms the atmosphere. This is known as the greenhouse effect and is linked to climate change. The primary human-produced greenhouse gas is carbon dioxide.

Human activities, including the combustion of carbon-based fuels increase the concentration of greenhouse gases in the atmosphere. This leads to greater absorption of infra-red radiation and an increase in atmospheric temperature. This is known as the enhanced greenhouse effect.

The following six greenhouse gases are covered under international climate change agreements and have been considered in this assessment:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- Sulphur hexafluoride (SF₆)
- Hydro fluorocarbons (HFCs)
- Perfluorocarbons (PFCs).

Each greenhouse gas behaves differently in the atmosphere with respect to its ability to trap outgoing radiation and its residence time in the atmosphere. To achieve a common unit of measurement each greenhouse gas has been compared to the warming potential of carbon dioxide over a 100 year period. This provides a global warming potential for each greenhouse gas that can be applied to the estimated emissions of the project. The resulting aggregated emissions are referred to in terms of carbon dioxide-equivalent emissions (or CO₂-e).

9.1.2 Assessment methodology

The greenhouse gas assessment for the project has been carried out at the level of detail available for this phase of the project design development.

Construction

Greenhouse gas emissions for the construction stage were estimated based on information provided in the *Australian National Greenhouse Accounts Factors* (Department of Industry, Innovation, Climate Change, Science, Research and

Tertiary Education, 2013). The emissions from vegetation clearance were calculated using the VicRoads Carbon Gauge Greenhouse Gas Calculator for Road Projects.

The scope of the greenhouse gas assessment in terms of greenhouse gas sources is provided in Table 9-1 below.

Table 9-1 Greenhouse gas sources by scope for the project

| Scope of emissions | Description | Greenhouse gas sources |
|--------------------|---|--|
| 1 | Direct greenhouse gas emissions associated with emissions generated on-site. | <p><i>Vegetation clearing:</i> Vegetation absorbs carbon dioxide from the atmosphere (by photosynthesis), therefore where vegetation is removed the ability to act as a carbon sink is lost.</p> <p><i>Construction equipment:</i> Most construction equipment is operated by the burning of fossil fuels, typically diesel, which creates greenhouse gas emissions.</p> <p><i>Generator use:</i> Some small equipment and lighting for out of hours works require the use of an onsite generator, typically powered by diesel, which creates greenhouse gas emissions.</p> |
| 2 | Indirect greenhouse gas emissions associated with electricity used on-site for lighting of the work site compounds, where actual emissions are generated elsewhere (generally at the source of the electricity generation). | <p><i>Electricity:</i> Electricity is generally consumed by site offices for lighting and security.</p> |
| 3 | Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities and waste disposal. | <p><i>Construction materials:</i> Different construction materials contain varying levels of embodied emissions for example; high-strength concrete contains a greater proportion of cement (which has a high level of embodied emissions), compared to concrete for lower-strength applications which contain fly-ash (which has a lower level of embodied emissions).</p> <p><i>Construction waste:</i> Clearing of vegetation, disposal of contaminated soil and wood material from the demolition of acquired dwellings creates greenhouse gases, as the breakdown of organic matter as waste material directly releases stored carbon dioxide to the atmosphere.</p> <p><i>Construction transport:</i> All construction-related transportation creates greenhouse gas emissions from the consumption and burning of fossil fuels.</p> |

Operation

Greenhouse gas emissions for the operational stage were calculated using Roads and Maritime *Tool for Roadside Air Quality* (Roads and Maritime, 2012). The tool estimates peak hour and annual greenhouse gas emissions by considering the interaction between road speed, gradient, traffic mix and traffic volumes for particular road types. The tool estimated peak hour and annual greenhouse emissions for the year 2026.

9.1.3 Assessment of potential impacts - construction

Greenhouse gas emissions were calculated for a range of sources that make up the overall construction of the project. The estimated scope 1, scope 2 and scope 3 emissions from construction are presented in Table 9-2 and illustrated in Figure 9-1.

Table 9-2 Estimated greenhouse gas emissions by scope for the construction stage

| Scope | Source | GHG emissions (tCO ₂ e) ¹ |
|--------------|---|---|
| Scope 1 | Construction plant and equipment | 20,660 |
| | Generator use | 41 |
| | Vegetation clearance | 7,016 |
| Scope 2 | Electricity use on-site | 79 |
| Scope 3 | Embodied emissions of construction materials | 21,312 |
| | Construction waste | 4,294 |
| | Transport to and from site | 621 |
| | Upstream fuel extraction, transmission and distribution | 1,617 |
| Total | | 55,641 |

¹ tCO₂e = tonnes of CO₂ equivalent

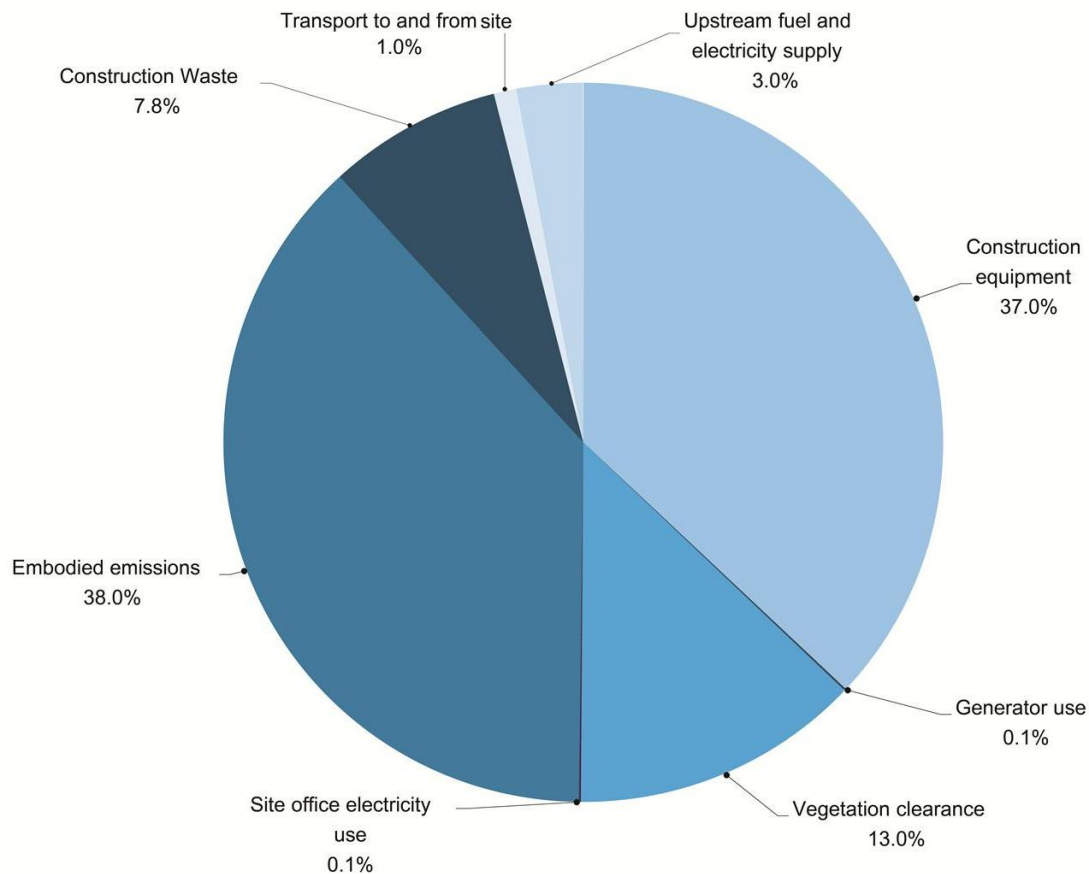


Figure 9-1 Estimated greenhouse gas emissions by scope for the construction stage

As shown in Figure 9-1, embodied emissions and construction equipment contribute to the majority (75 per cent) of the total greenhouse gas emissions for the construction stage of the project. This corresponds to around eight million litres of fuel that is expected to be used during construction. Other less significant sources of greenhouse gas emissions include vegetation clearance, construction waste and upstream fuel and electricity supply.

Opportunities to reduce greenhouse gas emissions during construction exist through investigating alternative, lower embodied carbon options for construction including:

- Specifying lower embodied energy concrete. For example, concrete that contains less Portland cement (which would be replaced with fly-ash) could be used for lower strength concrete applications. Recycled steel which has about half the embodied emissions of virgin steel
- Using biofuels (biodiesel, ethanol, or blends such as E10 or B80) which can considerably reduce the greenhouse gas emissions for construction equipment
- Limiting vegetation clearance where feasible and revegetating with native species.

Opportunities to reduce greenhouse gas emissions would be investigated by the construction contractor (refer to Section 9.1.5).

9.1.4 Assessment of potential impacts - operation

As discussed in the traffic and transport assessment in Section 8.1, traffic volumes forecasted in the Grafton area would be the same with or without the project, therefore the project is unlikely to generate additional greenhouse gas emissions during the operational stage, over and above the projected growth rate.

Roads and Maritime *Tool for Roadside Air Quality* (Roads and Maritime, 2012) estimated peak hour and annual greenhouse emissions with and without the project in the year 2026 would be 11,100 tonnes of CO₂-e/y.

Additional greenhouse gas emissions resulting from the operation of the project can be attributed to:

- Electricity consumed by street lighting and signals
- Maintenance activities which create greenhouse gas emissions due to the use of fuel and electricity, and from embodied emissions in maintenance materials and components.

These emissions are unlikely to represent a substantial increase in greenhouse gas emissions.

The project would improve traffic efficiency, reducing the number of times vehicles would need to stop and start due to traffic congestion during peak periods which is likely to result in some fuel efficiencies and reducing overall greenhouse gas emissions.

9.1.5 Environmental management measures

The management measures shown in Table 9-3 would be implemented to minimise greenhouse gas emissions.

Table 9-3 Environmental management measures for greenhouse gas impacts

| Issue | Environmental management measure | Responsibility | Timing |
|--------------------|---|-------------------------|----------------------------------|
| Lighting | Roads and Maritime will investigate the use of LED lighting in place of incandescent lamps as part of the project's detailed design, and use them where practicable to reduce electrical energy consumption. Any energy-efficient alternatives will have to meet lighting and safety standards for major roads. | Roads and Maritime | Detailed design |
| Embodied emissions | Fly-ash content within concrete will be utilised where feasible. Construction contractors will be required to propose recycled content construction materials where they are cost, quality and performance competitive. | Construction contractor | Pre-construction Construction |
| | Reuse of excavated road materials will be maximised as far as possible where they are cost, quality and performance competitive to reduce use of materials (with embedded energy). | Construction contractor | Pre-construction Construction |
| | Steel with high recycled content will be utilised where feasible, for example where it is cost, quality and performance competitive. Contractors will be required to propose recycled content construction materials where they are cost, quality and performance competitive. | Construction contractor | Pre-construction Construction |

| Issue | Environmental management measure | Responsibility | Timing |
|-------------------------------------|---|-------------------------|----------------------------------|
| Vehicle emissions | The feasibility of using biofuels (biodiesel, ethanol, or blends such as E10 or B80) will be investigated by the construction contractor, taking into consideration the capacity of plant and equipment to use these fuels, ongoing maintenance issues and local sources. Works will be planned to minimise fuel use. | Construction contractor | Pre-construction Construction |
| Construction energy management plan | A construction energy management plan will be developed as part of the project's construction environmental management plan. The plan will include a commitment to monitor on-site energy consumption and identify and address on-site energy waste. | Construction contractor | Pre-construction Construction |
| Vegetation clearance | Vegetation clearance will be minimised, where feasible, in accordance with the approved project. Areas to be revegetated will be revegetated in accordance with the project landscape plan. | Construction contractor | Construction |
| Sustainability education | The environmental induction developed for the project will include measures to promote energy-efficient work practices by construction personnel. | Construction contractor | Construction |

9.2 Utilities and services infrastructure

This section provides an assessment of the potential impact on existing public utilities and services during the construction and operation of the project. It also identifies management and mitigation measures to be implemented to minimise potential impacts.

9.2.1 Assessment methodology

The existing public utilities and services within or close to the proposed project area were identified from:

- A preliminary Dial Before You Dig search for Grafton and South Grafton, in June 2013 and September 2013
- Plans from Clarence Valley Council showing stormwater, water and sewerage infrastructure
- Ground investigations during concept design
- A survey completed in March 2014
- Consultation with utility service providers or owners identified by the Dial Before You Dig search. These service providers or owners were also consulted to identify future utility infrastructure that could potentially affect or be affected by the project.

Once this information was collected, a desktop review was carried out to identify existing and future public utilities and services potentially impacted by the project. The assessment identifies management and mitigation measures to be implemented to minimise potential impacts.

The information that was gathered has been considered in the design development of the project. The assessment of utility infrastructure may be further refined during detailed design based on information gathered from future investigations.

9.2.2 Existing environment

Existing public utilities and services within or close to the project have been identified as:

- Water supply pipes (50 to 500 mm diameter pipes) owned by Clarence Valley Council
- Sewerage (150 to 400 mm diameter pipes) owned by Clarence Valley Council
- Stormwater infrastructure (culverts, box culverts, 300 to 1050 mm diameter pipes, open channels and a pumping station) owned by Clarence Valley Council
- Electricity infrastructure (11 kilovolt crossing beneath the Clarence River at Grafton and minor and major transmission lines in South Grafton and Grafton) owned by Essential Energy
- Electricity infrastructure (132 kilovolt crossing of the Clarence River at Elizabeth Island) owned by Essential Energy, which forms part of TransGrid's infrastructure
- Telecommunications infrastructure owned by the National Broadband Network, Nextgen Group Holdings Pty Ltd, SingTel Optus Pty Limited, Telstra and TPG/AAPT (PowerTel) Limited.

These public utilities and services providers were consulted during the preparation of this EIS (refer to Chapter 7). The following feedback was received:

- National Broadband Network expressed interest in the potential for a 100 mm diameter conduit to be attached to the new Grafton Bridge for telecommunications infrastructure
- Essential Energy noted an easement across the Clarence River immediately downstream of the existing Grafton Bridge.

No feedback was received in regards to any future utility infrastructure that would impact the project.

9.2.3 Assessment of potential impacts

Table 9-4 provides a preliminary list of utility services identified as potentially affected by the project. This list is indicative only and based on the current project design. A final list of utility services that may be impacted by the project would be identified during detailed design.

Where construction of the project is likely to impact existing utility services it may be necessary to:

- Protect the utility service where it is indirectly affected and close to the proposed work to avoid it being accidentally damaged
- Relocate the utility service, where it is directly affected, around the construction site and reinstate the service after construction ends
- Decommission utility services connecting to properties beneath land to be acquired
- Modify construction methods to avoid impacts.

Table 9-4 Preliminary list of utility services potentially affected by the proposed project

| Utility service provider / owner | Utility service to be relocated | Location |
|-----------------------------------|--|--|
| Australian Rail Track Corporation | About 65 metres of unknown metallic services | Within the proposed bridge approach alignment, South Grafton |
| Clarence Valley Council | Multiple sections of water pipe, sewer pipe and pits | Western side of Iolanthe Street, South Grafton Pound Street, Grafton Southern side of Greaves Street, South Grafton |
| | Multiple sections of table drain, headwalls and pits | Eastern side of Pacific Highway/Iolanthe Street, South Grafton Southern side of Old Pacific Highway, South Grafton Western side of Iolanthe Street, South Grafton Eastern side of new Grafton Bridge, South Grafton |

| Utility service provider / owner | Utility service to be relocated | Location |
|----------------------------------|---|--|
| | Multiple sections of stormwater pipe and pits | Gwydir Highway, South Grafton Crossing of Old Pacific Highway, South Grafton Northern side of Old Pacific Highway, Grafton Crossing of Iolanthe Street, South Grafton Crossing of new Grafton Bridge, South Grafton Crossing of Pacific Highway, South Grafton Crossing of new Grafton Bridge, Grafton Pound Street, Grafton Crossing of Bridge Street, Grafton Clarence Street, Grafton Intersection of Dobie Street and Villiers Street, Grafton |
| | Watercourse | Eastern side of Iolanthe Street, South Grafton |
| | Pump station | Crossing of Pacific Highway, South Grafton |
| Essential Energy | Various overhead minor transmission lines and poles | Pacific Highway, South Grafton Iolanthe Street, South Grafton Gwydir Highway, South Grafton Roundabout at Gwydir Highway and Bent Street, South Grafton |
| | Easement across the Clarence River | Easement across the Clarence River immediately downstream of the existing Grafton Bridge. Based on the preliminary information provided by Essential Energy, the easement would not be impacted by the project however this would be confirmed during detailed design |
| | Telecommunications cable and pit | Crossing of entry to Pound Street, Grafton |
| SingTel Optus Pty Limited | Telecommunications cable and pits | Southern side of Spring Street; and Old Pacific Highway, South Grafton Western side of entry to Pound Street; and Pound Street, Grafton Southern side of Spring Street; and Old Pacific Highway, South Grafton |
| TPG/AAPT (PowerTel) | Telecommunications cable and pits | Southern side of Spring Street and Old Pacific Highway, South Grafton Southern side of North Coast Railway; entry to Pound Street; and Pound Street, Grafton |

9.2.4 Environmental management measures

The following measures in Table 9-5 are proposed to manage impact on utility infrastructure during construction and operation of the project.

Table 9-5 Environmental management measures for utility and services infrastructure

| Impact | Environmental management measure | Responsibility | Timing |
|---|---|-------------------------|------------------|
| Coordination for future utility infrastructure developments | The National Broadband Network Co will be consulted during detailed design about the location, timing and cost of a potential conduit attached to the new Grafton Bridge. | Roads and Maritime | Detailed design |
| | Essential Energy will be consulted during detailed design about the location and timing of a potential easement across the Clarence River. | Roads and Maritime | Detailed design |
| Protection or relocation of utility services | Relevant service utility providers or owners will be consulted to verify locations, impacts and any protection, relocation or decommissioning work required. | Roads and Maritime | Detailed design |
| | A Dial Before You Dig search will be carried out to identify the location of utility services. | Construction contractor | Pre-construction |
| | A services search within land not covered by the Dial Before You Dig search will be carried out to identify the location of utility services. | Construction contractor | Pre-construction |
| | Existing services to be potentially impacted by the project will be physically relocated. | Construction contractor | Pre-construction |
| Decommissioning of utility services | Relevant service utility providers or owners will be consulted before the removal of any decommissioned utility services beneath acquired properties. | Construction contractor | Pre-construction |

9.3 Waste minimisation and management

This chapter provides an assessment of the potential waste generated from the construction and operation of the project and outlines management and mitigation measures to be implemented to minimise these impacts.

