Roads and Traffic Authority of NSW

Oxley Highway to Kempsey
Upgrading the Pacific Highway

Environmental Assessment

MAIN VOLUME

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20. Other environmental issues

This chapter presents a high level assessment for issues not identified as key issues in the Director-General's environmental assessment requirements or not identified as requiring a comprehensive level of assessment in the environmental risk analysis as outlined in **Chapter 9 Environmental risk analysis**. The issues discussed include:

- Air quality.
- Non-Aboriginal heritage.
- Geology and soils.
- Contamination.
- Waste.
- Hazards.
- Greenhouse gas.
- Climate change.

20.1 Air quality

20.1.1 Methodology

To assess the potential impacts on the air quality of the surrounding environment from the construction and operation of the Proposal, a qualitative assessment of the existing air shed was undertaken based upon available desktop information.

20.1.2 Existing air quality

Local air conditions in the Proposal area are not influenced by large-scale industrial land uses, exposed soil areas or burning of material, and are therefore considered to be good quality.

There are no ambient air quality monitoring stations located in proximity to the Proposal. The nearest ambient air monitoring station operated by DECCW is located in Newcastle. This monitoring station is not indicative of the environment in the Proposal area due to the distance and differences in terms of land use (urban versus rural).

Air quality monitoring was undertaken for the Sapphire to Woolgoolga Pacific Highway upgrade between October 2005 and January 2006 near Korora, just north of Coffs Harbour. The monitoring site was located immediately adjacent to the existing Pacific Highway and the monitoring results would represent a worst case scenario as air pollutants disperse and decrease with distance from the source. The annual average daily traffic volumes at the time of monitoring were approximately 19,700 compared with the annual average daily traffic volumes (2004) on the existing highway in the Proposed area that range from approximately 12,300 south of Hastings River Drive to approximately 15,000 at the Hastings River crossing.

Results of monitoring at Korora for carbon monoxide, oxides of nitrogen, nitrogen dioxide and particulate matter (less than 10 microns in diameter and less than 2.5 microns in diameter), all of which are present in exhaust emissions, showed that all were well below the DECCW air quality goals.

Based on these results, it can be extrapolated that given the lower volumes of road traffic and less urban nature of the area surrounding the Proposal relative to the monitoring location, existing air quality in the Proposal area would be well below the DECCW air quality goals.

20.1.3 Construction impacts

Air quality impacts generated during the construction phase would arise primarily due to construction dust emissions.

Environmental impacts of airborne particulate matter (dust) are generally related to the size of the particle and the dispersion of the dust. Health effects are associated with fine particles less than 10 microns, in equivalent aerodynamic diameter, whereas coarser particles (10 to 100 microns) are associated with effects on amenity (eg visible dust plumes or deposition on surfaces).

As a dust plume is transported downwind from a source, the coarser particulates progressively drop out of the air column to deposit on surfaces (land, water, cars, etc) downwind of the source. Finer particles would be retained in the air column longer by turbulent mixing. Wind erosion or dust lift-off can become significant under strong winds (greater than 5 metres per second). Increased levels of soil moisture reduce the wind erosion potential of exposed soil surfaces.

The major causes of potential dust generation during the construction phase would include:

- Clearance of vegetation and topsoil material.
- General surface earthworks and excavation activities.
- Batch plant operations.
- Rock crushing.
- Pneumatic rock breaking.
- Handling of topsoil and earthworks material (eg stockpiling, loading, dumping).
- Levelling and grading of embankments, cuttings and pavement materials.
- Passage of construction and other vehicles over unconsolidated soil surfaces and unsealed access roads or sections of the Proposal.
- Wind erosion of disturbed or unvegetated surfaces and stockpile sites.

The dominant sources of dust emissions during construction would be activities associated with the operation of dozers, graders, scrapers and haul trucks due to the high level of mechanical disturbance of material associated with these machines. However, these impacts would be short term and localised within the construction zone as the construction works move along the route.

Exhaust emissions from construction plant and equipment would also impact local air quality but this would be negligible and short-term.

Consideration has also been given to the potential construction air quality impacts of the possible staging option described in **Section 7.3.2,** in comparison to the construction of the entire Proposal to a full motorway standard.

In this regard, potential construction air quality impacts would generally be similar for both this staging option and the ultimate motorway standard upgrade. However, those impacts would occur during two separate construction periods, and therefore sensitive receptors would be exposed to potential construction air quality impacts on two separate occasions.

The management measures as described in **Section 20.1.5** would be implemented for the construction period of both the staging option and the ultimate motorway standard upgrade.

Should the Proposal be delivered in stages, the staging report described in **Section 7.3.3** would detail the construction air quality impacts of the staging option. If any additional or altered impacts are identified, the staging report would further assess these impacts and identify appropriate management measures.

20.1.4 Operational impacts and improvements to local air quality

Traffic growth along the Pacific Highway would continue irrespective of whether the Proposal proceeds or not. The improvements to the Pacific Highway offered by the Proposal would generate additional opportunistic use of the highway on this section of the Sydney to Brisbane transport network. However, the extent of this increase in 'opportunistic' traffic, and the associated airborne pollutants, would be expected to be minimal when compared to the overall expected rate of traffic growth for the highway over time.

The overall traffic efficiency of this section of the Pacific Highway would be expected to improve as a result of the Proposal. This improvement in efficiency would result from the reduced grade of the highway in a number of locations, the separation of through and local traffic flows, removal of the highway from villages, removal of in-traffic conflicts associated with existing at-grade intersections and accesses, as well as the improved horizontal alignment.

The volume of airborne pollutants from vehicles tends to be highest at the roadside, and diminishes with distance from the road as particles drop out of the air stream. As approximately 60 per cent of the Proposal is located along or near to the existing Pacific Highway road reserve, the level of airborne pollutants from vehicles in these areas would be expected to be similar to the existing pollutant levels.

In the areas where the Proposal deviates from the existing route, the level of airborne pollutants from vehicles would be expected to increase significantly over the existing air quality conditions. However, most of these sections are located in areas that are used for forestry or are sparsely populated, and therefore sensitive receptors would not be greatly affected by any increase in airborne pollutant levels near the road. Where the Proposal crosses the Hastings River floodplain, it is located in proximity to a number of rural residences. However, given that the Proposal remains relatively close to the existing highway and taking into account the presence of commercial industrial operations in this area, any deterioration in air quality conditions is not expected to be significant.

Conversely where the Proposal does deviate from the existing highway alignment, those receptors located in proximity to the existing highway would experience an improvement in air quality conditions.

Vehicle emission standards and controls are subject to continuing improvement. Along with the improvements to the Pacific Highway, over time this would result in improved air quality conditions in areas adjoining the highway. However, these measures are of a broader community and legislative nature, and are outside of the scope of the Proposal.

Allowing for both the positive and negative air quality impacts of the operation of the Proposal, it would be expected that the overall air quality in this area would be improved as a result of the improved traffic flow conditions and operating efficiency for all vehicles. Design refinements during the detailed design phase would ensure the grading and alignment of the upgraded highway are best suited to maintaining peak vehicle operating efficiency.

Consideration has also been given to the potential operational air quality impacts of the possible staging option described in **Section 7.3.2**, in comparison to the construction of the entire Proposal to a full motorway standard.

In this situation, some of the proposed service roads would not be built, and some at-grade intersections and access points would also be retained on the upgraded highway for this staging option. This would result in a slight increase in air quality impacts due to the slightly higher level of conflict between local and through traffic for this staging option in comparison to the ultimate motorway standard upgrade.

However, there would be relatively low volumes of traffic using the proposed service and access roads, combined with a corresponding reduction in the signposted speed limit to 100 kilometres per hour on the upgraded highway for this staging option. It would therefore be expected that the overall air quality levels would be similar to, or slightly decreased as a result of the adoption of this staging option in comparison with the ultimate motorway standard upgrade.

Management measures as described in **Section 20.1.5** would be implemented for the operation of both this staging option and the ultimate motorway standard upgrade.

Should the Proposal be delivered in stages, the staging report described in **Section 7.3.3** would detail the operational air quality impacts of the staging option. If any additional or altered impacts are identified, the staging report would further assess these impacts and identify appropriate management measures.

20.1.5 Management of impacts

Prior to the commencement of the construction works, sensitive receptors and land uses within close proximity to the Proposal would be identified for consideration in the development and implementation of air quality management strategies.

Management of construction impacts

Measures to manage the air quality construction impacts would include the following:

- Daily weather updates and strong wind warnings would be used to help manage construction areas and stockpiles, as well as minimising the production and impact of dust emissions.
- Dust deposition monitoring and visual monitoring for dust plume emissions would be undertaken throughout the construction period.
- A complaints register would be established to record complaints received from nearby residents and land users, as well as the action taken to resolve the issue.
- Existing vegetation would be retained where possible and cleared areas would be re-vegetated as soon as possible.
- Construction site and stockpile areas would be designed, located and managed to minimise dust emissions, as well as making the best use of physical barriers and vegetation for windbreaks.
- Dry material would be watered prior to it being loaded for haulage, unless this would make the material unsuitable for specific construction requirements.
- Haulage and access routes for construction traffic would be located and managed to minimise dust emissions.
- All loads of dirt, sand, soil or other loose materials would be covered.

- Measures to minimise dirt, mud or debris from tyres being carried on to paved roads would be implemented.
- Material spillage on public roads would be cleaned up immediately.
- Construction vehicles, mobile plant and machinery would be maintained and operated in accordance with the manufacturers' specifications to minimise exhaust emissions.
- Batch plants would be fitted with filters to assist with dust and fume suppression during operation of the plants.

Operational impacts

During the detailed design phase, the concept design would be reviewed to ensure that the gradient and length of the steeper sections of the Proposal are minimised where possible. The placement of vegetation or earth mounds would also be considered if warranted to help filter or divert airborne pollutants away from sensitive receptors and land uses.

20.2 Non-Aboriginal heritage

20.2.1 Methodology for non-Aboriginal heritage assessment

The non-Aboriginal heritage assessment was carried out in two phases. The first phase was an initial predictive study during the route selection process, followed by a more detailed investigation for this Environmental Assessment. The detailed investigation included research into the historical and environmental context of the Proposal area followed by a comprehensive field survey.

The research included searches of the following Federal, State and local heritage registers and planning instruments:

- National Heritage List.
- Commonwealth Heritage List.
- Register of the National Estate.
- EPBC Act protected matters search tool.
- State Heritage Register and State Heritage Inventory.
- National Trust of Australia (NSW).
- *North Coast Regional Environmental Plan*.
- *Hastings Local Environmental Plan 2001*.
- *Kempsey Local Environmental Plan 1987*.
- NSW Roads and Traffic Authority Section 170 Heritage and Conservation Register.

Additional research into local history and historical records was conducted, including at the:

- National Library of Australia.
- NSW State Archives.
- State Library of NSW (Mitchell Collection).
- Port Macquarie Local Historical Society.
- Port Macquarie Library.

The investigations identified non-Aboriginal heritage items listed or recorded within an initial investigation corridor of approximately 2 kilometres in width. As the alignment was refined, this corridor was amended and the searches updated. A predictive model was developed to assist with the identification of non-Aboriginal heritage items that could be present within the initial investigation corridor but had not been previously identified. The predictive model was developed using an assessment of historic land use activities and the types of relics associated with particular industries or occupations that could have existed in the in landscape.

A qualified archaeologist undertook a comprehensive archaeological survey in March 2007 sampling approximately 560 hectares of the Proposal route. The survey included walking the Proposal and undertaking onsite assessments on individual properties. Survey was not completed on small areas of modified ground where the potential for heritage items was small, and several small areas of properties where access was not available. On average, a 150 metre wide area was searched during the detailed field assessment.