9.3.1 Legislative framework

The *Waste Avoidance and Resource Recovery Act 2001* and the *Protection of the Environment Operations Act 1997* are the key legislation that govern matters relating to waste generation, reuse, recycling, transport and disposal in NSW. The legislation also establishes a waste minimisation hierarchy that prioritises waste solutions according to how successfully they conserve natural resources.

A review of the waste regulatory framework relevant to the project is presented below.

Waste Avoidance and Resource Recovery Act 2001

Waste management for the project would be carried out in accordance with the *Waste Avoidance and Resource Recovery Act 2001*. The Act establishes a waste hierarchy, which requires that resource management options are considered against a hierarchy of the following order:

- Avoidance of unnecessary resource consumption
- Resource recovery (including reuse, reprocessing, recycling and energy recovery)
- Disposal.

Other principles and objectives of the Act to be followed by the project are to:

- Encourage the most efficient use of resources and to reduce environmental harm in accordance with the principles of ecologically sustainable development
- Provide for the continual reduction in waste generation
- Minimise the consumption of natural resources and the final disposal of waste by encouraging the avoidance of waste and the reuse and recycling of waste
- Ensure that industry shares with the community the responsibility for reducing and dealing with waste
- Ensure the efficient funding of waste and resource management planning, programs and service delivery
- Achieve integrated waste and resource management planning, programs and service delivery on a State-wide basis
- Assist in the achievement of the objectives of the *Protection of the Environment Operations Act 1997*.

In addition, the *Waste Avoidance and Resource Recovery Strategy 2007* (DECC, 2007) and the *NSW Government's Waste Reduction and Purchasing Policy* provide guidance on waste management priorities. Road and Maritime would have regard to the guidance provided in these documents when carrying out the project.

Protection of the Environmental Operations Act 1997

The *Protection of the Environment Operations Act 1997* specifies the requirements for licences and the regulation of activities that have the potential to pollute or harm the environment. The Act also makes it an offence to unlawfully transport waste material (Section 143); to use the premises as a waste facility without the authority to do so (Section 144); or provide misleading information regarding waste storage, transport and disposal (Section 144AA).

Protection of the Environment Operations (Waste) Regulation 2005

This regulation sets out the provisions around the way waste is managed in terms of storage and transportation as well as reporting and record keeping requirements for waste facilities. Material that requires removal from the project site and which is deemed to be of unsuitable condition for use would be disposed of offsite as per the requirements set out in this regulation. Any such material would first be sorted and classified according to the *NSW Waste Classification Guidelines* (DECCW, 2008) before it is removed off-site.

This regulation also enables the Environment Protection Authority to issue general resource recovery exemptions to promote the reuse of certain materials. These 'resource recovery exemptions' are granted by the Environment Protection Authority where the exemption sought is a genuine, fit for purpose reuse of the waste rather than another path to waste disposal. An exemption facilitates the use of waste materials outside of certain requirements of the waste regulatory framework.

The Environment Protection Authority issues general exemptions for commonly recovered, high volume and well characterised waste materials. A general exemption may be used by Roads and Maritime, without seeking approval from the Environment Protection Authority, provided the generators, processors and consumers fully comply with the conditions of the exemption. The general exemptions currently in force that are relevant to the project are:

- Excavated natural material exemption (EPA, 2008a)
- Excavated public road material exemption (EPA, 2012a)
- Raw mulch exemption (EPA, 2008b)
- Reclaimed asphalt pavement exemption (EPA, 2012b)
- Recovered aggregate (EPA, 2010)
- Stormwater (EPA, 2008c)
- Treated drilling mud (EPA, 2011).

Environmentally Hazardous Chemicals Act 1985

The *Environmentally Hazardous Chemicals Act 1985* provides the Environment Protection Authority with the authority to declare chemical substances as chemical wastes and to make chemical control orders relating to those substances. Chemical control orders are made when chemicals or chemical wastes pose serious threats to the environment and there are particular challenges in their management.

This Act also provides that, by reason of a chemical control order, an authorised licence be obtained for certain activities relating to the manufacturing, processing, keeping, distributing, conveying, using, selling or disposing of an environmentally hazardous chemical or a declared chemical waste.

Waste Classification Guidelines

The *NSW Waste Classification Guidelines* (DECCW, 2008) are to be adhered to for the assessment, classification, management and disposal for all waste on the project.

9.3.2 Assessment of potential impacts - construction

Construction of the project would generate a number of waste streams, including:

- Spoil and excavation waste. The spoil generated from construction is likely to be predominantly soil with some clay. Small amounts of sandstone spoil may be generated from bridge piling work. The project would have a net fill requirement, with the cut to fill amounts from roadworks (about 25,000 cubic metres) to be beneficially reused on the project where suitable in either earthworks for

roadworks (100,000 cubic metres fill requirement) or levee raising works (84,000 cubic metres imported fill requirement)

- Green waste. This waste stream would be generated from clearing relatively small amounts of vegetation, mainly consisting of isolated trees and low-growing shrubs and grasses in areas along the project alignment. Waste would include logs, green waste and weeds. Logs and green waste would be mulched (where not contaminated by weeds) and beneficially reused onsite for landscaping as a first preference, or offsite in the local area
- Demolition waste. The project would require the demolition and removal of structures, road pavement, old railway infrastructure and utilities resulting in bricks, concrete, timber, steel, glass and other types of building demolition waste. Utilities associated with these properties would become redundant and would also require removal or demolition. Waste materials expected to be generated include asphalt, concrete, gravel, scrap metal, timber and plastics. There is the potential to uncover asbestos in structures for demolition, as discussed in Section 8.10
- Demolition waste from heritage listed items. As noted in Section 8.5, the project would require the demolition of various dwellings that have local heritage value. Some demolished waste from these items could be reused or salvaged.

Additional construction waste streams that could be generated include:

- Excess building materials (concrete, asphalt, steel, timber, plastics, packaging materials)
- Waste generated from concrete batching plants (ie excess concrete)
- Waste produced from the maintenance of various heavy construction equipment including liquid hazardous waste, fuel and oils
- Contaminated materials. During construction, the disturbance of existing contaminated soils may mobilise certain contaminants. Potential impacts from construction activities on contaminated land are assessed in Section 8.1. Material that is potentially contaminated is unlikely to be re-used and would be disposed off-site in accordance with the *NSW Waste Classification Guidelines* (DECCW, 2008) and the *Protection of the Environment Operations Act 1979*
- General waste, including food, paper and other waste generated by construction workers and construction compounds
- Acid sulfate soil and treated acid sulfate soil. Acid sulfate soils are discussed in Section 8.1
- Wastewater from stockpiled materials contaminated runoff from concrete bridge decks, water captured in excavations, dam de-watering
- Sewage from ancillary sites.

These waste streams could have potential impacts in terms of:

- Excessive volumes of waste generated on-site
- Excessive volumes of waste sent to landfill from the inadequate collection, classification and disposal of waste
- Contamination of soil, surface water and groundwater from inadequate waste handling
- Amenity. There could be odour impacts and increases in vermin from inappropriate general waste storage and disposal.

Management of surplus material approach

Surplus material excavated from the project may consist of virgin excavated natural material (being natural rock, soil, sand and clay), excavated natural material (at least

98 per cent natural soil or rock material) or excavated public road materials (typically asphalt or concrete pavement materials).

The preferred approach to managing surplus material would be to re-use or recycle the material on-site (with the exception of contaminated material) and within the project boundary. The long-term management of surplus material can include landscaping or permanent stockpiles within each project section, through backfilling of borrow sites, batter flattening, landscape mounds or stockpiles

It is unlikely that any suitable surplus material would need to be removed from the project site because the volume of fill needed to construct the project is much greater than the volume of material that would be excavated.

Some unsuitable material may be generated during the construction of the project. Unsuitable material is surplus material that cannot be used beneficially elsewhere onsite. This material would need to be disposed of offsite.

Areas of the project where unsuitable material could be generated include the floodplain areas. Offsite disposal of unsuitable material would be required.

Disposal of surplus material offsite to other public land is permitted or to private land with the permission of the landholder. Before any surplus material is disposed offsite, it would be classified in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (DECCW, 2009) and the *Protection of the Environment Operations Act 1997*. The amount of material that may require disposal offsite as waste would be determined during detailed design.

9.3.3 Assessment of potential impacts - operation

Limited volumes of waste are likely to be generated from the operation of the project. Waste would most likely be derived from road and bridge maintenance activities and from users of the road and pedestrian and cycle path. Waste streams and potential waste impacts are likely to include:

- General waste along the pedestrian and cycle path. Litter has the potential to cause both land and water pollution
- Trimmed vegetation from landscaped areas
- Excess concrete and asphalt from road maintenance and repair activities
- Vehicle oils and greases from maintenance vehicles
- Vegetation, soil and silt from the clearing of drains and culverts
- Litter generated by road users
- Contaminated waste as a result of fuel spills, accidents or leaks. A risk assessment would be carried out before construction to determine the need for spill containment, as well as the location and size of such containment. Spills and contamination risks are identified in Chapter 11 Environmental risk analysis.

9.3.4 Environmental management measures

The following waste management measures in Table 9-6 would be implemented to minimise waste impacts.

Table 9-6 Environmental management measures for waste

| Issue | Environmental management measure | Responsibility | Timing |
|---------|--|--------------------|-----------------|
| General | Rubbish bins will be located at strategic locations. | Roads and Maritime | Detailed design |

| Issue | Environmental management measure | Responsibility | Timing |
|---|--|-------------------------|----------------------------------|
| Demolition waste from heritage listed items | Roads and Maritime will investigate options for reusing or salvaging demolition waste from heritage items | Roads and Maritime | Pre-construction |
| General | <p>A construction waste management plan will be prepared as part of the construction environmental management plan to identify measures for minimising and managing waste. The construction waste management plan will include:</p> <ul style="list-style-type: none"> • The type and volume of all materials to be utilised during the project construction • Destinations for each resource/waste type either for on-site reuse or recycling, off-site reuse or recycling, or disposal at a licensed waste facility • Quantity and classification of excavated material generated as a result of the project • Disposal strategies for each type of material • Details of how waste will be stored and treated on-site • Identification of all non-recyclable waste • Identification of strategies to 'avoid', 'reduce', 'reuse', and 'recycle' • Management of surplus material as documented in this section of the EIS (refer to Section 9.3.2) • Identification of available recycling facilities on and off-site • Identification of suitable methods and routes to transport waste • Procedures and disposal arrangements for unsuitable excavated material or contaminated material • Site clean-up for each stage. | Construction contractor | Pre-construction Construction |

| Issue | Environmental management measure | Responsibility | Timing |
|----------------------|---|---|----------------------------------|
| | <p>A resource use management strategy will be prepared as part of the construction waste management plan to identify the hierarchy for sourcing and use of resources. The strategy will include:</p> <ul style="list-style-type: none"> • Project areas with a deficit in material will import surplus material from other project sections in preference to external sources • Where possible, the distances that earthworks materials are moved across the project as a whole will be minimised • Any unsuitable material will be used for landscaping or disposed of within each project section, either for batter flattening or noise mounds or placed in stockpile • Construction contractors will reduce the amount of unsuitable waste generated during excavations, where feasible (eg treatment at source) • Other locations of disposal of unsuitable material will be considered including borrow source areas created as part of the project • The generation and management of unsuitable material during project earthworks will be monitored to ensure appropriate management of the issue • Details on materials that will be sourced from the project (including location and type) • Proposed sustainable material sourcing (such as recycled materials or use of waste water) • Materials that could be recycled and re-used on-site or transferred to other project sections. | Construction contractor | Pre-construction Construction |
| Spills and accidents | A risk assessment will be carried out to determine the need, location and size, of spill containment mechanisms. | Roads and Maritime Construction contractor | Pre-construction Construction |

| Issue | Environmental management measure | Responsibility | Timing |
|-----------------------------------|---|-------------------------|-------------------|
| Asbestos on demolished structures | Asbestos surveys will be conducted for structures to be demolished as part of the project. An asbestos certified disposal service will be engaged for properties identified as having asbestos materials. | Construction contractor | Before demolition |
| General | The handling, storage and transport of hazardous materials and waste will be in accordance with the <i>National Code of Practice Storage and handling of dangerous goods</i> (Workcover, 2001) and the relevant material safety data sheet for the product. | Construction contractor | Construction |
| | Regular visual inspections will be conducted to ensure that work sites are kept tidy and to identify opportunities for reuse and recycling. | Construction contractor | Construction |
| | Requirements for waste management will form part of site training and induction processes. | Construction contractor | Construction |
| | All generated waste will be managed and disposed of in accordance with relevant State legislation and government policies including the <i>Waste Avoidance and Resource Recovery Act 2001</i> , the <i>Waste Avoidance and Resource Recovery Strategy 2007</i> and the <i>Waste Reduction and Purchasing Policy</i> . The <i>Waste Classification Guidelines</i> (DECCW, 2008) will also be used to classify the different types of waste. | Construction contractor | Construction |
| Beneficial reuse | <p>The project will aim for the following:</p> <ul style="list-style-type: none"> • 100% beneficial reuse of usable spoil, recognising that there is likely to be a significant volume of excavated material that is potentially contaminated or otherwise unsuitable for reuse. Sampling and testing will confirm which excavated material is suitable for reuse • 95% beneficial reuse of construction and demolition waste • Minimising the need for extracting new material by reusing material from other nearby projects (eg the Woolgoolga to Ballina Pacific Highway upgrade) where feasible and reasonable. | Construction contractor | Construction |

| Issue | Environmental management measure | Responsibility | Timing |
|-------------------------|---|-------------------------|--------------|
| | <p>For any surplus material the following beneficial re-use options will be considered:</p> <ul style="list-style-type: none"> • Construction of acoustic and visual mounds where there is a benefit to residents and other sensitive receivers • Flattening of road batters • Rehabilitation of borrow pits • Engineered fill • Improvements to flood prone land. | Construction contractor | Construction |
| Liquid wastes | Liquid waste, including waste oil, will be collected and stored in appropriately bunded areas. | Construction contractor | Construction |
| Records | A waste register will be maintained for the construction site. It will detail the types of waste collected, amounts, date and time, and details of disposal. | Construction contractor | Construction |
| Materials and packaging | Where feasible and reasonable, materials will be bought in bulk to minimise the amount of packaging required. | Construction contractor | Construction |
| | Sources of material that have sustainable packaging design, such as recycled and recyclable packaging, will be favoured over other material sources where cost effective. | Construction contractor | Construction |
| | The use of recycled products in construction work will be investigated. | Construction contractor | Construction |
| Demolition waste | Where practicable, houses, redundant services and other structures will be deconstructed rather than demolished to allow as much material as possible to be re-used or recycled off-site. | Construction contractor | Construction |
| Green waste | Logs and green waste will be mulched (where not contaminated by weeds) and beneficially reused onsite for rehabilitation and landscaping as a first preference, or offsite in the local area. | Construction contractor | Construction |

9.4 Cumulative impacts

This chapter presents an assessment of the potential cumulative impacts of the project when considered in conjunction with other developments and activities occurring in and around the Grafton area.

Table 9-7 below shows the Director-General's environmental assessment requirements relevant to the cumulative impacts addressed in this chapter.

Table 9-7 Director-General's environmental assessment requirements relevant to cumulative impacts

| Director General's environmental assessment requirements | Where addressed in EIS |
|---|------------------------|
| Consideration of the potential cumulative impacts due to other development in the vicinity. | Section 9.4.3 |

9.4.1 Assessment methodology

Cumulative impacts are incremental environmental impacts that are caused by past, present or reasonably foreseeable future activities which, when combined, may have a cumulative effect. When considered in isolation, the environmental impacts of any single project upon any single receiver or resource may not be significant. Significant effects may arise, however, when individual effects are considered in combination, either within the same project or together with other projects.

The assessment of cumulative impacts is focused on the known key environmental issues associated with the construction and operation of the project and their interaction with other projects in the vicinity of the project.

The relevant environmental components considered in this cumulative assessment are listed below and include key project issues and other issues covered in this EIS. The issues considered are:

- Traffic and transport
- Flooding and hydrology
- Sea level rise effects
- Noise and vibration
- Non-Aboriginal heritage
- Aboriginal heritage
- Socio-economic, property and land use
- Visual amenity, built form and urban design
- Biodiversity
- Soils, sediments and water
- Mineral resources
- Air quality
- Wind and wind-wash effects
- Greenhouse gases
- Utility infrastructure
- Resource and waste management.

Other projects in this assessment were identified taking into account:

- Location – other projects located close to the proposed project (ie intersected by the bridge alignment or the sections of levee to be raised)
- Project timeframe – other projects likely to be under construction concurrently with the construction and/or operation of the proposed project
- Project size – projects were identified by virtue of being listed on the Department of Planning and Environment Major Projects Register and through consultation with Roads and Maritime and Clarence Valley Council.

Table 9-8 lists the projects that meet the above criteria, and therefore have potential to contribute to cumulative impacts along with the project. It includes the location and a brief description of each project, project status, construction timeframe and likely environmental impacts based on the information available.

The key impacts of the projects listed in Table 9-8 have been assessed by the various proponents as part of the environmental assessment and approval process. In the case of future urban development projects, this EIS has assumed relevant key impacts based on impacts observed, project team knowledge of the area and other comparable urban development projects.