Further investigation of the area potentially impacted by the Proposal was undertaken to:

- Identify the nature and extent of any non-Aboriginal heritage evidence within the Proposal area.
- Assess the significance of any listed non-Aboriginal heritage items identified during the investigations.
- Assess the potential impacts of the Proposal on any non-Aboriginal heritage items identified during the investigations.
- Identify management measures for any non-Aboriginal heritage items impacted by the Proposal.

A number of non-Aboriginal heritage items, typically 'relics' under the NSW *Heritage Act 1977*, were identified during the survey. These were recorded in detail in April 2007 by a historical archaeologist, and further research and consultation with local landowners was undertaken. An assessment of significance was undertaken in accordance with the NSW Heritage Office guidelines.

The archaeological survey did not include those sections of the service road network that would use existing local roads as shown on **Figure 6-1a** to **Figure 6-1b** and **Figure 6-2a** to **Figure 6-2q**. Discussions regarding the applicability of the findings to these sections are provided in **Section 20.2.3**

20.2.2 Existing environment

Historical context

The first non-Aboriginal explorers moved their way northward from Sydney by land and sea. John Oxley travelled north by land in 1818 and returned to the area in 1820 to assess the suitability of a port at the mouth of the Hastings River.

Port Macquarie was established as a penal colony in 1823 when convicts were transported by ship from Newcastle. The convicts cut cedar from the forests surrounding the Hastings and Maria rivers for transport to the southern colonies. The convicts also produced lime for the construction industry in Sydney. Five limekilns were operated near Pipers Creek (Kneale 1993).

Free settlement in the Port Macquarie area was permitted after 1830. This settlement was initially concentrated around the port and in areas with ready access to the rivers, as the rivers were the main corridor for transporting the materials and supplies. Other areas further away from the rivers and port were slower to develop.

Much of the study area has been substantially modified since the original non-Aboriginal settlement. The first industry in the locality involved timber harvesting and later settlers cleared much of the suitable land for agricultural and pastoral use.

Key findings from the research

The research into the historical and environmental context of the study area revealed the following findings:

- No Commonwealth listed heritage items.
- Two non-Aboriginal heritage items listed on the Register of National Estate (Kundabung Lime Kilns and Pipers Creek Lime Kilns). These are located outside the Proposal area.
- No items listed by the National Trust of Australia.
- No items on the NSW State Heritage Register.
- One item listed on the RTA Section 170 Heritage and Conservation Register (Maria River bridge).
- Four items of local heritage significance.

Maria River bridge

Searches of heritage registers and planning instruments and a comprehensive field survey have resulted in the identification of 16 potential heritage items along the Proposal, as shown in **Figure 20-1**.

20.2.3 Impacts on non-Aboriginal heritage

The Proposal would not directly impact any non-Aboriginal heritage items listed on any Commonwealth or State heritage register. An assessment of the potential impacts on the Maria River bridge and the remaining 15 potential heritage items identified through the site survey and predictive modelling was undertaken in accordance with the Heritage Branch, Department of Planning's *NSW Heritage Manual: Assessing heritage significance* (2001). The results of the assessments and the statement of the impacts on the items are presented in **Table 20-1**. **Section 20.2.4** details management measures to reduce impact on non-Aboriginal heritage items.

Figure 20-1 Potential non-Aboriginal heritage items

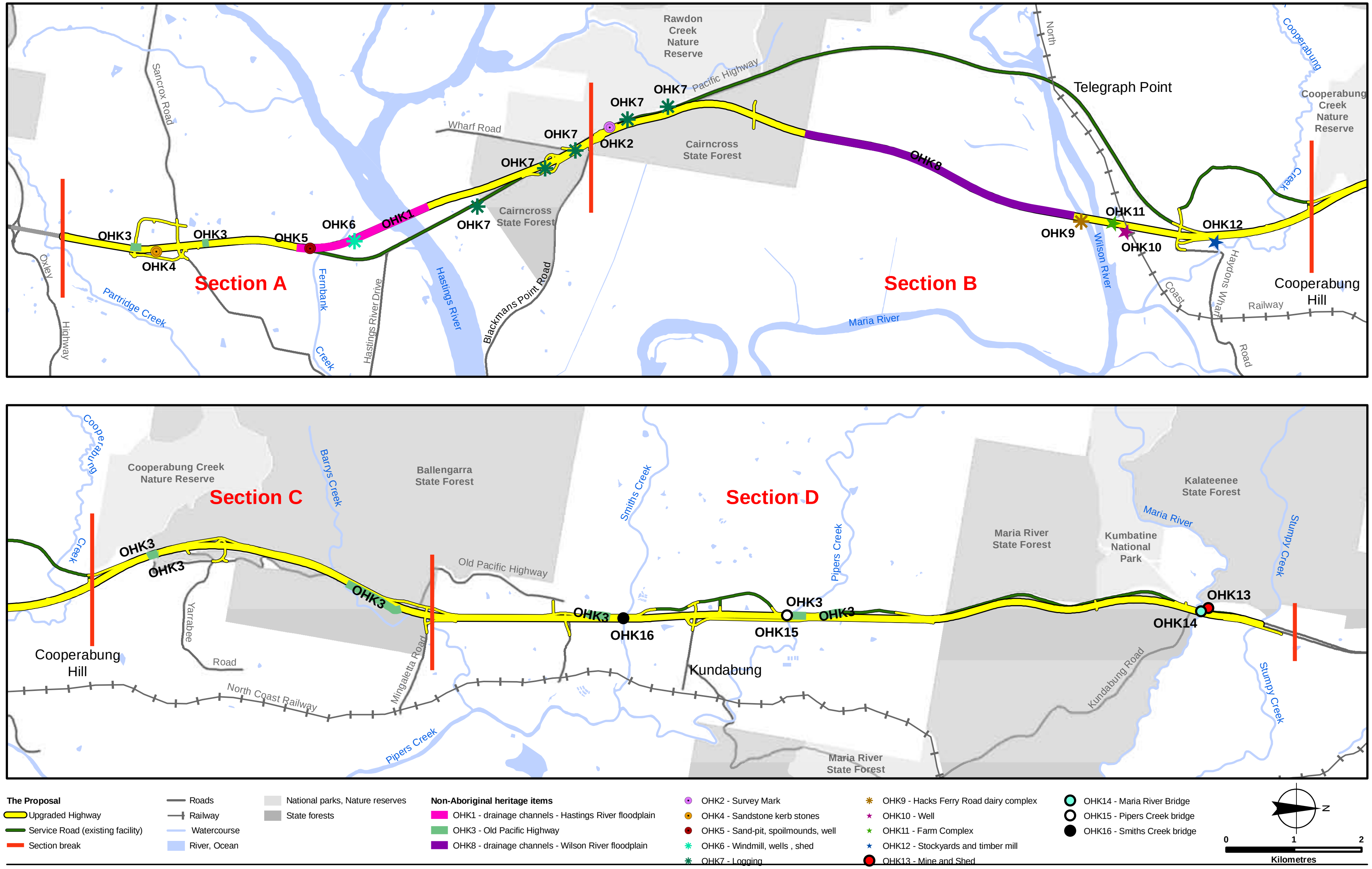


Table 20-1 Potential non-Aboriginal heritage items

Item number/name	Description	Heritage significance	Impact / comment
OHK1 Drainage channels	A number of drainage channels associated with the Hastings River floodplain, forming part of the dairying landscape.	Nil heritage significance. It does not fulfil any criteria for local or State listing and is a common feature contained within a cultural landscape related to farming.	A new alignment of dual carriageway would be constructed in the vicinity of this item. The impacts to these channels from construction would be relatively minor and confined to the width of the highway impact zone (approximate maximum of 80 m) where they cross relatively perpendicular to the channels. Substantial sections of these drains would remain in existence in adjacent pastoral areas.
OHK2 Survey marker	Survey mark ('RD') on a tree stump 15 m east of the existing highway.	Nil heritage significance. It does not fulfil any criteria for local or State listing and demonstrates a method commonly employed by surveyors in rural areas.	This item would be impacted by construction and likely moved or destroyed as a result of construction activities.
OHK3 Old Pacific Highway – various locations.	Remains of the Pacific Highway, sealed sections no longer in use.	Nil heritage significance. It does not fulfil any criteria for local or State listing and is a common feature contained within a cultural landscape related to farming.	Impacts would vary according to location and extent of new construction.
OHK4 Sandstone kerb stones	Eight hand-cut sandstone kerbstones, possibly convict cut. Original location not known.	Local heritage significance. Criterion (a) – moderate. Historical – (potential) evidence from early (convict) road construction. Criterion (c) – moderate. Aesthetic/technical – while not in situ, the stones are in reasonable condition and demonstrate early stone-working skills.	The items are located approximately 20 m from the edge of the proposed upgraded highway and could be impacted. The items could be fenced and left in situ or, if required, they are readily movable and can be relocated. Record of the location of the heritage site would be made to preserve the value of the item.
OHK5 Sand-pit, spoil mounds, well	Sandpit and timber-lined well. Possibly used for highway construction.	Nil heritage significance. It does not fulfil any criteria for local or State listing and is a common feature contained within a cultural landscape related to farming.	The sandpit and timber-lined well are likely to be removed as a result of construction.
OHK6 Windmill, wells, shed	Farrowing shed, timber-lined well and windmill. Some items of farm machinery.	Nil heritage significance. It does not fulfil any criteria for local or State listing and is a common feature contained within a cultural landscape related to farming.	Substantially impacted as infrastructure would be removed.

Item number/name	Description	Heritage significance	Impact / comment
OHK7 Logging – various locations	Tree stumps with springboard cuts used by loggers.	Nil heritage significance. It does not fulfil any criteria for local or State listing and is a common feature contained within a cultural landscape related to farming.	A number of tree stumps would be removed for construction, however some would remain.
OHK8 Drainage channels - Wilson River floodplain	A number of drainage channels associated with the Wilson River floodplain, forming part of the dairying landscape.	Nil heritage significance. It does not fulfil any criteria for local or State listing and is a common feature contained within a cultural landscape related to farming.	The impacts to these channels from construction would be relatively minor and confined to the width of the highway impact zone (approximate maximum of 100 m).
OHK9 Hacks Ferry Road dairy complex	A dairy complex consisting of a house, milking shed, barn, hay shed and feed shed. The barn and feed shed are located within the investigation corridor.	Local heritage significance. Criterion (a) – moderate. Historical – site relates to the development of the dairy industry in this area. Criterion (c) – moderate. Technical – provides a good example of a dairy feed shed. Criterion (e) – little. Archaeological – limited research potential due to continuous use and site disturbance.	Item could be impacted by construction as some infrastructure could be removed. Opportunities to minimise impacts on this item would be explored during detailed design.
OHK10 Well	Timber-lined well, possibly marginally adjacent to investigation corridor.	Nil heritage significance.	Item could be impacted by construction as infrastructure could be removed.
OHK11 Farm complex	New house and shed adjacent to older concrete shed floor, hut platform, well and orchard. Hut platform includes hand-made bricks and is associated with very old fruit trees.	Local heritage significance. Criterion (a) – moderate. Historical – site of early settlement (1895) in this area. Criterion (e) – moderate. Archaeological – likely to contain evidence of early domestic and farming activities.	This site would be removed by construction. Further detailed archaeological assessment would be carried out prior to construction.