Table 9-8 Projects with potential to contribute to cumulative impacts along with the project

| Description | Status | Assumed key impacts based on current knowledge |
|---|---|--|
| Pacific Highway Upgrade – Woolgoolga to Ballina | | |
| <p>155 km section of the highway upgraded to four-lane dual carriageway between Woolgoolga and Ballina.</p> <p>The highway would bypass South Grafton.</p> <p>Timeline: Tenders will be invited late 2014 for the early work soft soil sections along the project, with worked likely to start in 2015.</p> | <p>NSW Planning approval received 24 June 2014.</p> <p>This approval has now been forwarded to the Federal Department of the Environment, for consideration under the <i>Environmental Protection and Biodiversity Conservation Act 1999</i>.</p> | <p>Hydrology, water and soils</p> <p>Biodiversity</p> <p>Landscape and visual impacts</p> <p>Aboriginal and non-Aboriginal heritage</p> <p>Traffic</p> <p>Noise and vibration</p> <p>Land use</p> <p>Social and economic</p> |
| Proposed service station, fast food restaurant and café at the intersection of Spring Street and Iolanthe Street, South Grafton | | |
| <p>Development of a service station (185 m²), restaurant and café (30 seat capacity) on an existing car yard site at the intersection of Spring Street and Iolanthe Street, South Grafton. A total of 20 on-site car parking spaces will be provided.</p> <p>Timeline: Unknown.</p> | <p>Application has been approved by Clarence Valley Council with conditions</p> | <p>Traffic, parking and access</p> <p>Visual</p> <p>Noise and vibration</p> |

| Description | Status | Assumed key impacts based on current knowledge |
|--|---|--|
| Lapsed Homemaker Centre development approval at the intersection of Through Street and Iolanthe Street, South Grafton | | |
| Bulky goods retailing development comprising three interconnected buildings (12,000 m ²) arranged around a communal car park. Timeline: Unknown. | Approval has lapsed. However it sets precedence for future use of the site. | Traffic, parking and access Visual Noise and vibration |
| Future urban development projects | | |
| The key residential growth areas identified by Clarence Valley Council and documented in the <i>Mid North Coast Regional Strategy 2006-31</i> (Department of Planning, 2009) relevant to the project are Junction Hill, Waterview Heights, and Clarenza. Timeline: For the purposes of this EIS, It was assumed that take up of the development would occur in Junction Hill initially, followed by Waterview Heights and finally Clarenza. | Areas have been identified | Operational traffic, parking and access Resource and waste management |

9.4.2 Potential cumulative impacts – construction and operation

As shown in Table 9-8, some of the projects are still being assessed by the approval authority. It is not certain when or if these projects will start construction and be completed and, therefore, the extent and nature of any related impacts is also uncertain. The likely impacts of these projects will be assessed as part of the development consent process by the relevant approval authority.

The projects identified in Table 9-8, when considered with the construction and operation of the Grafton Bridge project may result in cumulative environmental impacts. The likely cumulative impacts are described in Table 9-9.

Table 9-9 Potential cumulative impacts

| Project | Potential cumulative impacts |
|--|--|
| Pacific Highway Upgrades | <p>The following impacts are likely to occur as a result of the construction of these projects:</p> <ul style="list-style-type: none"> • Cumulative traffic disruptions to road users travelling to and from Grafton using the existing Pacific Highway • The South Grafton bypass included within the Woolgoolga to Ballina upgrade would have potential minor traffic impacts to traffic between Grafton and the new Pacific Highway alignment during construction • Cumulative demand on resources including mineral resources • Cumulative impacts on the heritage (Aboriginal and non-Aboriginal) and biodiversity of the Mid North Coast region • Cumulative changes to land use and property impacts in the Clarence Valley local government area • Cumulative amount of spoil and waste generated. <p>Operationally, these projects are expected to improve traffic efficiency and road safety, and contribute to the economic development of the Clarence Valley and the Mid North Coast region.</p> |
| South Grafton projects: service station and homemaker centre proposals | <p>The timeline for approval, construction and operation of these proposals is unknown. The cumulative assessment presented below has made the conservative assumption that these projects will have started and that there will be construction timeline overlaps. If these overlaps occur, then the following impacts are likely:</p> <ul style="list-style-type: none"> • Disruption to traffic (including pedestrian and cyclists) movements as a result of construction activities • Visual impact due to construction hoarding • Impacts for patrons wishing to access existing businesses along Iolanthe Street • Noise impacts due to construction activities. <p>A cumulative increase in the demand for goods and services in Grafton may also be expected. The businesses that are most likely to experience this demand are warehouses, quarries, hotels, eateries, food outlets and local retailers due to the flow-on effects resulting from an increase in the number of construction workers.</p> <p>Once the proposed Grafton Bridge is operational, the following cumulative benefits are likely:</p> <ul style="list-style-type: none"> • Subject to Council's approval, there would be an increased opportunity for new businesses on Iolanthe Street and Pound Street to attract customers • The projects would indirectly support employment and economic growth in Grafton and South Grafton. |

| Project | Potential cumulative impacts |
|-----------------------------------|---|
| Future urban development projects | <p>Future growth areas would be expected to be positively impacted by the provision of an improved bridge to Grafton and the proposed road upgrades in South Grafton. The project does not directly impact on any lands to be occupied by these urban developments and included as part of the <i>Mid North Coast Regional Strategy 2006-31</i> (Department of Planning, 2009).</p> <p>The project has been designed to allow for potential future pedestrian and cycle path connections to Clarenza (as described in Section 8.1).</p> |

9.4.3 Environmental management measures

Cumulative impacts for the construction works will be managed and mitigated through a construction environmental management plan that the construction contractor will be required to implement and adhere to. For example, the construction environmental management plan would require the construction contractor to consider other developments and projects that may also be under construction. This would seek to minimise where possible traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic (refer to Section 8.1.5). In seeking to mitigate cumulative demand in resources, the project would aim to minimise the need for extracting new material by reusing material from other nearby projects (eg the Woolgoolga to Ballina Pacific Highway upgrade) where feasible and reasonable (refer to Section 9.3.4). Proposed environmental management measures to manage cumulative impacts during construction are listed in Table 9-10.

During operation, the cumulative impact assessment presented in this section shows positive combined impacts from the interaction between the project and other developments. No additional mitigation measures would be required for the operational stage of the project.

Table 9-10 Environmental management measures for cumulative impacts

| Impact | Environmental management measure | Responsibility | Timing |
|--|---|-------------------------|------------------|
| Potential cumulative impacts during construction | Construction contractor will identify all other developments and projects occurring in the vicinity of the project and identify environmental impacts to be monitored during construction which have the potential for cumulative effects to occur. | Construction contractor | Pre-construction |
| | Construction contractor will review environmental impacts every six months during construction. Any new impacts identified during construction will be addressed appropriately to reduce cumulative effects and reported as part of the construction environmental management plan. | Construction contractor | Construction |

10 Summary of environmental management measures

This chapter describes how the project would be managed throughout detailed design, construction and operation, to reduce potential environmental impacts that have been identified through the impact assessment process. Table 10-1 below shows the Director-General’s environmental assessment requirements relevant to the environmental management measures addressed in this chapter.

Table 10-1 Director-General’s environmental assessment requirements relevant to environmental management measures

| Director General’s environmental assessment requirements | Where addressed in EIS |
|--|---|
| <p>Where relevant, the assessment of key issues below, and any other significant issues identified in the risk assessment, must include:</p> <ul style="list-style-type: none"> - adequate baseline data; - consideration of the potential cumulative impacts due to other development in the vicinity; and - measures to avoid, minimise and if necessary, offset the predicted impacts, including detailed contingency plans for managing any significant risks to the environment. | <p>Chapter 8 and Chapter 9</p> <p>Section 9.4</p> <p>Chapter 10</p> |

A framework for managing the potential impacts is provided with reference to environmental management plans and relevant Roads and Maritime or Government guidelines. A number of environmental management measures have been identified in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the project. Should the project proceed, these environmental management measures would be incorporated into the relevant phase of the project. All measures listed in Table 10-2 would be incorporated into the construction environmental management plan and/or the operational framework for the project.