Item number/name	Description	Heritage significance	Impact / comment
OHK12 Stockyards and timber mill.	Post and rail stockyards. Scant remains of timber mill including steam engine base. Engine has been removed.	Local heritage significance. Criterion (a) – moderate. Historical – timber has been an important industry in this area since the latter part of the 19th century and responsible for the early settlement of much of this area. This item is indicative of this phase of local history. Criterion (e) – moderate. Archaeological – highly likely that this site contains evidence of the timber industry and the footprint of mill buildings. Stockyards of little significance due to poor condition and modifications.	Item could be impacted by construction as infrastructure could be removed. Opportunities to minimise impacts on this item would be explored during detailed design.
OHK13 Mine and shed	Mine shaft and spoil heap with associated shed.	Nil heritage significance. Item does not fulfil any criteria for local or State listing.	Mine could contain dumped relics, but limited research potential and in poor condition. Item could be impacted by construction as infrastructure could be removed.
OHK14 Maria River bridge	Timber and concrete composite bridge. Original trestle bridge over Maria River. Unique construction method using concrete slab over timber trestles. Recently replaced as the northbound traffic crossing for the Pacific Highway.	Listed on the RTA Section 170 Register as an item of State significance. The bridge is exceptional and probably the first major bridge of its type to be built in Australia. It was a forerunner for the highly successful Doolan Deck System. It is the oldest surviving example of the composite timber and concrete design. Criterion (a) – Exceptional. Historical – earliest of its type in Australia (1954). Criterion (c) – Exceptional. Technical – prototype of concrete slab and timber composite construction. Criterion (f) – Exceptional. Rarity – unique in NSW, first of its type.	This bridge would remain as part of the proposed service road network subject to re-evaluation of its condition during the detailed design phase. Management measures would be implemented to minimise indirect impacts on this item.
OHK15 Pipers Creek bridge	Bridge over Pipers Creek built using concrete piles and beams.	Nil heritage significance. It does not fulfil any criteria for local or State listing and is a common feature contained within a cultural landscape related to farming.	The Proposal would require the removal and replacement of the existing bridge.

Item number/name	Description	Heritage significance	Impact / comment
OHK16 Smiths Creek bridge	Bridge over Smiths Creek built using concrete piles and beams. Remains of timber piles in creek could be from an earlier bridge.	Nil heritage significance. It does not fulfil any criteria for local or State listing and is a common feature contained within a cultural landscape related to farming.	The Proposal would require the removal and replacement of the existing bridge.

Service and access roads

New service and access roads that would be constructed as part of the Proposal have been assessed as part of the upgraded highway as discussed above. Those sections of the service road network that would use existing local roads as shown on **Figure 6-1a** to **Figure 6-1b**, and **Figure 6-2a** to **Figure 6-2q** are assessed below. While no specific archaeological investigations have been undertaken for these service and access roads, some sections are located immediately adjacent to the area of the detailed investigations undertaken for the Proposal. Subject to detailed design these existing local roads could require upgrading to meet the required minimum criteria for service and access roads.

From Fernbank Creek to Haydons Wharf Road half interchange, the existing Pacific Highway would be used as the proposed service road. While some known heritage items and areas of potential heritage have been identified in the vicinity, it is not proposed to upgrade the existing highway and there are no expected impacts to heritage items or places.

Cooperabung Drive would be used to the north of Telegraph Point. Investigations undertaken for the Proposal identified that the only known recorded heritage item is KC Cooper and Sons Sawmill, which is listed on the *Hastings Local Environmental Plan 2001*. The area has some potential for items of heritage significance including evidence of early road building / structures and timber getting activities however the likelihood of such relics is considered low.

At Kundabung the service road network would utilise the existing Rodeo Drive and Ravenswood Road. Investigations undertaken for the Proposal identified that a section of old Pacific Highway (OHK3) occurs at the southern end of Ravenswood Road, however it was assessed and considered to have no heritage significance as discussed in **Table 20-1**.

North of Ravenswood Road, the existing highway would be used as the service road. In this area the landscape is characterised by heavily forested areas including Cairncross State Forest. There are no known sites in the immediate vicinity. It is not proposed to upgrade the existing highway and there are no expected impacts to heritage items or places.

A proposed new access road is required to connect Kemps Road from just north of Maria River to the proposed interchange at the southern limit of the Kempsey to Eungai Pacific Highway upgrade. Investigations undertaken for the Proposal identified that there are no known recorded heritage items in the vicinity. The area has some potential for items of heritage significance including evidence of early timber getting activities however the likelihood of such relics is considered low.

Staging implications

Consideration has been given to the potential non-Aboriginal heritage impacts of the possible staging option described in **Section 7.3.2**, in comparison to the construction of the entire Proposal to a full motorway standard.

In this regard, both the possible staging option and motorway standard upgrade would traverse or adjoin some areas or items with non-Aboriginal heritage value. While there would be two separate construction periods associated with the adoption of this staging option, it is considered that there would be no new or additional impacts on any of these non-Aboriginal heritage areas or items.

Potential impacts on non-Aboriginal heritage would be managed in accordance with the measures outlined in **Section 20.2.4**, for both this staging option and the motorway standard upgrade.

Should the Proposal be delivered in stages, the staging report described in **Section 7.3.3** would detail the non-Aboriginal heritage impacts of the staging option. If any additional or altered impacts are identified, the staging report would further assess these impacts and identify appropriate management measures.

20.2.4 Management measures for non-Aboriginal heritage

The following management measures would be implemented:

- All personnel working onsite would receive training in their responsibilities under the *Heritage Act 1977*. Site-specific training would be given to workers when working in the vicinity of identified heritage items.
- Where heritage items are not directly impacted, care would be taken to not disturb them. This would include briefing of the construction works team to protect such assets during the construction phase, minimising access and clear delineation of items including fencing and signage, which would be provided where necessary in consultation with a heritage specialist. Identified heritage items would be clearly marked on construction plans.
- An education program would be undertaken for construction personnel on their obligations for historic relics.
- Item OHK4 (sandstone kerb stones): Temporary fencing, signage or equivalent would be installed prior to construction taking place in the vicinity of the items. Alternatively, these items would be relocated to a safe storage place prior to construction following, if required, archaeological assessment and recording.
- OHK9 (Hacks Ferry Road dairy complex) and OHK12 (stockyards and timber mill): Opportunities to minimise impacts on these items would be explored during detailed design.
- Item OHK11 (farm complex): An archaeological hand excavation would be undertaken of the hut platform prior to construction commencing. Further detailed archaeological assessment of any associated features with research potential identified in the immediate vicinity would be carried out prior to construction commencing.
- Item OHK14 (Maria River bridge): Construction techniques and environmental management measures would be developed and implemented for construction activities in the vicinity of the bridge. This would include the management of vibration from construction activities. Relevant employees and contractors would be informed of the nature and location of the item and advised of the techniques to be used to avoid impacts on the item.
- In the event new heritage items are discovered during construction, all work that could impact the item would cease in the immediate vicinity until an appropriate assessment can be conducted.