Table 10-2 Summary of environmental management measures

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|--|-----|--|---|------------------|
| General environmental management | | | | |
| General environmental management | G1 | <p>A Construction Environmental Management Plan will be prepared and implemented to ensure appropriate environmental management measures are followed during project delivery. The Construction Environmental Management Plan will provide a framework for environmental management during construction and will:</p> <ul style="list-style-type: none"> • Outline all environmental management practices and procedures to be followed during construction and demolition works associated with the project • Describe all activities to be undertaken on the site during construction of the project • Detail how the environmental performance of the construction works will be monitored • Detail what corrective actions will be taken to address identified adverse environmental impacts • Describe of the roles and responsibilities for all relevant employees involved in the project • Include relevant sub-plans. <p>The Construction Environmental Management Plan will be developed in accordance with <i>Guideline for the Preparation of Environmental Management Plans</i> (Department of Infrastructure, Planning and Natural Resources, 2004).</p> | Roads and Maritime Construction contractor | Construction |
| Traffic and transport | | | | |
| Operational impacts on river navigation and access | TT1 | The provision of permanent aids to navigation on the bridge will be investigated as part of detailed design. | Roads and Maritime | Detailed design |
| Road safety audit | TT2 | Roads and Maritime will conduct a project road safety audit as part of detailed design to identify and address potential safety issues associated with the operation of the project | Roads and Maritime | Detailed design |
| Future traffic demand | TT3 | If more detailed information regarding future demand becomes available during detailed design of the project, Roads and Maritime will assess the suitability of incorporating the revised projections. | Roads and Maritime | Pre-construction |
| Construction impacts on public transport | TT4 | Access to bus stops will be maintained during construction in consultation with the bus operators where feasible and reasonable. | Roads and Maritime | Pre-construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|------------------------------|-----|--|---|--|
| Construction traffic impacts | TT5 | <p>Construction traffic management measures will be developed and identified as part of the construction environmental management plan. The plan will:</p> <ul style="list-style-type: none"> • Detail how the traffic associated with construction activities will be managed in accordance with the relevant standards, including <i>Traffic Control at Work Sites</i> (Roads and Maritime, 2010), AS1742 and Roads and Maritime Specification G10 • Confirm haulage routes between material source sites and ancillary site / flood levee stockpile access locations • Quantify the impacts on level of service during critical construction periods and demonstrate how the mitigation measures proposed will enable acceptable traffic operations and level of service on the road network during construction • Identify how the continuous, safe and efficient movement of traffic for both the public and construction workers will be maintained • Identify site-specific traffic control measures (including signage) to be provided to manage and regulate traffic movements at relevant locations during construction • Identify access arrangements at both construction sites and quarry sites, detailing vehicle ingress / egress movements • Include requirements and methods to consult and inform the local community of impacts on the local road network and traffic • Describe impacts on all transport modes, identifying appropriate mitigation measures in accordance with the relevant guidelines and in consultation with relevant parties (ie bus and rail operators). • Consider other developments and projects that may also be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic. | <p>Construction contractor Roads and Maritime</p> | <p>Pre-construction Construction</p> |
| Construction traffic impacts | TT6 | <p>Construction deliveries will be timed to occur outside peak traffic periods when feasible and reasonable, to minimise impacts on road network.</p> <p>Where feasible and reasonable, machinery and materials to be delivered over long distances will be transported to Grafton by rail and hauled to site by road transport. Consultation will be initiated with the appropriate rail operators / owners to explore this opportunity at the appropriate design stage.</p> <p>Emergency services will be notified in advance of changes to traffic conditions (eg partial or total road closures).</p> | <p>Construction contractor Roads and Maritime</p> | <p>Construction</p> |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|---|------|---|---|--------------|
| Construction impacts on the road network | TT7 | Local roads used for construction access will be repaired where required and maintained in serviceable condition. | Construction contractor Roads and Maritime | Construction |
| Construction impacts on public transport | TT8 | Roads and Maritime will coordinate the placement of the new Pound Street bridge with ARTC to ensure the North Coast Line possession coincides with other works required along the line. In addition, North Coast Line users (passengers and freight operators) will be notified of impending changes to minimise impacts on them. | Construction contractor Roads and Maritime | Construction |
| Construction impacts on river navigation and access | TT9 | Exclusion zones around critical areas of construction activities and floating construction plant will be clearly marked in accordance with Roads and Maritime advice and requirements. | Construction contractor | Construction |
| | TT10 | Commercial fishing licence holders on the Clarence River at Grafton will be consulted during construction to minimise impacts and address any access issues in and around the construction site. | Construction contractor Roads and Maritime | Construction |
| | TT11 | A proclaimed Marine Notice will be issued through Roads and Maritime alerting river users of ongoing construction activities. | Construction contractor Roads and Maritime | Construction |
| | TT12 | Temporary aids to navigation will be provided where feasible and reasonable and in accordance with Roads and Maritime advice and requirements (such as lighted buoys to mark exclusion zones). | Construction contractor Roads and Maritime | Construction |
| | TT13 | Early and ongoing liaison with local marine events organisers (including Grafton Rowing Club, Grafton River Sailing Club and the Grafton Bridge to Bridge Waterski Race organiser) will be carried out to ensure the viability of these annual events and general activities organised by the clubs. | Construction contractor Roads and Maritime | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|---|------|--|---|----------------------------|
| Construction impacts on river navigation and access | TT14 | A construction navigation management plan will be prepared and implemented to set out river procedures and impact reduction measures to be adopted during construction. | Construction contractor Roads and Maritime | Construction |
| Flooding and hydrology | | | | |
| Impacts of flooding on the project construction | FH1 | <p>Flood monitoring and response measures will be included as part of the construction environmental management plan.</p> <p>These measures will include protocols to monitor the forecast of large rainfall and flood events in the project area and protocols to minimise the risk of damage to infrastructure and equipment during a large flood or rainfall event and will include but not limited to:</p> <ul style="list-style-type: none"> • Methods of monitoring rising water and where possible notification from upstream • A register of all materials stored in work areas within the banks of the Clarence River and within the levee system • Methods and responsibilities for removal of all materials safely from work areas during a flood event • Notification and consultation with relevant stakeholders. | Construction contractor | Pre-construction |
| Impacts of the project on flood evacuation routes | FH2 | NSW State Emergency Services will be notified of any partial or total road closures during construction | Construction contractor | Pre-construction |
| Consultation | FH3 | Roads and Maritime will consult with affected landowners during detailed design and construction regarding flooding impacts on properties, residences and other structures. | Roads and Maritime | Pre-construction |
| Flood modelling | FH4 | <p>Detailed flood modelling will be carried out to further refine the levee raising mitigation measures proposed for the project and to further consider the need to raise any houses not protected by the existing levee which would be affected by increased flood levels within the river.</p> <p>As part of this modelling, floor level surveys will be carried out on properties identified as potentially affected by residual impact from the project.</p> | Roads and Maritime | Pre-construction of bridge |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|---|-----|--|-------------------------|----------------------------|
| Residual impacts on properties and infrastructure | FH5 | Property-specific flood risk will be assessed for each property identified as being affected by residual impact from the project, based on the results of the floor level survey. Flood mitigation options will be developed and implemented in consultation with property owners and Clarence Valley Council. | Roads and Maritime | Pre-construction of bridge |
| Impacts of project construction on existing flood regimes | FH6 | Flood mitigation works will be staged to ensure no worsening of the existing flood regimes during construction. | Construction contractor | Pre-construction of bridge |
| Climate change and sea level rise | | | | |
| Managing climate change risks to the project | CC1 | Bridge approach embankments will be investigated in detailed design to take into account sea level rise and severity of storms and flooding resulting from climate change. The proposed pump station in Grafton will be equipped with redundant power supply capacity. Adopted design flood levels will include an appropriate allowance for increased rainfall intensities due to climate change in accordance with the <i>NSW Floodplain Risk Management Guideline – Practical Considerations of Climate Change (DECC, 2007)</i> . | Roads and Maritime | Detailed design |
| | CC2 | Regular inspections of project elements will be carried out for early identification of potential issues relating to embankments and ground conditions. Operational procedures will be in place for the regular and timely removal of debris and falling trees and branches. | Roads and Maritime | Operation |
| Noise and vibration | | | | |
| New railway bridge above Pound Street | NV1 | The redeveloped section of rail should be equal to or better than the existing viaduct in terms of noise impact, with no additional noise impact introduced into the system via expansion joints or similar. | Roads and Maritime | Detailed design |
| Pump station, Grafton | NV2 | The pump station and pump station building will be designed to achieve the industrial noise emission criteria outlined in this EIS (refer to Table 8-33). | Roads and Maritime | Detailed design |
| Noise wall design | NV3 | Noise walls developed for the project would be designed in accordance with the <i>Noise wall design guideline</i> (Roads and Maritime, 2006). | Roads and Maritime | Detailed design |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|--------------------------------|------|--|---|--------------|
| General | NV4 | The appointed construction contractor will be required to prepare a detailed Construction Noise and Vibration Management Plan (CNVMP). This plan will include but not limited to the following: <ul style="list-style-type: none"> • Roles and responsibilities • Noise-sensitive receiver locations • Predicted impacts • Mitigation strategy • Monitoring methodology • Community engagement strategy. | Roads and Maritime Construction contractor | Construction |
| | NV5 | Workers and contractors will be inducted and trained (such as through toolbox talks) in the use of equipment in ways that minimise noise. | Construction contractor | Construction |
| | NV6 | Site managers will periodically check the site and nearby residences for noise problems so that solutions can be quickly applied, where required. | Construction contractor | Construction |
| Working hours | NV7 | Construction work will be undertaken in accordance with the approved construction hours as outlined in Section 6.4 of the EIS. | Roads and Maritime Construction contractor | Construction |
| | NV8 | Noise from construction work that might be carried out outside the recommended standard hours will follow Section 2.3 of the <i>Interim Construction Noise Guidelines</i> (DECC, 2009) where feasible and reasonable. | Construction contractor | Construction |
| Sensitive receivers | NV9 | The location of stationary plant (such as air-compressors and generators) will be located as far away as feasible and reasonable from sensitive receivers. | Construction contractor | Construction |
| Noise screening – construction | NV10 | Natural screening by topography and vegetation will be used wherever possible to reduce noise impacts. | Construction contractor | Construction |
| | NV11 | Site sheds, other temporary structures or screens will be used to limit noise exposure where feasible and reasonable. | Construction contractor | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|--------------------------------|------|---|---|---------------------------|
| Construction equipment | NV12 | Low noise construction equipment and/or methods will be preferred, where feasible and reasonable. | Roads and Maritime Construction contractor | Construction |
| | NV13 | Compliance with the Transport for New South Wales <i>Construction Noise Strategy</i> which summarises the maximum allowable noise levels for construction equipment to be applied to the project. | Roads and Maritime Construction contractor | Construction |
| Programming | NV14 | Construction programming should aim to reduce noise impacts and minimise noisy activities occurring concurrently as far as feasible and reasonable. | Construction contractor | Construction |
| Community consultation | NV15 | The Draft Community Consultation Strategy prepared for the project outlines methods for consultation with the community during construction which are to be followed, including, but not limited to: <ul style="list-style-type: none"> • Advance notification of planned activities and expected disruption/effects • Construction noise complaints handling procedure • Effective monitoring of noise levels in and around potentially affected dwellings. | Roads and Maritime Construction contractor | Construction |
| Piling | NV16 | Alternative piling methodologies will be investigated to reduce potential impacts from these activities. | Construction contractor | Construction |
| Vibration | NV17 | Limit construction vibration impacts on sensitive receivers. | Construction contractor | Construction |
| Noise screening – operation | NV18 | Operational noise barriers will be installed as early as possible to provide ongoing screening from construction activities, where feasible and reasonable. | Roads and Maritime Construction contractor | Operation Construction |
| Noise architectural treatments | NV19 | Noise architectural treatments at affected properties will be developed and implemented in consultation with property owners. | Roads and Maritime | Operation |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|--|------|--|--------------------|---------------------------------|
| Operational noise | NV20 | <p>No later than one year after commencement of operation of the project, Roads and Maritime will undertake operational noise monitoring to compare the actual noise performance of the project against predicted noise performance. The report will include, but not necessarily be limited to:</p> <ul style="list-style-type: none"> • Noise monitoring to assess compliance with operational noise levels predicted • A review of the operational noise levels in terms of criteria and noise goals • Methodology, location and frequency of noise monitoring undertaken • Details of any complaints and enquiries received in relation to operational noise • Any required recalibrations of the noise model • An assessment of the performance and effectiveness of applied noise mitigation measures • Any additional feasible and reasonable measures required. | Roads and Maritime | Operation |
| Non-Aboriginal heritage | | | | |
| Prepare an interpretation plan for the project | NH1 | A heritage interpretation plan will be prepared to provide opportunities to enhance understanding and appreciation of the heritage items, values and themes associated with Grafton. In particular, the interpretation plan will identify heritage items that are to be removed and provide opportunities for compensating for these losses. This may include incorporating formalised heritage walks and tree-planting programs into the landscaping and planning of the project. | Roads and Maritime | Detailed design |
| Consideration of heritage in urban design principles | NH2 | Heritage considerations will be incorporated into the urban design and landscape objectives developed for the project. These features will be refined further during detailed design development for the project. | Roads and Maritime | Detailed design |
| Noise mitigation treatment on heritage items | NH3 | If required, architectural noise treatments on heritage items will be applied in a sympathetic manner to minimise impact on the significance of the heritage item. | Roads and Maritime | Detailed design Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|--|-----|---|-------------------------|----------------------------------|
| Construction impacts | NH4 | <p>A construction heritage management plan (CHMP) will be prepared as part of the construction environmental management plan for the project.</p> <p>The CHMP will detail how construction impacts on Aboriginal and non-Aboriginal heritage will be minimised and managed.</p> <p>The CHMP will include:</p> <ul style="list-style-type: none"> • Details of Aboriginal and non-Aboriginal cultural heritage sites within and adjacent to the Project • Details of management measures for the project • Procedures for dealing with previously unidentified finds • Heritage training and induction processes for construction personnel • Procedures for ongoing Aboriginal consultation and involvement for the duration of the project. | Construction contractor | Pre-construction |
| Heritage values to be considered during flood mitigation works | NH5 | Any construction and vegetation clearance within or near the curtilage of heritage items will be sympathetic to minimise the removal of, or impact on, associated heritage values. | Roads and Maritime | Pre-construction |
| Prepare an archival record before impact occurs and at the completion of the project | NH6 | <p>Archival recording will be prepared for the following heritage items: CZB10, CZB11, CZB13, CZB16, CZB17, CZB18, CZB19, CZB20 & CZB21, CZB24, CZB25, CZB26, CZB27, CZB28, CZB29, CZB30, CZB31, CZB32, CZB33, CZB34, CZB35, CZB36 and CZB37.</p> <p>Archival recording will also be carried out for portions of Pound Street within the Grafton Conservation Area (C3).</p> <p>The archival records will record the process of development and alterations to heritage values. A program of archival recording will be completed before impacts occur and at the completion of the project. All archival recording will be completed in accordance with the Heritage Branch guidelines <i>How to Prepare Archival Records for Heritage Items</i> and <i>Photographic Recording of Heritage Items Using Film or Digital Capture</i> (Heritage Office 2001, revised 2004, 2006).</p> | Roads and Maritime | Pre-construction |
| Relocation of King George V Plaque | NH7 | Following archival recording, the King George V Plaque (CZB19) will be relocated to a safe location and later reinstated on the new section of viaduct at Pound Street. | Construction contractor | Pre-construction Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|---|-----|--|---|----------------------------------|
| No-go areas and temporary fencing | NH8 | <p>No-go areas will be established around three heritage items:</p> <ul style="list-style-type: none"> • CZB07 (Fisher's Drain) • FMW29 (<i>SS Induna</i> shipwreck) • FMW34 (Water Trough, Lane Park). <p>For CZB07 and FMW34, no-go areas will be established at an appropriate distance to protect the heritage values of the heritage items but allow construction to proceed unhindered.</p> <p>For FMW29, <i>SS Induna</i>, both terrestrial and maritime temporary exclusion areas will be established during construction to exclude the entry of vehicles or equipment associated with construction. The 'no-go' area perimeter will be placed on the existing property boundary to the south of the <i>SS Induna</i>. A maritime exclusion area (to be in accordance with Maritime and navigational requirements) will be placed 15 metres from the shipwreck to remind workboats to not enter this area.</p> <p>No-go areas will be marked on all construction plans and pointed out in induction talks with contractors undertaking work in vicinity to the items.</p> | Construction contractor | Pre-construction Construction |
| Archaeological monitoring (if required) | NH9 | <p>The EIS has determined that the proposed flood mitigation works traverse areas of moderate and high potential for the survival of archaeological resources of local significance. Depending on the level of impact and the form of the proposed works, monitoring of these moderate and high archaeologically sensitive areas may be required. No monitoring is required for sites with low archaeological significance.</p> <p>Monitoring is proposed as it is not appropriate to carry out archaeological testing and salvage within or next to the existing flood levee. This is due to the risks associated with compromising the flood protection measures around Grafton. An archaeological excavation program will expose properties within Grafton to an unacceptable level of risk and therefore is not appropriate in this instance.</p> <p>An archaeological monitoring program will be developed as part of the heritage management sub-plan developed for the project. The monitoring program will provide the following details:</p> <ul style="list-style-type: none"> • Description of the proposed works, including level of disturbance and consideration of previous levee construction activities and how this relates to the impacts from the work • Details of involvement of a suitably qualified archaeologist for all initial ground disturbance works which may impact upon archaeological deposits • Process to be followed should any heritage items be identified during the monitoring period. | Construction contractor Roads and Maritime | Pre-construction Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|---|------|--|-------------------------|---------------------------------|
| Discovery of unexpected non-Aboriginal objects and/or human remains | NH10 | If unexpected non-Aboriginal heritage items or skeletal remains are encountered, the <i>Roads and Maritime Services Standard Management Procedure for Unexpected Archaeological Finds (2012)</i> will be implemented. | Construction contractor | Construction |
| Aboriginal heritage | | | | |
| Golden Eel dreaming site | AH1 | Detailed design and construction stages will avoid further encroachment towards the Golden Eel dreaming site. | Roads and Maritime | Detailed design Construction |
| Consultation with Aboriginal community | AH2 | The Aboriginal community will continue to be consulted as an identified group within the overall community consultation strategy for the project. | Roads and Maritime | Detailed design Construction |
| Interpretive strategy for tangible and intangible Aboriginal heritage | AH3 | An interpretive strategy will be formulated in conjunction with the local Aboriginal community. This will highlight salient sites and features within the landscape in a manner that respectfully enhances and protects these values. The interpretative strategy will be integrated with the non-Aboriginal heritage interpretation plan for the project. | Roads and Maritime | Detailed design Construction |
| Construction impacts | AH4 | A construction heritage management plan (CHMP) will be prepared as part of the construction environmental management plan for the project. The CHMP will detail how construction impacts on Aboriginal and non-Aboriginal heritage will be minimised and managed. The CHMP will include: <ul style="list-style-type: none"> • Details of Aboriginal and non-Aboriginal cultural heritage sites within and adjacent to the project • Details of management measures for the project • Procedures for dealing with previously unidentified finds • Heritage training and induction processes for construction personnel • Procedures for ongoing Aboriginal consultation and involvement for the duration of the project. | Construction contractor | Pre-construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Aboriginal cultural heritage induction | AH5 | The project site induction will incorporate Aboriginal culture awareness training for all relevant staff and contractors. This induction will include information about the Aboriginal culture and history of the locality, the location of sites and items that require protection, heritage management measures and protocols, and legal obligations. This training will be developed in consultation with the Grafton Ngerrie LALC and provided to relevant staff before commencing work on-site. | Construction contractor | Construction |
| Known Aboriginal objects and places | AH6 | Aboriginal sites located in close proximity to the project construction work zone will be designated 'no-go' areas and will be clearly identified and appropriately fenced to prevent access or damage during construction. | Construction contractor | Construction |
| Discovery of unexpected Aboriginal cultural material and human remains | AH7 | In the event that unexpected Aboriginal cultural material or skeletal remains are encountered, the <i>Standard Management Procedure for Unexpected Archaeological Finds</i> (Roads and Maritime, 2012) will be implemented. | Construction contractor | Construction |
| Socio-economic, property and land use | | | | |
| Excess land | SE1 | Roads and Maritime will prepare an excess land strategy during detailed design and would investigate opportunities to return available regionally significant farmland, following completion of the project. | Roads and Maritime | Detailed design |
| Social infrastructure – Basmar Hall | SE2 | Roads and Maritime will communicate in a timely way with the tenants of Basmar Hall regarding its closure, to maximise the opportunity for tenants to find alternative space. | Roads and Maritime | Detailed design Pre-construction |
| Impacted moorings | SE3 | Roads and Maritime will consult with the owners of the moorings during the detailed design stage and before construction. | Roads and Maritime | Detailed design Pre-construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Affected residents | SE4 | <p>Roads and Maritime will:</p> <ul style="list-style-type: none"> Continue ongoing timely communication with affected residents on project timing and acquisition processes Deal in an efficient and empathetic manner with residents who seek acquisition on hardship grounds Provide compensation in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> and Roads and Maritime policies. | Roads and Maritime | Detailed design Pre-construction Construction |
| Local amenity – vegetation | SE5 | <p>Roads and Maritime and the construction contractor will minimise impacts, where feasible and reasonable, on existing character trees, including figs and jacarandas.</p> <p>Visual impacts and mitigation measures are outlined in Section 8.8 of this EIS.</p> | Roads and Maritime Construction contractor | Detailed design Construction |
| Community engagement | SE6 | <p>Roads and Maritime will prepare and implement a community consultation strategy to fully inform the community of works during the construction process. The Strategy will be implemented by the construction contractor.</p> <p>A draft of this strategy is presented in Appendix C. The mitigation measures below will be incorporated into the strategy.</p> | Roads and Maritime Construction contractor | Pre-construction Construction |
| Social infrastructure – Grafton TAFE Campus and Gummaney Aboriginal pre-school | SE7 | Roads and Maritime and the construction contractor will continue to liaise with Grafton TAFE Campus and the Gummaney Aboriginal pre-school to minimise impacts on access and operations. | Roads and Maritime Construction contractor | Pre-construction Construction |
| Social infrastructure – Clarence River Sailing Club and other Clarence River event organisers | SE8 | Roads and Maritime will consult with Clarence River Sailing Club and other Clarence River event organisers regarding the need to make alternative access arrangements during construction. | Roads and Maritime | Pre-construction Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Local amenity – residents and business | SE9 | <p>Roads and Maritime and the construction contractor will maintain ongoing and timely communication with nearby residents regarding construction work. This will include notice on timing and duration of activities and potential localised impacts.</p> <p>The community and business will be notified of any construction activities outside standard construction working hours.</p> <p>Management measures to reduce construction noise impacts would be required and would be implemented as identified in Section 8.4 of this EIS.</p> | <p>Roads and Maritime</p> <p>Construction contractor</p> | <p>Pre-construction</p> <p>Construction</p> |
| Local business and tourism | SE10 | Roads and Maritime and the construction contractor will maintain ongoing timely communication with affected businesses on project timing, changes to traffic conditions and access arrangements. | <p>Roads and Maritime</p> <p>Construction contractor</p> | <p>Pre-construction</p> <p>Construction</p> |
| Social infrastructure – general | SE11 | <p>The construction contractor will:</p> <ul style="list-style-type: none"> • Maintain access to existing bridge pedestrian links • Maintain access for river users, including the Clarence River Sailing Club, and provide appropriate safety and maritime directional and safety signage on structures in the river • Maintain communications with police and emergency services in relation to changed access arrangements and traffic management plans. | Construction contractor | Construction |
| Local business and tourism | SE12 | The construction contractor will maintain access to affected businesses at South Grafton and Grafton and provide directional signage. | Construction contractor | Construction |
| Local amenity – construction traffic | SE13 | <p>Roads and Maritime will develop construction traffic management measures as part of the construction environmental management plan. The measures will detail access arrangements for residents close to the ancillary sites and construction work zones including residents along Greaves Street and Bridge Street.</p> <p>Mitigation measures are outlined in Section 8.1 of this EIS to enable acceptable traffic operations and level of service on the road network during construction.</p> | Roads and Maritime | Construction |
| Social infrastructure – Clarence River Visitor Information Centre and other businesses | SE14 | Roads and Maritime will maintain access to the Clarence River Visitor Information Centre and other businesses along Spring and Charles streets in South Grafton by providing directional signage in accordance with relevant Roads and Maritime and Government guidelines. | Roads and Maritime | Construction Operation |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Visual amenity, built form and urban design | | | | |
| Impacts in Grafton | V1 | <p>Detailed design will investigate opportunities to:</p> <ul style="list-style-type: none"> • Refine car parking arrangements on the southern side of Pound Street • Adjust the kerbline along Pound Street between Clarence Street and Villiers Street. This would enable extra tree planting on both sides of the street and the removal of proposed parallel parking on the southern side. This would improve the visual and pedestrian amenity, reduce the scale of the street and reduce the encroachment of works in TAFE land • Reduce the batter steepness around the water detention basin to avoid the need for fencing • Reduce the construction boundary to reduce impacts on Pound Street and Greaves Street • Refine the drainage detention basin design in Grafton to minimise its visual impact. | Roads and Maritime | Detailed design |
| Proposed bridge | V2 | <p>During detailed design, the pier designs will be developed to further reinforce the complementary relationship between the proposed bridge piers and the piers on the existing bridge. In particular, the option of tapering the piers at their long elevation will be considered.</p> <p>In addition, opportunities will be considered to further streamline the appearance of the bridge, including:</p> <ul style="list-style-type: none"> • Aligning the edges of the piers with the outside faces of the girders • Investigating monolithic construction as an alternative to the current pier design • Ensure the proposed bridge soffit appears as a series of continuous curves with a segmented appearance to be avoided. | Roads and Maritime | Detailed design |
| Impacts in South Grafton | V3 | <p>Detailed design will consider:</p> <ul style="list-style-type: none"> • Flattening the fill embankments to the bridge approach road to better integrate it with the surrounding flat rural landscape • Opportunities to enhance the location's role as the southern arrival point to South Grafton and Grafton • Incorporating safe and efficient bicycle access on the Iolanthe Street / Pacific Highway / Through Street roundabout and the Gwydir Highway / Pacific Highway roundabout to allow a connection to the regional Coastline Cycleway route on the Pacific Highway. | Roads and Maritime | Detailed design |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Flood mitigation impacts | V4 | <p>Consideration should be given to undertaking an arborist assessment to inform the design development and optimum levee alignment.</p> <p>Where the levee has existing structures (eg a building) a specific levee raising design will be required. Where feasible and reasonable, the design will:</p> <ul style="list-style-type: none"> • Investigate opportunities to avoid changes to the existing structure (eg minor realignment of the levee crest) • Keep changes to the existing structure to a minimum • Identify a construction method that will keep the structure operational while construction work is being carried out (subject to safety considerations). <p>Roads and Maritime will consult with the infrastructure owners during detailed design.</p> <p>For heritage listed items, the design will seek to avoid or minimise the need to modify the structure and investigate non-intrusive options to achieve the required levee level. Levee raising materials and finishes will be sympathetic to minimise impact on the significance of the heritage item.</p> | Roads and Maritime | Detailed design |
| Construction impacts | V5 | <p>Detailed design and documentation drawings will define the extent of all construction activity, including temporary work, to protect the area during construction.</p> <p>Construction facilities will be contained within the construction work zone and occupy the minimum area practicable for the intended use.</p> <p>Suitable barriers will be erected to screen views from nearby areas.</p> <p>Work sites will be returned to at least their pre-construction state once work is complete, or progressively reinstated throughout the construction process, where possible.</p> <p>Pollution and dust emissions will be minimised and monitored throughout the construction period (refer to Section 8.12).</p> <p>Footpaths affected by construction activities will be diverted or re-routed.</p> <p>Trees to be retained within construction facilities areas will be identified, protected and maintained.</p> <p>Temporary lighting will be screened or diverted to reduce unnecessary light spill.</p> <p>Material used for temporary land reclamation will be removed once construction is complete.</p> | Construction contractor | Pre-construction Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Biodiversity | | | | |
| Impact on hollow-bearing trees and foraging resources | B1 | <p>Disturbance and clearing of native vegetation will be minimised, particularly avoiding and minimising vegetation removal wherever possible through the detailed design process. Detailed design will investigate opportunities to retain the two hollow bearing and five habitat trees identified within the project area.</p> <p>A revegetation management sub-plan will be developed as part of the flora and fauna management plan to revegetate with species suitable for the creation of hollows and foraging resources. Strategies to compensate for the loss of hollow bearing/habitat trees will focus on revegetation and rehabilitation activities along riparian and adjoining areas.</p> | Roads and Maritime | Detailed design |
| Revegetation management and landscaping | B2 | <p>As part of the flora and fauna management plan, a revegetation management sub-plan will be developed to provide specific details for the re-establishment of native vegetation on areas disturbed by the project construction.</p> <p>This plan will be developed in accordance with <i>Roads and Maritime Biodiversity Guidelines</i> (RTA, 2011) and the design principles identified in <i>Appendix L, Technical Paper: Flora and Fauna Assessment</i>. It will also include details for the regeneration and rehabilitation of areas with a focus on riparian areas within the project area with reference to Guide 3, Guide 6 and Guide 10 of the <i>Roads and Maritime Biodiversity Guidelines</i>.</p> <p>The plan will include objectives to incorporate local native species across all revegetation and landscaping efforts along the Clarence River and in the adjoining project area. This will include species consistent with freshwater wetlands on coastal floodplain and sub-tropical coastal floodplain forest threatened ecological communities species composition, which could potentially provide foraging resources and roosting to threatened fauna species, and increase corridors and connectivity throughout the landscape.</p> | Roads and Maritime | Detailed design |
| Protection of fish habitat | B3 | <p>During detailed design, the project design team will comply with the <i>Policy and Guidelines for Fish Habitat Conservation and Management</i> (DPI, 2013) in relation to requirements for maintaining fish passage via the design and construction of instream structures.</p> | Roads and Maritime | Detailed design |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Flora and fauna management | B4 | <p>A flora and fauna management plan (FFMP) will be prepared as part of the construction environmental management plan before construction in accordance with <i>Biodiversity Guidelines – Protecting and Managing Biodiversity on RTA Projects</i> (Roads and Maritime, 2011).</p> <p>The FFMP will detail how impacts on biodiversity will be minimised and managed during construction and operation and will incorporate specific management measures identified in the EIS.</p> <p>Measures outlined in this table will be addressed within the flora and fauna management plan, including timeframes for implementation and monitoring to be developed post-EIS and project approval.</p> | Construction contractor Roads and Maritime | Pre-construction |
| Vegetation clearing | B5 | <p>To minimise the impacts of vegetation clearing and habitat loss the following specific measures will be implemented:</p> <ul style="list-style-type: none"> • Clearing of vegetation will be carried out in accordance with <i>Guide 1 Pre-clearing Process of Biodiversity Guidelines</i> (RTA, 2011). These guidelines cover the felling of both non-habitat and habitat trees and the rescue and relocation of fauna • The pre-clearing process will be consistent with <i>Guide 2 Exclusion zones of Biodiversity Guidelines</i> (RTA, 2011) and include: pre-clearing surveys by an experienced/qualified ecologist and mapping and delineating the boundaries of threatened flora and/or fauna species, threatened ecological communities and/or suitable habitat (hollow bearing/habitat trees) • Pre-clearance surveys to include surveys for Hairy-joint Grass during flowering period (between summer and autumn) within final impact areas • Pre-clearing surveys to be carried out for the Three-toed Snake-tooth Skink, in suitable areas, not yet surveyed (ancillary sites, especially in North Grafton where houses are to be demolished) before demolition and construction works during late spring and early summer in accordance with the relevant guidelines (DSEWPaC,2011; DEC, 2004 and TSSC, 2008) • Construction traffic will be restricted to defined access tracks and construction works zone areas • The location of exclusion zones will be identified, with temporary fencing or flagging tape to indicate the limits of clearing (in accordance with the <i>Roads and Maritime Biodiversity Guidelines</i> (RTA, 2011)) • All relevant staff will be inducted and informed of the limits of vegetation clearing and the areas of vegetation to be retained. | Construction contractor | Pre-construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|---------------------|----|--|-------------------------|------------------|
| Weed management | B6 | <ul style="list-style-type: none"> Weeds will be controlled in accordance with RTA (2011a) – <i>Biodiversity Guidelines Guide 6: Weed Management</i> Declared noxious weeds will be managed in accordance with the requirements of the Noxious Weeds Act 1993 Weed infested topsoil will be appropriately stockpiled with sediment fencing and as soon as practical, disposed of or treated appropriately to limit potential impacts on nearby areas of native vegetation. | Construction contractor | Pre-construction |
| Pests and pathogens | B7 | <p>The FFMP will outline a strategy for the implementation of site hygiene protocols and management measures according to <i>Biodiversity Guide 7 – Pathogen Management from Roads and Maritime</i> (2011) to reduce the risk of localised or regional introduction of Myrtle Rust, <i>Phytophthora cinnamomi</i> and the amphibian chytrid fungus as a result of the project.</p> <p>Measures for preventing the introduction and/or spread of disease causing agents such as bacteria and fungi will be implemented, as detailed in RTA (2011a) – <i>Biodiversity Guidelines Guide 7: Pathogen management</i>.</p> | Construction contractor | Pre-construction |
| Impact on fauna | B8 | <p>Where practical, vegetation removal (especially of the two hollow-bearing and five habitat trees identified) will occur outside the main fauna breeding season (August to February) to avoid potential breeding disturbance to fauna, particularly avifauna (birds and bats).</p> <p>Pruning or lopping tree limbs will be conducted in preference to tree removal wherever possible.</p> <p>An appropriate tree removal procedure will be adopted. It will require the presence of a qualified ecologist or wildlife expert experienced in the rescue of fauna as detailed in <i>RMS Biodiversity Guidelines -Guide 4: Clearing of vegetation and removal of bush rock including the staged removal process</i> (2011).</p> <p>Woody debris and habitat trees removed for the project will be managed in accordance with <i>RMS Biodiversity Guidelines - Guide 5: Re-use of woody debris and bush rock</i> (2011).</p> <p>Fauna handling during vegetation removal will be carried out by a licensed fauna ecologist or wildlife carer, as detailed in <i>RMS Biodiversity Guidelines Guide 9: Fauna handling</i> (2011).</p> | Construction contractor | Pre-construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|----------------------------------|-----|--|-------------------------|------------------|
| Threatened flora and fauna | B9 | <p>Threatened species guidelines will be developed for threatened flora and fauna likely to occur directly within the project area and which may be impacted during construction, in order to show and educate construction workers of its appearance and outline what should be done if the species is found during construction. Relevant species will include:</p> <ul style="list-style-type: none"> • Hairy-joint grass • Three-toed Snake-tooth Skink • Grey-headed Flying-fox • Microbats. | Construction contractor | Pre-construction |
| Unexpected finds | B10 | <p>If unexpected threatened fauna or flora species are discovered, works will stop immediately and the <i>Unexpected Threatened Species Find Procedure</i> RTA (2011a) as well as the <i>Biodiversity Guidelines Guide 1: Pre-clearing process</i> (Roads and Maritime, 2011) will be followed. This procedure will be included in the FFMP developed for the project.</p> | Construction contractor | Pre-construction |
| Nest box and microbat management | B11 | <p>Nest boxes and bat roost structures will be installed in accordance with the principles outlined in the <i>Roads and Maritime Guide 8 Nest Boxes</i> (2011). Details of the number and type of nest boxes will be included in the FFMP prepared for the project, and will include the following details:</p> <ul style="list-style-type: none"> • The number and type of nest boxes required based on the number, quality and size of the hollows that will be removed • Specifications for nest box dimensions, installation requirements, locations of nest boxes and ongoing monitoring and maintenance • Installation timeframes, including the installation of 70% of nest boxes before the removal of any vegetation • Staged habitat removal, including removal of secondary or less preferential roosting habitat before removal of primary habitat, such as hollow-bearing trees and houses. • Pre-demolition inspection and exclusion measures to prevent continued use of roosts. These will be prepared to address the subject species, specific habitat, roosting habits at each location, and capture and handling procedures (if required). | Construction contractor | Pre-construction |
| Impact on aquatic fauna | B12 | <p>Direct disturbance of aquatic fauna and riparian zones will be minimised in accordance with <i>Roads and Maritime Biodiversity Guidelines – Guide 10 Aquatic habitat and riparian zones</i> (2011).</p> | Construction contractor | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|--|-----|---|-------------------------|-----------------|
| Bank stability, sedimentation and erosion | B13 | <p>Erosion and sediment control measures will be implemented and maintained to:</p> <ul style="list-style-type: none"> Prevent sediment moving off-site and sediment laden water entering any water course, drainage lines, or drain inlets Reduce water velocity and capture sediment on-site Minimise the amount of material transported from site to surrounding road surfaces Divert clean water around the site in accordance with <i>Managing Urban Stormwater: Soils and Construction Guidelines</i> (Landcom, 2004). <p>Erosion and sedimentation controls will be checked and maintained on a regular basis (including clearing of sediment from behind barriers) and records kept and provided on request.</p> <p>Erosion and sediment control measures will not be removed until the works are complete and areas are stabilised.</p> <p>Work areas will be stabilised progressively during the works.</p> <p>A progressive erosion and sediment control plan is to be prepared for the works.</p> <p>The <i>Guidelines for in stream works on waterfront land</i> (NSW DPI 2012) will be implemented when constructing and installing piers, bridge footings and undertaking river front landscape works.</p> | Construction contractor | Construction |
| Impact on aquatic habitat | B14 | Where feasible and reasonable any large woody debris that may be encountered during construction will be relocated. | Construction contractor | Construction |
| Soils, sediments, water and contaminated land | | | | |
| Acid sulfate soils disturbance | SW1 | Acid-resistant construction materials will be used where possible in areas known to contain acid sulfate soils. | Roads and Maritime | Detailed design |
| Protection of water quality during operation | SW2 | Operational water quality management and protection measures, such as swales, to protect nearby waterways from pollutants from the bridge and approaches will be further refined and investigated in consultation with Clarence Valley Council. | Roads and Maritime | Detailed design |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Construction soils and water management plan | SW3 | <p>As part of the construction environmental management plan, a soil and water management plan will be prepared in line with current Roads and Maritime specifications. The plan will include (but not limited to):</p> <ul style="list-style-type: none"> • Details of erosion and sediment controls to be implemented, including erosion and sediment control plans developed for the project • Details of inspection frequency for control measures • Monitoring and maintenance of environmental control measures • Environmental work method statements for high risk activities such as dewatering and works within waterways • Procedures to manage stockpiles generated during construction • Tannin leachate management measures • Acid sulfate management measures • Detailed consideration of measures to prevent (where possible) or minimise any water quality impacts • Measures to manage known and unexpected contamination during the construction stage • Consideration of water dissipation due to wick drains. | Construction contractor | Pre-construction |
| Soil erosion and sediment control | SW4 | <p>Erosion and sediment control measures will be implemented in accordance with the Landcom/Department of Housing <i>Managing Urban Stormwater, Soils and Construction Guidelines</i> (the Blue Book) and maintained to:</p> <ul style="list-style-type: none"> • Prevent sediment moving off-site and sediment laden water entering any water course, drainage lines, or drain inlets • Reduce water velocity and capture sediment on-site • Minimise the amount of material transported from site to surrounding pavement surfaces • Divert clean water around the site. | Construction contractor | Construction |
| | SW5 | Erosion and sedimentation controls will be checked and maintained on a regular basis (including clearing of sediment from behind barriers) and records kept and provided on request. | Construction contractor | Construction |
| | SW6 | Erosion and sediment control measures will not be removed until the works are complete and areas are stabilised. | Construction contractor | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Soil erosion and sediment control | SW7 | Work areas will be stabilised progressively during the works. | Construction contractor | Construction |
| | SW8 | Water from site will be used for construction purposes, such as dust suppression, where feasible and reasonable. | Construction contractor | Construction |
| Acid sulfate soils disturbance | SW9 | Where excavation is to be carried out in areas anticipated to contain acid sulfate soils, work will proceed according to the soils and water management plan (acid sulfate soils section). Specific controls to be implemented will include: <ul style="list-style-type: none"> • Capping exposed surfaces with clean fill to prevent oxidation • Placing excavated acid sulfate soils separately in a lined, bunded and covered area • Neutralising acid sulfate soils for reuse (where appropriate) by using additives such as lime • Disposing of acid sulfate soils where necessary in accordance with the relevant guidelines set out in the <i>Acid Sulfate Soils Assessment Guidelines</i> (Ahern et al, 1998). | Construction contractor | Construction |
| | SW10 | If acid sulfate soils are disturbed, any acid produced will be neutralised and acid waste prevented from leaving the site in accordance with the applicable guidelines. | Construction contractor | Construction |
| Protection of water quality during construction | SW11 | Construction water quality management measures to protect nearby waterways from construction activities will be included in the soil and water management plan developed for the project. This plan will include (but not limited to) the following measures: <ul style="list-style-type: none"> • Appropriate controls to minimise risk of release of dirty water into drainage lines and/or waterways • Visual monitoring of local water quality (ie turbidity, hydrocarbon spills/slicks) is to be carried out on a regular basis to identify any potential spills or deficient erosion and sediment controls • Water quality control measures to prevent any materials (eg concrete, grout, sediment etc) entering waterways. | Construction contractor | Construction |
| Temporary working platforms | SW12 | Before commencement of works within the river, a workshop will be held with relevant government agencies including representatives from EPA, NSW Office of Water, Department of Primary Industries Fisheries, Roads and Maritime and the construction contractor to discuss potential options for temporary working platforms. Any temporary working platforms will be managed in accordance with the principals detailed in Section 6.6.1 of the EIS. | Construction contractor | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|--|------|---|-------------------------|--------------|
| Exposed areas | SW13 | Exposed areas will be progressively rehabilitated. Methods will include permanent revegetation, or temporary protection with spray mulching or cover crops. | Construction contractor | Construction |
| Stockpile site management | SW14 | Topsoil, earthworks and other excess spoil material will be stockpiled in accordance with the principles outlined in <i>Stockpile Management Guidelines</i> (Roads and Maritime, 2011). | Construction contractor | Construction |
| | SW15 | Stockpiles will be placed within a designated ancillary site or stockpile area in accordance with the following principles: <ul style="list-style-type: none"> • Not require removal of areas of native vegetation (where feasible and reasonable) • Not be located under the 'dripline' of trees • Be located outside known areas of weed infestation • Be located such that waterways and drainage lines are not directly impacted. | Construction contractor | Construction |
| | SW16 | Where practicable, stockpiles will be located away from areas subject to concentrated overland flow. Stockpiles located on a floodplain will be managed so as to minimise loss of material in flood or rainfall events. | Construction contractor | Construction |
| | SW17 | All construction stockpiles will comply with the requirements of the <i>Protection of the Environment Operations Act 1997</i> and <i>Waste Avoidance and Resource Recovery Strategy 2007</i> for any waste activities that involve the generation, storage and/or disposal of waste. The NSW Resource Recovery Exemptions will also be applied to the storage and management of stockpiled material. | Construction contractor | Construction |
| | SW18 | Stockpiles containing potential acid sulfate soils will be managed in accordance with the <i>Acid Sulfate Soils Manual</i> (Acid Sulfate Soils Management Advisory Committee, 1998). | Construction contractor | Construction |
| Emergency spill response during construction | SW19 | Emergency spill response measures will be developed and incorporated into the soils and water management plan as part of the construction environmental management plan. This plan will detail measures for the prevention, containment and clean-up of accidental spills of fuels and chemicals. | Construction contractor | Construction |
| Chemical use and storage | SW20 | The storage, handling and use of the chemicals and fuels will be in accordance with the <i>Work Health and Safety Act 2000</i> and <i>Workcover's Storage and Handling of Dangerous Goods Code of Practice</i> (WorkCover, 2005). | Construction contractor | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Chemical use and storage | SW21 | Physical controls to address the potential risks associated with the use and storage of chemicals on-site will include: <ul style="list-style-type: none"> • Bunded storage facilities for chemicals and fuels • Bunded areas for refuelling and washdown • Effective spill kits at all construction sites. | Construction contractor | Construction |
| Disturbance of contaminated soils | | | | |
| Detailed site investigation | CS1 | A detailed site investigation will be prepared for the areas of potential contamination identified in this EIS in accordance with <i>Guidelines for Consultants Reporting on Contaminated Sites</i> (OEH, 2011). The site investigation will provide detailed information on the type, extent and level of contamination and assess: <ul style="list-style-type: none"> • Contaminant dispersal in air, surface water, groundwater, soil and dust • The potential effects of contaminants on public health, the environment and the project structures • Off-site impacts on soil, sediment and biota (where applicable) • The adequacy and completeness of all information available to be used in making decisions on remediation. | Roads and Maritime | Detailed design |
| Site remedial action plan | CS2 | If the results of the detailed site investigation indicate a remedial action plan needs to be prepared and implemented, this plan will be prepared in consultation with Department of Planning and Environment and Office of Environment and Heritage. The plan will be prepared in accordance with <i>Guidelines for Consultants Reporting on Contaminated Sites</i> (OEH, 2011). | Construction contractor | Pre-construction |
| Asbestos on demolished structures | CS3 | An asbestos survey will be conducted for structures to be demolished as part of the project. An asbestos certified disposal service will be engaged for properties identified as having asbestos materials. | Construction contractor | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
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| Air quality | | | | |
| Dust generation during construction | AQ1 | <p>An air quality management plan will be developed as part of the construction environmental management plan to manage any increased dust impacts from construction activities. The plan will consider and describe construction activity processes such as: handling of spoil, management of stockpiles, operation of machinery, and traffic management.</p> <p>The plan will have regard to the measures outlined in the <i>Local Government Air Quality Toolkit, Module 3: Guidance note – Construction sites</i> (NSW EPA 2007) and include the following:</p> <ul style="list-style-type: none"> • A plan showing the locations of all potentially affected properties and residences on a map • Details of potential sources and impacts of dust • Air and dust management objectives consistent with EPA guidelines • Details of air quality control measures to be implemented during construction • A monitoring program to assess compliance with the identified objectives • Details of mitigation measures to be implemented during weather conditions where high dust episodes are likely (such as strong winds in dry weather) • A progressive stabilisation/rehabilitation strategy for disturbed surfaces with the aim of minimising exposed surfaces • Contingency plans to be implemented in the event of non-compliances and/or complaints about dust • Procedures for regularly reviewing the effectiveness of the air quality/dust management plan. | Construction contractor | Pre-construction / construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|-------------------------|-----|---|-------------------------|----------------------------------|
| Concrete batching plant | AQ2 | <p>If a concrete batching plant is required, dust control measures would be incorporated into the design of the concrete batching plant. These could include the following:</p> <ul style="list-style-type: none"> • A partially enclosed load hopper (on three sides) when truck loading/delivery is in progress • Continual wetting operations to reduce emissions during all materials handling • Bulk cement would be stored in silos with filter components on the vents • A dry batch dust collector to extract dust during the transfer of the concrete product to the trucks and any emissions from the loading of the weigh hoppers (this system has a dust extraction efficiency of 99.9% for all particulates greater than 5 microns) • A fully enclosed conveyor • Surface wetting along all exposed surfaces and stockpiles during unfavourable meteorological conditions (i.e. windy and dry conditions) • Use of water carts along haul roads and access points as required to minimise generation of dust. | Construction contractor | Construction |
| Greenhouse gases | | | | |
| Lighting | GG1 | Roads and Maritime will investigate the use of LED lighting in place of incandescent lamps as part of the project's detailed design, and use them where practicable to reduce electrical energy consumption. Any energy-efficient alternatives will have to meet lighting and safety standards for major roads. | Roads and Maritime | Detailed design |
| Embodied emissions | GG2 | Fly-ash content within concrete will be utilised where feasible. Construction contractors will be required to propose recycled content construction materials where they are cost, quality and performance competitive. | Construction contractor | Pre-construction Construction |
| | GG3 | Reuse of excavated road materials will be maximised as far as possible where they are cost, quality and performance competitive to reduce use of materials (with embedded energy). | Construction contractor | Pre-construction Construction |
| | GG4 | Steel with high recycled content will be utilised where feasible, for example where it is cost, quality and performance competitive. Contractors will be required to propose recycled content construction materials where they are cost, quality and performance competitive. | Construction contractor | Pre-construction Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|---|-----|---|-------------------------|----------------------------------|
| Vehicle emissions | GG5 | The feasibility of using biofuels (biodiesel, ethanol, or blends such as E10 or B80) will be investigated by the construction contractor, taking into consideration the capacity of plant and equipment to use these fuels, ongoing maintenance issues and local sources. Works will be planned to minimise fuel use. | Construction contractor | Pre-construction Construction |
| Construction energy management plan | GG6 | A construction energy management plan will be developed as part of the project's construction environmental management plan. The plan will include a commitment to monitor on-site energy consumption and identify and address on-site energy waste. | Construction contractor | Pre-construction Construction |
| Vegetation clearance | GG7 | Vegetation clearance will be minimised, where feasible, in accordance with the approved project. Areas to be revegetated will be revegetated in accordance with the project landscape plan. | Construction contractor | Construction |
| Sustainability education | GG8 | The environmental induction developed for the project will include measures to promote energy-efficient work practices by construction personnel. | Construction contractor | Construction |
| Utilities and services infrastructure | | | | |
| Coordination for future utility infrastructure developments | UI1 | The National Broadband Network Co will be consulted during detailed design about the location, timing and cost of a potential conduit attached to the new Grafton Bridge. | Roads and Maritime | Detailed design |
| | UI2 | Essential Energy will be consulted during detailed design about the location and timing of a potential easement across the Clarence River. | Roads and Maritime | Detailed design |
| Protection or relocation of utility services | UI3 | Relevant service utility providers or owners will be consulted to verify locations, impacts and any protection, relocation or decommissioning work required. | Roads and Maritime | Detailed design |
| | UI4 | A Dial Before You Dig search will be carried out to identify the location of utility services. | Construction contractor | Pre-construction |
| Protection or relocation of utility services | UI5 | A services search within land not covered by the Dial Before You Dig search will be carried out to identify the location of utility services. | Construction contractor | Pre-construction |
| | UI6 | Existing services to be potentially impacted by the project will be physically relocated. | Construction contractor | Pre-construction |
| Decommissioning of utility services | UI7 | Relevant service utility providers or owners will be consulted before the removal of any decommissioned utility services beneath acquired properties. | Construction contractor | Pre-construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|---|-----|--|-------------------------|----------------------------------|
| Waste minimisation and management | | | | |
| General | WM1 | Rubbish bins will be located at strategic locations. | Roads and Maritime | Detailed design |
| Demolition waste from heritage listed items | WM2 | Roads and Maritime will investigate options for reusing or salvaging demolition waste from heritage items | Roads and Maritime | Pre-construction |
| General | WM3 | <p>A construction waste management plan will be prepared as part of the construction environmental management plan to identify measures for minimising and managing waste. The construction waste management plan will include:</p> <ul style="list-style-type: none"> • The type and volume of all materials to be utilised during the project construction • Destinations for each resource/waste type either for on-site reuse or recycling, off-site reuse or recycling, or disposal at a licensed waste facility • Quantity and classification of excavated material generated as a result of the project • Disposal strategies for each type of material • Details of how waste will be stored and treated on-site • Identification of all non-recyclable waste • Identification of strategies to 'avoid', 'reduce', 'reuse', and 'recycle' • Management of surplus material as documented in this section of the EIS (refer to Section 9.3.2) • Identification of available recycling facilities on and off-site • Identification of suitable methods and routes to transport waste • Procedures and disposal arrangements for unsuitable excavated material or contaminated material • Site clean-up for each stage. | Construction contractor | Pre-construction Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|-----------------------------------|-----|---|---|----------------------------------|
| General | WM4 | <p>A resource use management strategy will be prepared as part of the construction waste management plan to identify the hierarchy for sourcing and use of resources. The strategy will include:</p> <ul style="list-style-type: none"> • Project areas with a deficit in material will import surplus material from other project sections in preference to external sources • Where possible, the distances that earthworks materials are moved across the project as a whole will be minimised • Any unsuitable material will be used for landscaping or disposed of within each project section, either for batter flattening or noise mounds or placed in stockpile • Construction contractors will reduce the amount of unsuitable waste generated during excavations, where feasible (eg treatment at source) • Other locations of disposal of unsuitable material will be considered including borrow source areas created as part of the project • The generation and management of unsuitable material during project earthworks will be monitored to ensure appropriate management of the issue • Details on materials that will be sourced from the project (including location and type) • Proposed sustainable material sourcing (such as recycled materials or use of waste water) • Materials that could be recycled and re-used on-site or transferred to other project sections. | Construction contractor | Pre-construction Construction |
| Spills and accidents | WM5 | A risk assessment will be carried out to determine the need, location and size, of spill containment mechanisms. | Roads and Maritime Construction contractor | Pre-construction Construction |
| Asbestos on demolished structures | WM6 | Asbestos surveys will be conducted for structures to be demolished as part of the project. An asbestos certified disposal service will be engaged for properties identified as having asbestos materials. | Construction contractor | Before demolition |
| General | WM7 | The handling, storage and transport of hazardous materials and waste will be in accordance with the <i>National Code of Practice Storage and handling of dangerous goods</i> (Workcover, 2001) and the relevant material safety data sheet for the product. | Construction contractor | Construction |
| | WM8 | Regular visual inspections will be conducted to ensure that work sites are kept tidy and to identify opportunities for reuse and recycling. | Construction contractor | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|-------------------------|------|--|-------------------------|--------------|
| General | WM9 | Requirements for waste management will form part of site training and induction processes. | Construction contractor | Construction |
| | WM10 | All generated waste will be managed and disposed of in accordance with relevant State legislation and government policies including the <i>Waste Avoidance and Resource Recovery Act 2001</i> , the <i>Waste Avoidance and Resource Recovery Strategy 2007</i> and the <i>Waste Reduction and Purchasing Policy</i> . The <i>Waste Classification Guidelines</i> (DECCW, 2008) will also be used to classify the different types of waste. | Construction contractor | Construction |
| Beneficial reuse | WM11 | The project will aim for the following: <ul style="list-style-type: none"> • 100% beneficial reuse of usable spoil, recognising that there is likely to be a significant volume of excavated material that is potentially contaminated or otherwise unsuitable for reuse. Sampling and testing will confirm which excavated material is suitable for reuse • 95% beneficial reuse of construction and demolition waste • Minimising the need for extracting new material by reusing material from other nearby projects (eg the Woolgoolga to Ballina Pacific Highway upgrade) where feasible and reasonable. | Construction contractor | Construction |
| | WM12 | For any surplus material the following beneficial re-use options will be considered : <ul style="list-style-type: none"> • Construction of acoustic and visual mounds where there is a benefit to residents and other sensitive receivers • Flattening of road batters • Rehabilitation of borrow pits • Engineered fill • Improvements to flood prone land. | Construction contractor | Construction |
| Liquid wastes | WM13 | Liquid waste, including waste oil, will be collected and stored in appropriately bunded areas. | Construction contractor | Construction |
| Records | WM14 | A waste register will be maintained for the construction site. It will detail the types of waste collected, amounts, date and time, and details of disposal. | Construction contractor | Construction |
| Materials and packaging | WM15 | Where feasible and reasonable, materials will be bought in bulk to minimise the amount of packaging required. | Construction contractor | Construction |

| Environmental issue | ID | Environmental management measures | Responsibility | Timing |
|--|-----------|---|-------------------------|------------------|
| Materials and packaging | WM16 | Sources of material that have sustainable packaging design, such as recycled and recyclable packaging, will be favoured over other material sources where cost effective. | Construction contractor | Construction |
| | WM17 | The use of recycled products in construction work will be investigated. | Construction contractor | Construction |
| Demolition waste | WM18 | Where practicable, houses, redundant services and other structures will be deconstructed rather than demolished to allow as much material as possible to be re-used or recycled off-site. | Construction contractor | Construction |
| Green waste | WM19 | Logs and green waste will be mulched (where not contaminated by weeds) and beneficially reused onsite for rehabilitation and landscaping as a first preference, or offsite in the local area. | Construction contractor | Construction |
| Cumulative impacts | | | | |
| Potential cumulative impacts during construction | C11 | Construction contractor will identify all other developments and projects occurring in the vicinity of the project and identify environmental impacts to be monitored during construction which have the potential for cumulative effects to occur. | Construction contractor | Pre-construction |
| | C12 | Construction contractor will review environmental impacts every six months during construction. Any new impacts identified during construction will be addressed appropriately to reduce cumulative effects and reported as part of the construction environmental management plan. | Construction contractor | Construction |