20.3 Geology and soils

Geotechnical investigations have been carried out in the Proposal area with the aim of providing technical information on the prevailing ground conditions, to assist with route selection and concept design and to identify any potential geotechnical issues for this Environmental Assessment.

20.3.1 Methodology for geology and soils assessments

The geotechnical investigations comprised:

- Review of existing information.
- Geological and geomorphological mapping.
- Drilling boreholes.
- Excavating test pits.
- Cone penetration testing.
- Seismic refraction traverses.
- In situ testing.
- Sampling of soils, rock and groundwater.
- Geotechnical laboratory testing.

20.3.2 Existing geological and soil conditions

Topography

The Proposal area comprises two distinct landforms. In the south, the Proposal crosses low-lying alluvial floodplains, varying from gentle to steep grades. In the north, the topography comprises ridgelines and hills with steeper gradients and higher elevations.

The two main floodplains are associated with the Hastings River (Section A) and the Wilson River (Section B). Sections A and B also contain gentle to very gentle undulating hills with elevation generally less than 30 metres above sea level.

Section C contains the main ridges and hills in the Proposal area, with the topography comprising steeper gradients and higher elevation. These landforms are associated with Cooperabung Hill where elevation ranges up to 166 metres above sea level.

Topography in Section D comprises the undulating hills and elevated land surrounding the Maria River. Smaller flood plains associated with the tributaries of the Maria River are also located in this section.

Geology and soils

The investigations carried out for the Environmental Assessment revealed that the geology of the Proposal area comprises marine sedimentary rocks of the Tamworth Forearc Basin and Banard Basin, together with unconsolidated quaternary sediments deposited on the Hastings and Wilson river floodplains.

The floodplains are characterised by isolated and mixed deposits of sand, silt and clay underlain by siltstone, and fine to medium grained sandstone and mudstone. The alluvial deposits in these areas extend up to 15 metres or more below ground level. Palaeochannels appear to be located below the southern floodplains of both the Hastings and Wilson rivers and consist of sands and gravels up to 10 or more metres thick.

The ridgelines and hills are typically characterised by hard residual clay and silty clay underlain by siltstone, and fine to coarse-grained sandstone and mudstone. The thickness of the soil in these areas ranges from approximately 0.5 to 5 metres deep.

Testing carried out on soils that are likely to be exposed during the construction of the Proposal indicate that they would be prone to wind erosion.

Acid sulfate soils

Acid sulfate soils are sediments deposited under estuarine conditions (ie close to sea level) and contain the sulphide mineral pyrite. As long as acid sulfate soils are not disturbed or drained, these materials are relatively harmless and are termed potential acid sulfate soils. However, if the sediments are exposed to air, the pyrite could be oxidised and generate sulfuric acid. When the rate of acid production exceeds the neutralising capacity of the parent material acid sulfate soil is formed. The acid discharge could impact the surrounding environment which could result in impacts on activities associated with watercourses and land such as aquaculture enterprises and farming activities.

Acid sulfate soils:

The potency of acid sulfate soil is measured in H^+ per tonne soil. The higher the number, the more acidic the soil and the greater the potential impacts.

Acid sulfate soil or acidic soil has been identified in the upper 1 metre of soil across the Hastings and Wilson river floodplains at concentrations exceeding the NSW *Acid Sulfate Soil Manual* (Stone, Ahern and Blunden 1998) action criterion.

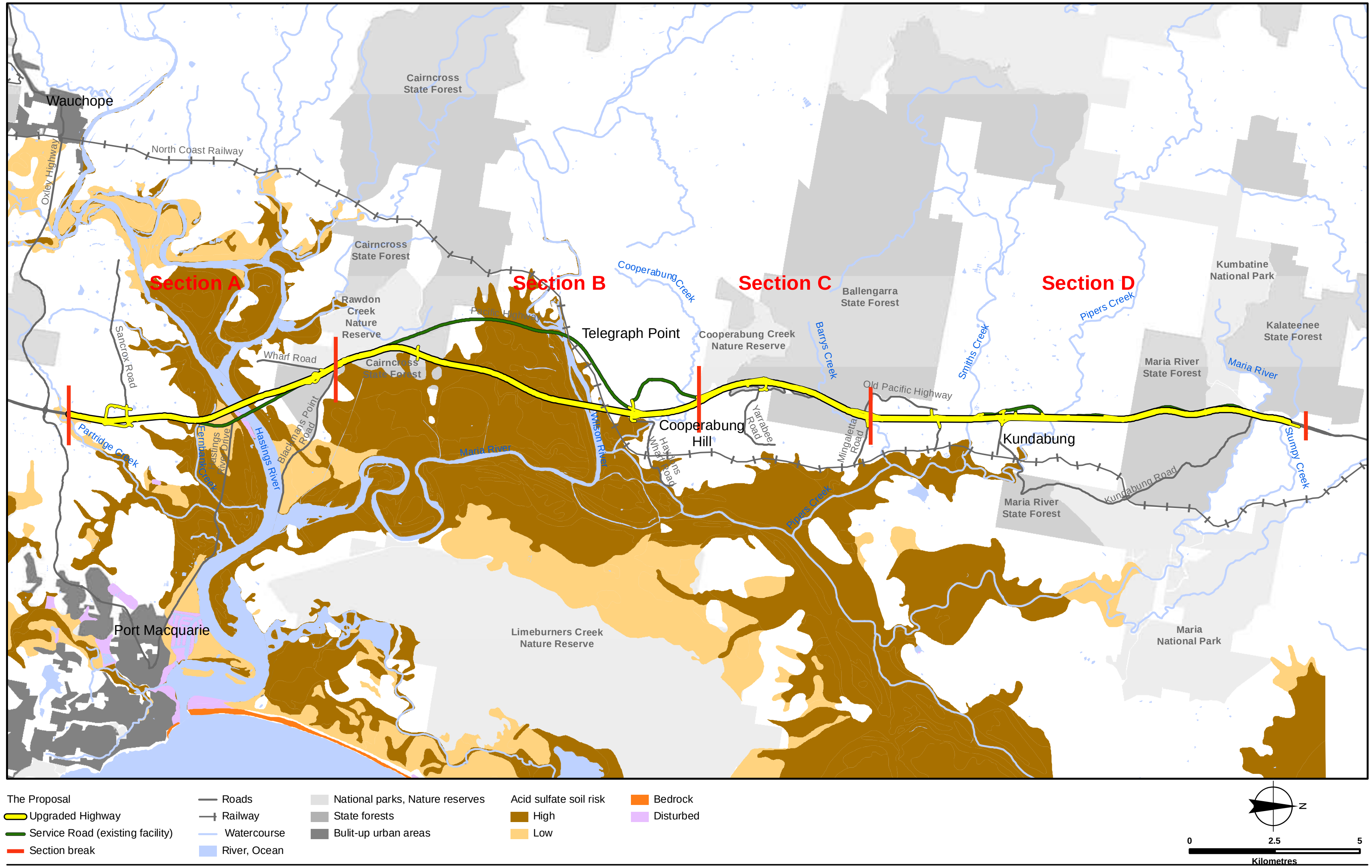
A review of acid sulfate soil risk mapping indicates a high probability for the presence of potential acid sulfate soil and acid sulfate soil in several areas along the route of the Proposal including:

- In the low lying areas on the floodplain between Fernbank Creek and the Hastings River. Acid sulfate soil could exist either within 1 metre of the ground surface or between 1 to 3 metres of the surface. This poses a potential risk of pollution as a result of disturbance.
- On the alluvial floodplains and low-lying swamp area between Blackmans Point Road and Bill Hill Road. Acid sulfate soil could exist within 1 to 3 metres of the ground surface.
- In the alluvial plains, alluvial levee, alluvial swamps and estuarine swamps on the floodplain to the south of the Wilson River. Acid sulfate soil could generally be greater than 2 metres below the ground surface.
- In the estuarine swamp on the floodplain to the north of the Wilson River. Acid sulfate soil could be within 1 metre of the ground surface. This poses a potential risk of pollution as a result of disturbance.
- Adjacent to the existing alignment of Cooperabung Creek directly north of Haydons Wharf Road.

Figure 20-2 illustrates the acid sulfate soil risk along the Proposal.

Sections C and D, around Cooperabung Hill, Kundabung and Maria River State Forest are described as having no known occurrence of acid sulfate soil.

Figure 20-2 Acid sulfate soil risk along the Proposal route



Acid sulfate rock

Some rocks contain sulfate minerals that when exposed to air can cause the generation of weak acidic solutions in a similar way to the acid sulfate soil discussed above. A large amount of sulfate minerals needs to be present in the rock and those minerals need to be exposed to the air for acid generation to occur. The rate of acid generation from rock is much slower than that from acid sulfate soil. No acid sulfate rocks have been identified in the Proposal area.

Soft soils

> **Soft soils**
>
> Soft soil is described in construction terms as having limited resistance to load, and is weak in terms of supporting structures such as buildings or roads.

The Proposal would traverse deep alluvial materials within the Hastings and Wilson river floodplains, in addition to shallow alluvial materials at Fernbank Creek, Cooperabung Creek, Smiths Creek, Pipers Creek and Maria River. Geotechnical investigations indicate that the depth of alluvium within the shallow creek crossings would be less than 5 metres below ground surface. Investigations across the Wilson River floodplain indicate the depth of the alluvium varies between 2 to 8 metres while the depth of the alluvium in some areas of the Hastings River floodplain is in excess of 15 metres deep.

Cooperabung Creek is expected to contain relatively shallow alluvium with a low potential for soft soil. The Proposal would traverse alluvium material at Fernbank Creek, Smiths Creek, Pipers Creek and Maria River. These areas are not expected to contain soft soils.

Figure 20-3 illustrates the location of soft soils present in the Proposal area.

20.3.3 Impacts of changes to surface and subsurface conditions

Hillsides

The Proposal would cross several small hillsides as well as the larger Cooperabung Hill. The construction of embankments on hillsides could cause changes in the subsurface soils conditions if not properly managed. These changes have the potential to lead to instability in an embankment, and the soils below, as a result of the increased stress from the embankment. This could lead to the disturbance of the natural drainage pattern within the soil. These changes could be problematic in areas where natural springs, soaks or colluvium soils exist.