11 Environmental risk analysis

This chapter explains how environmental issues for the project were identified through an environmental risk analysis, and presents the findings of that analysis. The Director-General's environmental assessment requirements relevant to the environmental risk analysis are detailed in Table 11-1.

Table 11-1 Director-General's environmental assessment requirements relevant to environmental risk analysis

| Director General's environmental assessment requirements | Where addressed in EIS |
|--|---|
| The EIS must include an environmental risk analysis to identify the potential environmental impacts associated with the project. | Section 11.2. |
| The EIS must include an environmental risk analysis to identify potential environmental impacts associated with the infrastructure (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the EIS. | Environmental risk analysis in Section 11.2 Key issues are assessed in Chapter 8 Other issues are assessed in Chapter 9 Proposed mitigation measures are presented in Chapter 10 |

11.1 Overview

Before lodging the State significant infrastructure project application, Roads and Maritime reviewed the outcomes of preliminary investigations and community and stakeholder consultation and identified the most important environmental issues through a preliminary environmental risk analysis.

These findings formed the basis of Roads and Maritime's State significant infrastructure project application, and assisted the Director-General to formulate the 'key issues' for the project as outlined in the Director-General's environmental assessment requirements. The Director-General's environmental assessment requirements specify that the process of environmental risk analysis continue during the course of preparing the EIS.

The environmental risk analysis carried out during the EIS has:

- Identified environmental issues, including key issues in the Director-General's environmental assessment requirements, and any other issues
- Examined potential impacts and proposed mitigation measures in relation to the identified issues
- Identified the nature and extent of impacts likely to remain after mitigation measures are applied.

Each potential environmental impact was identified as either high, moderate or low based on the significance criteria presented in Table 11-2.

Table 11-2 Significance criteria for environmental risk analysis

| Impact | Criteria |
|----------|--|
| High | Impact a major issue. Mitigation measures and detailed design work are unlikely to remove all the effects upon the affected environment. |
| Moderate | Impact moderate. Less significant adverse impacts. Impacts can be easily mitigated by the application of standard environmental management measures. |
| Low | Minimal or no adverse impacts. |

Based on this analysis and the Director-General's environmental assessment requirements, each potential impact was assigned an environmental risk category of either 'key issue' or 'other issue'. This enabled the identification of matters that might be considered as additional key issues not previously identified in the Director-General's environmental assessment requirements, and provided the basis for an appropriately detailed assessment of these additional key issues.

The environmental risk categories are described in Table 11-3.

Table 11-3 Risk categories

| Risk category | Description |
|---------------|--|
| Key issue | High or moderate impact (actual or perceived) requiring further investigation to identify specific management and mitigation measures. |
| Other issue | Moderate or low impact that can be managed effectively with standard and best practice management and mitigation measures. |

11.2 Risk analysis summary

A summary of the environmental risk analysis is provided in Table 11-4. Those issues identified as key issues in the Director-General's environmental assessment requirements remain as key issues for the project as outlined in the following risk analysis.

The risk analysis did not identify any additional key environmental impacts to those identified in the Director-General's environmental assessment requirements.

Table 11-4 Environmental risk analysis

| Issue | Key issue in DGRs? | Potential adverse impact | Potential residual impact after implementation of standard environmental management measures | Risk category of residual impact | Where discussed in EIS |
|-----------------------|--------------------|---|---|----------------------------------|--|
| Traffic and transport | Yes | <p>Construction:</p> <ul style="list-style-type: none"> • Temporary closures/ disruptions/ delays to local and highway traffic including access to some properties • Temporary increased traffic volumes on sections of the road network, as about 18,700 truck trips would occur during construction • Temporary removal of parking, pedestrian and/or cyclist access • Temporary traffic and pedestrian and/or cyclist detours around the construction zone • Temporary disruption to rail services during work on viaduct at Pound Street • Temporary closure of mooring areas close to the new bridge and potential relocation of some mooring areas • Temporary disruption to maritime traffic on the Clarence River • Changed traffic patterns likely to cause short-term impacts while road users adjust and become familiar with changed traffic patterns. <p>Operation:</p> <ul style="list-style-type: none"> • Changes to travel routes for some road users (including pedestrians and cyclists) due to road closures and turn restrictions • Increased traffic volumes on sections of the road network • Potential relocation of some mooring areas. | <p>The following moderate impacts would remain after application of the traffic management and mitigation measures set out in Section 8.1 and Chapter 10:</p> <ul style="list-style-type: none"> • Changes to travel routes for some road users (including pedestrians and cyclists) due to road closures and turn restrictions • Increased traffic volumes on sections of the road network. <p>No other potentially significant residual impacts are expected to remain after the application of the proposed management measures.</p> | Key issue | <p>Section 8.1</p> <p>Appendix D: Technical Paper – Traffic and Transport Assessment</p> |

| Issue | Key issue in DGRs? | Potential adverse impact | Potential residual impact after implementation of standard environmental management measures | Risk category of residual impact | Where discussed in EIS |
|-----------------------------------|--------------------|---|--|----------------------------------|--|
| Flooding and hydrology | Yes | <p>Construction:</p> <ul style="list-style-type: none"> • A large flood in the Clarence River during construction could impact construction work and ancillary sites. A small portion of the South Grafton ancillary site and construction work zone is not protected by a levee • A large rainfall event could impact the Pound Street viaduct construction work zone • Changes may occur to the existing flood regime as bridgework outside the levee system progresses. <p>Operation:</p> <ul style="list-style-type: none"> • If unmitigated, there would be significant increases in the peak flood level upstream of the proposed bridge, which could damage properties • If unmitigated, a small number of properties (mostly outside the levee system) would be impacted after the completion of the levee raising work. | No potentially significant or moderate residual impacts are expected to remain after the application of the management measures outlined in Section 8.2. | Key issue | Section 8.2 Appendix E: Technical Paper – Flooding and Hydrology Assessment |
| Climate change and sea level rise | Yes | <p>Construction:</p> <ul style="list-style-type: none"> • No potential adverse impact. <p>Operation:</p> <ul style="list-style-type: none"> • Under future climate change scenarios, moderate increases in additional overtopping of the levees into Grafton and South Grafton would lead to increased flooding within the towns. The implementation of the flood mitigation works proposed as part of the project would reduce this impact on the project under future climate change scenarios. | No potentially significant or moderate residual impacts are expected to remain after the application of the proposed flood mitigation work. | Key issue | Section 8.3 Appendix E: Technical Paper – Flooding and Hydrology Assessment |

| Issue | Key issue in DGRs? | Potential adverse impact | Potential residual impact after implementation of standard environmental management measures | Risk category of residual impact | Where discussed in EIS |
|-------------------------|--------------------|--|---|----------------------------------|---|
| Noise and vibration | Yes | <p>Construction:</p> <ul style="list-style-type: none"> • Temporary noise impacts on sensitive receivers, particularly in Grafton • Negligible potential impacts from vibration. <p>Operation:</p> <ul style="list-style-type: none"> • A small number of residential and non-residential receivers in Grafton would experience acute noise exceedances • Negligible potential impacts from vibration. | <p>During construction, the following moderate to low impacts would remain after application of the proposed noise and vibration management plan and the mitigation measures in Section 8.4 and Chapter 10:</p> <ul style="list-style-type: none"> • Temporary noise exceedances on sensitive receivers, particularly in Grafton. <p>No potentially significant residual impacts are expected to remain during operation after the application of the mitigation measures outlined in Section 8.4.</p> | Key issue | Section 8.4 Appendix F: Technical Paper – Noise and Vibration Assessment |
| Non-Aboriginal heritage | Yes | <p>Construction:</p> <ul style="list-style-type: none"> • Demolition of 10 items of local heritage significance • Direct impact on the Grafton urban conservation area. <p>Operation:</p> <ul style="list-style-type: none"> • Indirect impacts (amenity, noise, visual) on about 66 heritage items including one State listed item (the existing Grafton bridge) and one regionally listed heritage item (Dunvegan). | <p>The following moderate impacts would remain after application of the mitigation measures set out in Section 8.5 and Chapter 10:</p> <ul style="list-style-type: none"> • Indirect impacts (amenity, noise, visual) on about 66 heritage items, including one State listed item (the existing Grafton bridge) and one regionally listed heritage item (Dunvegan). <p>No potentially significant residual impacts are expected to remain after the application of the proposed management measures.</p> | Key issue | Section 8.5 Appendix G: Technical Paper – Non-Aboriginal Heritage Assessment |

| Issue | Key issue in DGRs? | Potential adverse impact | Potential residual impact after implementation of standard environmental management measures | Risk category of residual impact | Where discussed in EIS |
|---------------------------------------|--------------------|---|--|----------------------------------|---|
| Aboriginal heritage | Yes | <p>Construction and operation:</p> <ul style="list-style-type: none"> Indirect (visual) impacts on the Golden Eel dreaming and ceremonial site. | <p>The following moderate to low impact would remain after application of the mitigation measures set out in Section 8.6:</p> <ul style="list-style-type: none"> Indirect (visual) impacts on the Golden Eel dreaming and ceremonial site. <p>No other potentially significant residual impacts are expected to remain after the application of the proposed management measures.</p> | Key issue | <p>Section 8.6</p> <p>Appendix H: Technical Paper – Aboriginal Cultural Heritage Assessment</p> |
| Socio-economic, property and land use | Yes | <p>Construction:</p> <ul style="list-style-type: none"> Partial and total property acquisition Changes in roads and river access arrangements Temporary amenity impacts (noise, visual). <p>Operation:</p> <ul style="list-style-type: none"> Reduced visibility of Clarence River Visitor Information Centre Existing land uses (including tourism, primary production, business development, recreational waterways, low density residential and public recreation land uses) changed to road infrastructure land use Impact on amenity in some residential areas (due to increased traffic volumes and visual impacts) Changes to travel routes for some members of the community Reduction in passing trade of businesses in some areas Changes to the existing sailing races route. | <p>The following moderate to low impacts would remain after application of the mitigation measures set out in Section 8.7 and Chapter 10:</p> <ul style="list-style-type: none"> Impact on amenity in some residential areas (due to increased traffic volumes and visual impacts) Changes to travel routes for some members of the community Reduction in passing trade of businesses in some areas Changes to the existing sailing races route Some residual impacts on displaced residents as a result of the project property acquisitions. | Key issue | <p>Section 8.7</p> <p>Appendix I: Technical Paper – Socio-economic, property and land use</p> |

| Issue | Key issue in DGRs? | Potential adverse impact | Potential residual impact after implementation of standard environmental management measures | Risk category of residual impact | Where discussed in EIS |
|--|--------------------|---|---|----------------------------------|---|
| Visual amenity, built form, urban design | Yes | <p>Construction:</p> <ul style="list-style-type: none"> Impact on the visual amenity of people living near construction zones and construction ancillary sites Impacts on town character due to removal of trees and vegetation. <p>Operation:</p> <ul style="list-style-type: none"> Change of views from and to the existing bridge Impacts on visual amenity of receivers located near the new bridge road structures (including proposed noise wall) particularly in Grafton Changes to landscape character on both sides of the river, particularly sections of Greaves Street, Pound Street and Clarence Street in Grafton. Changes would be partly due to loss of trees, widening of existing roads and the bridge approach structures. | <p>During construction, the following moderate to low impacts would remain after application of the mitigation measures set out in Section 8.8 and Chapter 10:</p> <ul style="list-style-type: none"> Impact on the visual amenity of people living near construction zones and construction ancillary sites Impacts on landscape character due to removal of trees and vegetation. <p>The following high to moderate impacts would remain during the project operation after application of the mitigation measures as set out in Section 8.8 and Chapter 10:</p> <ul style="list-style-type: none"> Impacts on visual amenity of receivers located near the new bridge and approach roads Changes to landscape character on the northern banks of the river, particularly sections of Greaves Street, Pound Street and Clarence Street in Grafton. <p>Over time, landscaping mitigation strategies will assist the project to blend into the surrounding environment.</p> | Key issue | Section 8.8 Appendix I: Technical Paper – Urban design and landscape concept report (including landscape character and visual impact assessment) |

| Issue | Key issue in DGRs? | Potential adverse impact | Potential residual impact after implementation of standard environmental management measures | Risk category of residual impact | Where discussed in EIS |
|----------------------------|--------------------|--|---|----------------------------------|---|
| Biodiversity | Yes | <p>Construction:</p> <ul style="list-style-type: none"> • Clearance of a small portion of Freshwater Wetlands on Coastal Floodplains and Subtropical Coastal Floodplain Forest (about 0.31 hectares in total) • Removal of two hollow-bearing trees and five habitat trees • Potential weed invasion and edge effects. <p>Operation:</p> <ul style="list-style-type: none"> • Impacts from spills of fuels or chemicals from accidents or during maintenance. | No potentially significant or moderate residual impacts are expected to remain after the application of the proposed management measures outlined in Section 8.9 and Chapter 10. | Key issue | Section 8.9 Appendix J: Technical Paper – Flora and Fauna Assessment |
| Soils, sediments and water | Yes | <p>Construction:</p> <ul style="list-style-type: none"> • Soil erosion and sedimentation • Potential exposure and/or disturbance of contaminated soil and acid sulfate soils • Increased turbidity and nutrients, and discharge of contaminated material in waterways • Risk of identifying unexpected contamination (from unknown contaminated sites) • If unmanaged, river-based construction activities have the potential to impact the water quality of the Clarence River. <p>Operation:</p> <ul style="list-style-type: none"> • Water quality impacts from spills of fuels or chemicals from accidents or during maintenance • Pollution impacts from stormwater runoff into the Clarence River from increased road surface area • If unmanaged, potential infrastructure damage to the project if soft soil areas are not adequately treated before construction. | No potentially significant or moderate residual impacts are expected to remain after the application of the proposed management measures outlined in Section 8.10 and Chapter 10. | Key issue | Section 8.10 |

| Issue | Key issue in DGRs? | Potential adverse impact | Potential residual impact after implementation of standard environmental management measures | Risk category of residual impact | Where discussed in EIS |
|----------------------------|--------------------|--|--|----------------------------------|------------------------|
| Mineral resources | Yes | Construction and operation: <ul style="list-style-type: none"> Negligible impact on significant mineral resources No impact on access to any current or future exploration activity. | No potentially significant or moderate impact on mineral resources is likely as a result of the construction or operation of the project after the application of the proposed environmental measures outlined in Chapter 10. | Key issue | Section 8.11 |
| Air quality | Yes | Construction: <ul style="list-style-type: none"> Temporary generation of dust or particulate emissions. Operation: <ul style="list-style-type: none"> No adverse impact on local air quality. | No potentially significant or moderate residual impacts are expected to remain after the application of the proposed management measures listed in Section 8.12 and Chapter 10. | Key issue | Section 8.12 |
| Wind and wind-wash effects | Yes | Construction: <ul style="list-style-type: none"> Non applicable. Operation: <ul style="list-style-type: none"> Wind effects on bridge structure Wind effects on pedestrians, cyclists, motorists and more indirectly, river users. | No potentially significant or moderate wind and wind-wash effects on the bridge and bridge users are expected after the application of the proposed management measures listed in Chapter 10. | Key issue | Section 8.13 |
| Greenhouse gases | No | Construction: <ul style="list-style-type: none"> Emission of greenhouse gases from construction plant and equipment, embodied emissions of construction materials, vegetation clearance and construction waste. Operation: <ul style="list-style-type: none"> Negligible generation of greenhouse gases from street lighting, traffic signals and bridge maintenance activities. | No potentially significant or moderate residual impacts are expected to remain after the application of the proposed management measures after the application of the proposed management measures listed in Section 9.1 and Chapter 10. | Other issue | Section 9.1 |

| Issue | Key issue in DGRs? | Potential adverse impact | Potential residual impact after implementation of standard environmental management measures | Risk category of residual impact | Where discussed in EIS |
|---------------------------------------|--------------------|---|--|----------------------------------|------------------------|
| Utilities and services infrastructure | No | <p>Construction:</p> <ul style="list-style-type: none"> Existing public utilities and services within or close to the project area have the potential to be disrupted or may need to be relocated. <p>Operation:</p> <ul style="list-style-type: none"> No impacts are predicted during operation. | No other potentially significant or moderate residual impacts are expected to remain after the application of the proposed management measures listed in Chapter 10. | Other issue | Section 9.2 |
| Resources and waste management | No | <p>Construction:</p> <ul style="list-style-type: none"> Generation of spoil and excavation waste, green waste and demolition waste (including demolition waste contaminated with asbestos). <p>Operation:</p> <ul style="list-style-type: none"> No adverse impacts are expected during operation. | No potentially significant or moderate residual impacts are expected to remain after the application of the proposed management measures outlined in Section 9.3 and Chapter 10. | Other issue | Section 9.3 |
| Cumulative impacts | Yes | <p>Construction:</p> <ul style="list-style-type: none"> Cumulative traffic disruptions to road users Cumulative demand on resources including mineral resources Cumulative impacts on the heritage (Aboriginal and non-Aboriginal) and biodiversity of the Mid North Coast region Cumulative changes to land use and property impacts in the Clarence Valley local government area Cumulative amount of spoil and waste generated. <p>Operation:</p> <ul style="list-style-type: none"> No adverse impacts are expected during operation. | No other potentially significant or moderate cumulative residual impacts are expected to remain after the application of the proposed management measures listed in Chapter 10. | Key issue | Section 9.4 |

12 Project justification and conclusion

This chapter presents a justification of the project and a conclusion to the EIS. It considers the strategic justification of the project, how the project satisfies the project objectives, the objects of the *Environmental Planning and Assessment Act 1979* and the principles of the ecologically sustainable development, and whether the project is in the public interest.

Table 12-1 Director-General's environmental assessment requirements relevant to project justification

| Director General's environmental assessment requirements | Where addressed in EIS |
|---|-------------------------------|
| Justification for the preferred project taking into consideration the objects of the Environmental Planning and Assessment Act 1979 | Section 12.1 and Section 12.4 |
| Detail how the principles of ecologically sustainable development will be incorporated in the design, construction and ongoing operation phases of the project. | Section 12.5 |
| Whether or not the project is in the public interest | Section 12.3 |

12.1 Strategic justification

12.1.1 Consistency with government policies

The Grafton Bridge project is consistent with NSW Government planning and transport policies and relevant strategic planning and transport policies, including:

- *NSW 2021: A Plan to Make NSW Number One* (NSW Government, 2011). This is because the project would reduce travel times between Grafton and South Grafton and improve road safety
- *State Infrastructure Strategy 2012 – 2032* (NSW Government, 2012). The project would help to achieve the key objectives for regional infrastructure in NSW, including to improve access to employment, connect people and communities, and improve local transport networks
- *Mid North Coast Regional Strategy* (Department of Planning, 2009). The project would help to meet the long-term development needs of the Mid North Coast Region by providing important transport infrastructure through Grafton, linking residential growth areas to potential employment land and providing infrastructure to support economic growth in the community, including the associated traffic growth.

The project is consistent with the Commonwealth *National Land Freight Strategy Discussion Paper* as it would provide a safer heavy vehicle route than the existing route and help meet the future road freight needs of the Northern Rivers and Mid North Coast regions. The project would also align with the *National Road Safety Strategy 2011–2020* as it would be designed with safety as a key priority and would help meet the strategy's objective of increasing safety on Australian roads.

The project is also consistent with relevant strategic planning and transport policies at a regional and local level.

Further details regarding the project's consistency with the government policies and strategic planning frameworks are presented in Chapter 3.

12.1.2 Justification for the proposed bridge width

As discussed in Section 8.1, the overall width of the bridge deck is proposed to be around 16 metres. The bridge has been designed with this width to:

- Accommodate traffic lanes, shoulders, median and balustrades and a pedestrian and cycle path
- Enable the bridge to be upgraded to four-lanes, should the need arise.

12.2 How the project satisfies the project objectives

The project objectives are outlined in Section 3.3. The way in which the project satisfies these objectives is presented in Table 12-2.

Table 12-2 How the project satisfies the project objectives

| Project objective | Comment |
|---|--|
| Enhance road safety for all road users over the length of the project | <p>The proposed bridge would improve road safety by:</p> <ul style="list-style-type: none"> • Prohibiting B-doubles and semi-trailers from using the existing bridge, and requiring them to use the new bridge. The existing bridge has pronounced kinks in its horizontal alignment at the northern and southern ends. Long, heavy vehicles (eg B-doubles and semi-trailers) cannot negotiate the kinks without crossing the centreline, creating a risk of crashes • Providing road approaches to the proposed bridge, and upgrades to the local road network, that are designed to meet required safety standards • Providing a dedicated pedestrian and cycle path segregated from vehicle lanes and with safe crossing points along the route. The pedestrian and cycle path would have passive surveillance from passing traffic improving the safety and access of pedestrians and cyclists. |
| Improve traffic efficiency between and within Grafton and South Grafton | <p>The proposed bridge would improve traffic efficiency across the Clarence River because:</p> <ul style="list-style-type: none"> • It would not be constrained by kinks, narrow lanes or 25/26 metre long B-double trucks peak restrictions as occurs on the existing bridge • It would provide an alternative crossing of the Clarence River in Grafton • The intersections proposed as part of the project would perform within acceptable limits of operation in 2039 during peak hour periods • The project would maintain current flood evacuation routes and would improve the overall efficiency of flood evacuation. |

| Project objective | Comment |
|---|--|
| Support regional and local economic development | <p>The proposed bridge would support regional and local economic development because it would:</p> <ul style="list-style-type: none"> • Increase traffic capacity across the Clarence River, which would improve freight transport efficiency and help to meet the road freight transport needs of the Northern Rivers and Mid North Coast regions • Facilitate local economic development by providing better access and connectivity for local residents into and between Grafton and South Grafton, including residents in the predicted growth area of Clarenza. |
| Involve all stakeholders and consider their interests | <p>Roads and Maritime has consulted extensively with the community, including affected landholders throughout, project planning, route options development and assessment, selection of the preferred option, strategic concept design, and EIS preparation.</p> <p>Roads and Maritime will continue consultation throughout the detail design and construction stages.</p> <p>The draft Community Consultation Strategy for construction (refer to Appendix C) outlines strategies for community liaison and consultation with all stakeholders, lists communication activities to implement these strategies and highlights how the community liaison process will be monitored, evaluated and reported back to the community.</p> |
| Provide value for money | <p>Value for money was a key consideration in the selection of the preferred option during route selection.</p> <p>Of the options evaluated, the proposed bridge would provide the greatest improvements to the efficiency of the road network, including during the morning and evening peak periods.</p> <p>During concept design, the extent of the project has been refined, which has reduced the overall cost of the project while still providing for improved traffic performance in Grafton and South Grafton through to 2039.</p> |
| Minimise impact on the environment | <p>The potential impacts on the environment have been minimised throughout the development of the project. Where possible, potential impacts have been avoided or minimised through the route selection process.</p> <p>Despite this, the project would have impacts on the environment, as identified in Chapter 8 and Chapter 9. Where possible, strategies to minimise and mitigate these impacts have been developed. These mitigation measures are outlined in Chapter 10.</p> |

12.3 The project is in the public interest

It is a basic principle that major development proposals should be demonstrated to be in the public interest before being allowed to proceed. The project meets this public interest requirement.

12.3.1 The bridge will address transport needs

Grafton Bridge currently experiences traffic congestion during peak periods and does not effectively meet ongoing safety and traffic requirements. The provision of a new crossing would be in the public interest as it would reduce congestion, provide a safer heavy vehicle route and provide a safer pedestrian and cycle path across the Clarence River.

The project will address short- and long-term transport needs in Grafton and South Grafton by:

- Increasing traffic capacity across the Clarence River, which would relieve traffic congestion on the existing bridge and provide capacity for future traffic growth. In addition, the proposed upgrades of the local road network would perform within acceptable limits of operation to at least 2039 based on traffic forecasts
- Providing a safe crossing for pedestrians and cyclists by providing purpose-designed pedestrian and cycle paths
- Providing a crossing that is designed to contemporary road design standards, without kinks or bottlenecks, and allowing for the safe movement of all vehicles, including large, heavy vehicles
- Improving freight transport efficiency by providing an alternative route across the Clarence River.

12.3.2 The bridge will support regional and local economic development

The project would support regional and local economic development, and provide growth and employment opportunities in the Grafton economic centre and the Iolanthe Street precinct.

12.3.3 The bridge has wide community support

The views of the community have been taken into account in determining whether the project is in the public interest. Some members of the community oppose the project location due to concerns about traffic and amenity impacts on the area. However, there is also considerable support within the community for an additional crossing with many in the community supporting the project as the most practical option.

The project also provides value for money to taxpayers and the community.

Therefore, despite some unavoidable adverse environmental and social impact (as addressed in the EIS), the project is in the public interest.

12.4 How the project satisfies the objects of the EP&A Act

The objects of the EP&A Act provide a framework within which the justification of the project can be considered. A summary of this assessment is provided in Table 12-3.

Table 12-3 How the project satisfies the objects of the EP&A Act

| EP&A Act objective | Comment |
|--|---|
| <p>To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, waters, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.</p> | <p>The project and the management and mitigation measures detailed in this EIS allow for the proper management, development and conservation of natural and artificial resources.</p> <p>The project would support regional and local economic development, improve traffic efficiency and enhance road safety.</p> <p>However, the project would result in the loss of a relatively small portion of regional significant farmland (6.8 hectares) and public open space (1.5 hectares).</p> |
| <p>To encourage the promotion and co-ordination of the orderly and economic use and development of land.</p> | <p>The project is expected to result in economic benefits at a regional and local level by increasing traffic capacity across the Clarence River, improving road safety and travel times, and creating job opportunities and potential economic benefits for local businesses during construction.</p> <p>The project would support future growth areas in South Grafton as identified in the Mid North Coast Regional Strategy, particularly near Clarenza, by improving access and connectivity to Grafton CBD.</p> <p>The project would also promote growth and employment opportunities in the Iolanthe Street precinct.</p> <p>However, the project would result in the loss of a relatively small portion of regionally significant farmland (6.8 hectares) and public open space (1.5 hectares).</p> |
| <p>To encourage the protection, provision and co-ordination of communication and utility services.</p> | <p>The project may carry utility services across the Clarence River.</p> <p>The project would require the protection, relocation and adjustment of existing public utility services, but it is not anticipated that any utility services would be negatively impacted as a result of the project once construction is complete.</p> |
| <p>To encourage the provision of land for public purposes.</p> | <p>The project is for a public purpose and would provide roads, pedestrian and cycle paths and a bridge that would be used by the public. The project would also improve safe access to the Grafton foreshore area.</p> |

| EP&A Act objective | Comment |
|---|--|
| To encourage the provision and co-ordination of community services and facilities. | <p>The project would provide a pedestrian and cycle path across the new bridge that would provide a safe and efficient link between Grafton and South Grafton, and a safe crossing of the Pacific Highway.</p> <p>The project would also improve the overall efficiency of evacuation during major flood events.</p> |
| To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats. | <p>From the start of project planning (ie from the route option development stage to the concept design stage) Roads and Maritime has sought to minimise the environmental, social and economic impacts of the project.</p> <p>As discussed in Chapter 8 and Chapter 9, the project would result in some impacts on the environment. The mitigation hierarchy (avoid, minimise, mitigate and offset) has been considered for all identified impacts, and strategies to minimise and mitigate these impacts have been developed and are identified in Chapter 10.</p> |
| To encourage ecologically sustainable development. | Ecologically sustainable development has been considered and is addressed in Section 12.5. |
| To encourage the provision and maintenance of affordable housing. | Not relevant to the project. |
| To promote the sharing of the responsibility for environmental planning between different levels of government in the State. | Not relevant to the project. |
| To provide increased opportunity for public involvement and participation in environmental planning and assessment. | <p>Roads and Maritime has consulted extensively with the community and relevant stakeholders on this project, providing a variety of opportunities to participate in the route selection process and the development of the concept design.</p> <p>Roads and Maritime has also considered community and stakeholder feedback wherever possible in the development and refinement of the project.</p> <p>Roads and Maritime will continue to consult with the local community, relevant government agencies and specific groups during the detailed design and construction of the project.</p> |

12.5 How the project satisfies the principles of ecologically sustainable development

Ecologically sustainable development is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. It requires the effective integration of economic and environmental considerations in decision-making processes.

The principles of ecologically sustainable development have been applied throughout the development of the project. The economic, social and environmental impacts considered during the route options development, assessment and selection of the preferred option and the design refinements made to the preferred option, are consistent with these principles.

Should the project be approved, Roads and Maritime would continue to apply the principles of ecologically sustainable development during the detailed design process to further avoid, minimise and manage potential impacts. These principles would also be applied during construction and operation through the implementation of the mitigation and management measures presented in Chapter 10.

The four main principles supporting the achievement of ecologically sustainable development are discussed below.

12.5.1 Precautionary principle

The precautionary principle deals with reconciling scientific uncertainty about environmental impacts with certainty in decision-making. It states that where there is a threat of serious or irreversible environmental damage, the absence of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation.

This principle was considered during route options development (refer to Chapter 4). The principle has guided the assessment of environmental impacts for this EIS and the development of mitigation measures.

The project satisfies the precautionary principle in the following ways:

- Any lack of full scientific certainty has not been used as a reason for postponing measures to prevent environmental degradation. As detailed in Chapter 8 and Chapter 9, mitigation measures are proposed to manage identified risks and threats of environmental damage. For example, targeted threatened species that were not found during the field surveys have been assumed to be present in the study area (refer to Section 8.9)
- The EIS documents the careful evaluation of environmental impacts associated with the project and has been undertaken using the best available technical information and adoption of best practice environmental standards, goals and measures to minimise environmental risks. The impact assessments have been undertaken in collaboration with key stakeholders and relevant statutory and agency requirements (refer to Chapter 7)
- Investigations in the study area have been ongoing since the route options development stage and information obtained during this time has allowed potential impacts to be identified. The development and refinement of the project has involved a number of different phases of investigation, consultation and assessment to ensure that, on balance, the most appropriate route option was selected (refer to Chapter 4)
- Conservative scenarios were considered while assessing environmental impact. For example, modelling undertaken for traffic (refer to Section 8.1 and *Appendix D, Technical Paper: Traffic and Transport*), flooding and climate change (refer to Section 8.2, Section 8.3 and *Appendix E Technical Paper: Flooding and hydrology*), and operational traffic noise (refer to Section 8.4 and *Appendix F, Technical Paper: Noise and Vibration*) have used conservative assumptions. Where potential adverse impacts could not be avoided, specific mitigation and management measures to protect the surrounding environment have been identified (refer to Chapter 10)
- The project has been designed to avoid impacts. For example:

- Refinements have been made to the road design to avoid the need to demolish the Ravensford (36 Villiers Street, Grafton) heritage item (refer to Section 8.5 and *Appendix G, Technical Paper: Non-Aboriginal Heritage*) and minimise the extent of property acquisition (refer to refer to Section 8.7 and *Appendix I: Technical Paper – Socio-economic, property and land use*)
- The bridge type, form and elements have been designed to avoid direct impacts on the existing Grafton rail and road bridge heritage item (refer to Section 4.3.3, Section 8.5, Section 8.8 and *Appendix J, Technical Paper: Urban Design and Landscape Concept Report* (including landscape character and visual impact assessment))
- The project in South Grafton has been designed to avoid impacts on the Golden Eel site (refer to Section 8.6.3 and *Appendix H, Technical Paper: Aboriginal Cultural Heritage Assessment*) and regionally significant farmland (refer to Section 8.7 and *Appendix I, Technical Paper: Socio-economic, property and land use*)
- Proposed urban concept design and landscape plan have been refined to avoid and minimise impact on the landscape character and visual amenity (refer to Section 8.8 and *Appendix J, Technical Paper: Urban Design and Landscape Concept Report* (including landscape character and visual impact assessment))
- Impacts on biodiversity values have been avoided via design refinement (refer to Section 8.9.5 and *Appendix L, Technical Paper: Flora and Fauna Assessment*).
- Specific measures to avoid impacts during construction are proposed, for example:
 - Proposed earthworks haulage would take into account peak periods to minimise impact on traffic and access across the existing bridge (refer to Section 8.1 and *Appendix D, Technical Paper: Traffic and Transport*)
 - Flood monitoring and response measures would be included as part of the construction environmental management plan and flood mitigation works will be staged to ensure no worsening of the existing flood regimes during construction (refer to Section 8.2)
 - Construction ancillary sites and stockpile areas have been located in suitable areas where socio-economic and environmental impacts would be avoided or minimised where feasible and reasonable (refer to Section 6.3.5 and Section 8.9.5)
 - Exclusion zones during construction are proposed for items and areas of heritage value (refer to Section 8.5, Section 8.6, *Appendix G, Technical Paper: Non-Aboriginal Heritage* and *Appendix H, Technical Paper: Aboriginal Cultural Heritage Assessment*).
- Prior the commencement of construction, a construction environmental management plan would be prepared. The plan would include the mitigation measures identified for implementation during the construction phase of the project (refer to Chapter 10). The implementation of the construction environmental management plan would ensure that the project achieves a high level of environmental performance during construction in accordance with the assessment undertaken for this EIS
- During operation, the project would avoid significant impacts. For example, flood mitigation works would be in place to avoid significant changes to the flood regime (refer to Section 8.2, Section 8.3 and *Appendix E Technical Paper: Flooding and hydrology*), noise architectural treatments and a noise wall would be in place to avoid significant impacts on sensitive receivers (refer to Section 8.4 and *Appendix F, Technical Paper: Noise and Vibration*) and a operational

stormwater management system would be in place to avoid impacts on water quality of the Clarence River (refer to Section 5.2.8 and Section 8.10).

12.5.2 Inter-generational equity

Social equity is concerned with the distribution of economic, social and environmental costs and benefits. Inter-generational equity introduces a temporal element with a focus on minimising the distribution of costs to future generations.

The project would be designed for a 100-year lifespan. Therefore, it would benefit existing and future generation in the Grafton area and in northern NSW.

In addition:

- The route alignment has been selected to minimise environmental impacts and to ensure that areas with high ecological and heritage values are conserved for future generations, to the extent possible (potential environmental impacts that have been avoided through the project development phase are described in Chapter 4)
- The project includes mitigation and management measures to minimise short- and long-term impacts (refer to Chapter 10)
- The project includes a number of measures to enable it to adapt to climate change flooding and sea level rise (see Section 8.3).

12.5.3 Conservation of biological diversity and ecological integrity

The project would conserve biological diversity and ecological integrity in the following ways:

- Mitigation measures are proposed that would minimise and manage impact on critical habitats, threatened species, populations and ecological communities and their habitats in the Grafton area
- A landscape plan has been developed which proposes the planting of native species of locally endemic flora to ensure that biological diversity in the Grafton area is maintained (refer to Section 8.8)
- The locations of construction ancillary facilities have been selected to avoid and minimise native vegetation clearance
- The biodiversity values of the Clarence River and the Clarence Valley, as well as the listed threatened species and endangered ecological communities habitats, would be maintained.

12.5.4 Improved valuation and pricing of environmental resources

The principle of internalising environmental costs into decision making requires consideration of all environmental resources – including air, water, land and living things – that may be affected by the carrying out of a project.

The project's impacts on environmental, economic and social resources have been considered as part of this EIS. The value placed on these resources is evident from the extent of the environmental investigations carried out and the design of proposed management measures.

12.6 Conclusion

This EIS addresses the key issues identified in the Director-General's environmental assessment requirements issued under Part 5.1 of the EP&A Act and the relevant provisions of Schedule 2 of the Environmental Planning and Assessment Regulation 2000. It also addresses other environmental impacts identified during the detailed environmental risk analysis undertaken as part of the EIS.

A checklist showing where the Director-General's environmental assessment requirements are addressed in this EIS is provided in Appendix A.

The EIS confirms that the project has a strong justification for proceeding. This is because it would provide transport efficiency and safety benefits, and facilitate economic growth in a regional city. In addition, the project is consistent with government planning strategies and policies at a national, State and regional level. It also satisfies the project objectives set by Roads and Maritime.

Throughout the development of the project consideration has been given to avoiding or minimising potential adverse environmental impacts (including the application of the principles of ecologically sustainable development).

The project would have some adverse environmental impacts, but the implementation of the proposed mitigation measures would seek to ensure the adequate management of these impacts. Overall, the benefits of the project outweigh these adverse impacts.

Extensive consultation has occurred with the community and stakeholders throughout all project stages, and the project has taken full account of community input. Roads and Maritime would continue consultation throughout the exhibition of the EIS to ensure the community and stakeholders are able to make informed responses to the EIS.

Overall, it is considered that the project would have acceptable environmental, social and economic outcomes for the Grafton area and the Mid North Coast region.

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Glossary of terms and abbreviations

| Term | Meaning |
|-----------------------------------|--|
| 100-year flood event | A 100-year flood is the flood that will occur or be exceeded on average once every 100 years. It has a 1% probability of occurring in any given year. The same principle applies to other flooding events, such as 10-year, 20-year and 50-year flood. |
| Alluvial | Being composed of soil or sediments, deposited by water in some form in a non-marine environment. |
| Aboriginal object | Any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of NSW, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains. |
| Abutment | The part of the bridge structure which supports the superstructure at its extremities. |
| AHIMS | NSW Office of Environment and Heritage Aboriginal Heritage Information Management System |
| Ancillary facilities | Site compounds, concrete batching plant, stockpile areas, precast facilities and flood mitigation stockpile sites. |
| Archaeological research potential | Ability of archaeological evidence to provide information about a site that could not be derived from any other source and which contributes to the archaeological significance of that site. |
| ARTC | Australian Rail Track Corporation |
| AS | Australian Standard |
| ASS | Acid Sulfate Soil |
| Australian height datum (AHD) | This is the standard datum that most flood levels are measured from. Its value is equivalent to mean sea level. |
| Average recurrence interval (ARI) | The long-term average number of years between the occurrence of a flood larger than the selected event. |
| B-double | A prime mover towing two semi-trailers. |
| Bearing | A connection that controls the interaction of bridge loads and movements between parts of the structure, usually the superstructure and the substructure. |
| Benefit-cost ratio | The ratio of the monetary benefits to the costs of a project as a measure of worth to the community. |
| Bioregion | Large land areas characterised by broad, landscape-scale natural features. |

| Term | Meaning |
|--|--|
| Box culvert | A culvert of rectangular cross section. |
| Bridge deck | Bridge floor directly carrying traffic. |
| Bulk earthwork | Bulk earthworks in construction includes the removal, moving or adding of large quantities of soil or rock to create a suitable height and level. |
| Carbon footprint | The total sets of greenhouse gas emissions caused by an organization, event, product or person. |
| CBD | Central business district |
| CCTV | Closed circuit television |
| CEMP | Construction environmental management plan |
| CHMP | Construction heritage management plan |
| CNVMP | Construction noise and vibration management plan |
| Connectivity | The degree to which streets or paths join with each other allowing community and modal integration. |
| Constructability | A measure of the ability to be constructed. |
| Contributory items | Buildings not listed as heritage items but within conservation areas. |
| CrashLink database | NSW traffic accident database. |
| CVC | Clarence Valley Council |
| dBA | Decibels using the A-weighted scale measured according to the frequency of the human ear. |
| Detention basin | An excavated area for temporary storage of water, installed to protect against flooding and or erosion. |
| DGB | Densely graded base |
| Director-General | Currently known as the Secretary of the Department of Planning and Environment |
| Director-General's environmental assessment requirements | These are the Director-General's environmental assessment requirements provided by the former Department of Planning and Infrastructure for the project. |
| DP&E | Department of Planning and Environment |
| DPI | Department of Primary Industries |
| Easement | A right of use and/or entry onto or through property. |
| EIS | Environmental impact statement |

| Term | Meaning |
|-------------------------|---|
| ENM | Excavated natural material |
| EP&A Act / the Act | Environmental Planning and Assessment Act 1979 (NSW) |
| EPA | NSW Environment Protection Authority |
| EPBC Act | Environment Protection and Biodiversity Conservation Act 1999 (Cth) |
| Fauna | Animals |
| Feasible and reasonable | <p>Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context.</p> <p>Feasible relates to engineering considerations and what is practical to build.</p> <p>Reasonable relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.</p> |
| Flood event | A flood as defined by the relevant government authority. |
| Flood hazard | A hazard caused by a flood. |
| Flood mitigation works | Works undertaken to mitigate flood impacts. |
| Flood regime | The normal inundation and flow patterns of flooding in a particular area. |
| Flora | Plants |
| Fluvial | Being associated with rivers and streams and the deposits and landforms created by them. |
| FM Act | Fisheries Management Act 1994 (NSW) |
| Greenhouse gas | Atmospheric gases that enhance the natural greenhouse effect, including carbon dioxide, methane, chlorofluorocarbons, nitrous oxide, ozone and water vapour. |
| Gross regional product | The market value of all final goods and services produced within a region in a given period of time. |
| Hardstand | Hard pavement using materials including concrete or asphalt. |
| Haunch | An increase in depth of the bridge superstructure adjacent to the piers to withstand the increased bending moments on the beam. |
| Infrastructure SEPP | State Environmental Planning Policy (Infrastructure) 2007 (NSW) |
| IPCC | Intergovernmental Panel on Climate Change |

| Term | Meaning |
|---------------------|---|
| Kilovolt | 1000 volts |
| km | Kilometre |
| kN | Kilonewton |
| LALC | Local Aboriginal Land Council |
| Landscape character | The aggregate of built, natural and cultural aspects that make up an area and provide its unique sense of place. Landscape in this context is taken to include all aspects of a tract of land – the built, planted and natural topographical and ecological features. |
| Levee | An embankment which regulates water levels (including flooding). |
| Level of service | A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. |
| LGA | Local government area |
| Lidar | Lidar is a detection system which works on the principle of radar, but uses light from a laser |
| Lintel | A structural horizontal beam or block that spans the space or opening between two vertical supports. |
| Local road | Roads that have a low speed limit, have a small footprint, serve local communities and that are generally conducive to walking and cycling. A road or street used primarily for access to abutting properties. |
| lot | A parcel of land defined by measurement as a lot in a deposited plan or as a Crown portion or allotment. |
| m | Metre |
| Metalliferous | Containing a metallic element. |
| mm | Millimetre |
| NEPM | National Environment Protection Measures |
| NSW | The State of New South Wales. |
| NV Act | Native Vegetation Act 2003 (NSW) |
| OEH | NSW Office of Environment and Heritage |
| PACHCI | Roads and Maritime procedure for Aboriginal Cultural Heritage Consultation and Investigation |

| Term | Meaning |
|---------------------------------------|--|
| Parapet | Low protective concrete wall at edge of the bridge deck. |
| PASS | Potential acid sulfate soil |
| Pier | A part of the bridge substructure which supports the superstructure at the end of the span and which transfers loads on the superstructure to the foundations. |
| Pile | A slender member driven into or formed in the ground to resist bridge loads. |
| Pile cap | A concrete member that connects the base of the pier column to the top of the piles. |
| PM10 | Particulate matter 10 micrometres or less in diameter. |
| Probable maximum flood (PMF) | The largest flood that could conceivably occur (a worst-case flood event). It is typically estimated from probable maximum precipitation coupled with the worst flood-producing catchment conditions. The PMF extent defines the floodplain and incorporates all flood-prone land. The PMF is a very rare and improbable flood. |
| Project area | <p>The area of construction works and operation of the project elements as described in Chapter 5 and Chapter 6 of the EIS.</p> <p>This area includes:</p> <ul style="list-style-type: none"> • Operational road boundary • Permanent ancillary elements such as operational detention basin and pump station in Grafton • Construction work zone, which includes temporary facilities such as South Grafton ancillary site, Pound Street ancillary site and the jetty for barge launching • Flood mitigation works construction zone, which includes temporary stockpile areas. |
| Property acquisition | Acquisition of privately owned land. |
| RBL | Rating background level |
| Receiver | An environmental modelling term used to describe a map reference point where the impact is predicted. A sensitive receiver/receptor is a home, work place, school or other place where people spend some time. |
| Regionally significant farmland | Land capable of sustained use for agricultural production with a reasonable level of inputs and which has the potential to contribute substantially to the ongoing productivity and prosperity of a region. |
| Representative concentration pathways | In climate science, radiative forcing, or climate forcing, is defined as the difference of sunlight received by the earth and energy radiated back to space. |

| Term | Meaning |
|---|---|
| Roads and Maritime | NSW Roads and Maritime Services |
| RoTAP | Rare or Threatened Australian Plants (RoTAP), are listed of rare or threatened Australian plant taxa. The list uses a coding system based on the IUCN Red List categories, including "Presumed Extinct", "Endangered", "Vulnerable", "Rare" or "Poorly Known". The RoTAP list (final revision 1996 published by CSIRO), in its early days was the only nationally recognised list of threatened plants, prior to the commencement of the EPBC Act. However, since the EPBC Act list was prepared, the RoTAP list is now little used but is referred to by botanists and is still maintained and referred to in scientific publications. |
| Secretary | Secretary of the Department of Planning and Environment. Formerly known as the Director-General of the Department of Planning and Infrastructure. |
| Secretary's environmental assessment requirements | Secretary's environmental assessment requirements issued by the Department of Planning and Environment. Formerly known as the Director-General's environmental assessment requirements issued by the Department of Planning and Infrastructure. |
| SEPP | A NSW State Environmental Planning Policy |
| Signalised crossing | Traffic lights |
| Silt curtain | Floating barriers designed specifically to contain and control the dispersion of floating turbidity or silt in a water body. |
| Soffit | Undersurface of the bridge superstructure. |
| Soft soil | Poor ground conditions from an engineering perspective, unconsolidated ground commonly found in alluvial areas. |
| Stockpile area | An area reserved for the storage of stockpiled materials. |
| Span | The distance between points of bridge support (eg piers, abutment). |
| Sterilise | To restrict future use of land, minerals and resources. |
| Stockpile | Temporarily stored materials such as soil, sand, gravel, mulch and spoil/waste. |
| Substructure | Part of the bridge structure, ie piers and abutments, which supports the superstructure. |
| Superstructure | Part of the bridge structure which supports traffic and includes deck, slab and girders. |
| t | Tonne |
| TAFE | North Coast TAFE Grafton Campus |

| Term | Meaning |
|-----------------------------------|--|
| Terrestrial | Related to land or the earth. |
| Threatened ecological communities | As defined under the <i>Threatened Species Conservation Act 1994</i> , an ecological community that is likely to become extinct or is in immediate danger of extinction. |
| Transition pier | Pier separating different bridge superstructure types. |
| Travel demand management | Application of strategies and policies to reduce travel demand. |
| TSC Act | Threatened Species Conservation Act 1995 (NSW) |
| TUFLOW | A two-dimensional unsteady flow hydraulic modelling software |
| Urban design | The process and product of designing human settlements, and their supporting infrastructure, in urban and rural environments. |
| Urban design objectives | The particular ends that need to be pursued to achieve an urban design vision. Objectives govern subsequent principles. |
| Urban design principles | These are the design rules and processes by which urban design objectives will be realised and which inform a project's design. Different designs may equally satisfy the same set of objectives and principles. |
| Viaduct | A long bridge generally composed of a series of spans over land, which carries a road or railway. |
| Wick drains | Artificial drainage paths comprising a central plastic core, surrounded by a thin geo-synthetic filter jacket. |
| Wind wash | Diminished performance of buildings or structures caused by air movement over or through a thermal barrier. |
| Wind rose | A graphic providing a view of how wind speed and direction are typically distributed at a particular location. |