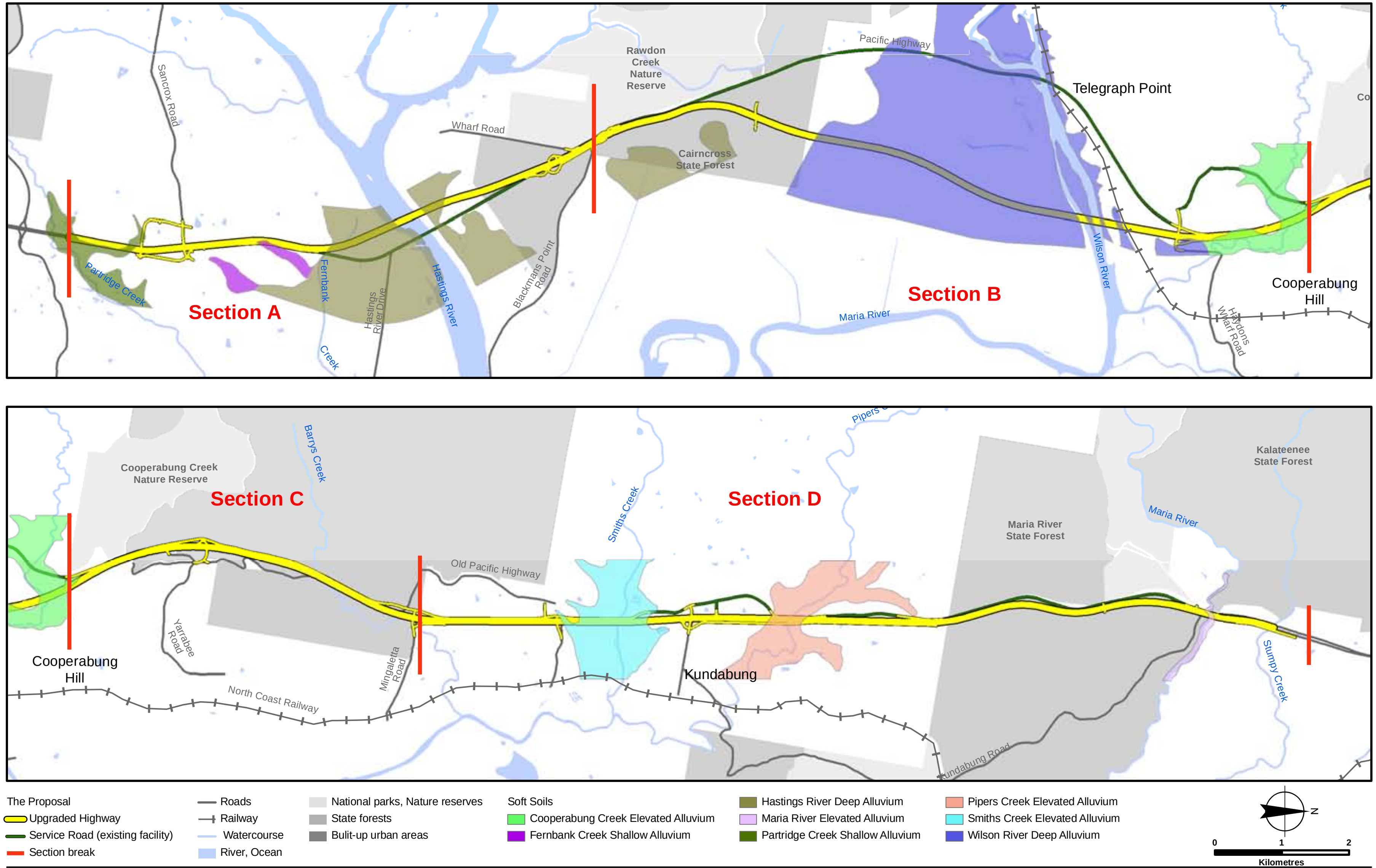
Cut slopes

The Proposal includes a number of cuttings to be excavated into hillsides and ridges. The larger cuttings would be located in the Cooperabung Hill and the Maria River State Forest. The material exposed in the cuttings would include hard rock and soil material with prominent jointing. Potential impacts to the stability of the slopes, and the underlying soils could occur if drainage patterns are interrupted.

Erosion

Soils and weak weathered rock could be at risk of erosion and sedimentation if not protected from the effects of concentrated flowing water or strong winds. Erosion, if not prevented, could lead to instability of cuts or fill slopes, and the transport of weathered material into adjoining watercourses. The eroded material could block drains or if allowed to escape into the environment, cause sedimentation and increase turbidity in nearby watercourses (refer to **Chapter 13 Water quality**).

Figure 20-3 Soft soils along the Proposal route



Acid sulfate soils

Road construction activities can result in the exposure of potential acid sulfate soil to air if either the water table is lowered or if potential acid sulfate soil is excavated from below the water table.

Port Macquarie-Hastings Council considers acid sulfate soil as a key management issue for the Hastings River. This is detailed in the *Port Macquarie-Hastings Estuary Management Plan* (Port Macquarie-Hastings Council 2001). Within this region, oxidation of acid sulfate soil has been accelerated through floodplain drainage works in the past and several acidification episodes have been recorded with pH (acidity) of the river as low as 2.0 (February 1992, Maria River).

The past discharge events have had impacts on the health and productivity of the estuary including fish kills, loss of oyster production, reduced spawning success and changes in habitat. The Hastings River, Wilson River and Fernbank Creek would be considered high risk for acid sulfate soil with the potential to produce acid discharge.

In the Hastings River, Fernbank Creek, Wilson River and Cooperabung Creek areas, the Proposal would require the construction of embankments across the floodplain and low lying areas as well as bridges and culverts across watercourses. There is the potential to disturb potential acid sulfate soils in these areas, and acid could leach into the ground or surface waters. Spoil material generated by excavation in these areas would be managed and treated to reduce the acid sulfate soil. A treatment regime and management plan is required for any disturbed soils in these areas.

Particular attention would need to be given to acid sulfate soil adjacent to Hastings River and Fernbank Creek, particularly where the water table is between 0 and 3 metres below the surface. At these locations there is environmental risk if acid sulfate soil is disturbed by construction works. Acid sulfate soil around the Hastings River could also impact other aspects of the local environment such as oyster leases, mangroves, and seagrasses adjacent to and within the river.

Disturbance of potential acid sulfate soil adjacent to the Wilson River would also be an environmental risk with potential impacts on mangroves and State listed wetlands.

Soft soils

The crossing of the Hastings and Wilson river floodplains, where there is deep alluvial material, is likely to require major embankments with specific foundation treatments required in areas of soft soil. Embankment heights could also be locally higher at the locations of possible interchanges and traffic arrangements (due to on-ramps and off-ramps and overbridges), watercourse crossing approaches and where larger culverts are required. The design of higher embankments in areas of soft soil would require detailed geotechnical assessment.

As Cooperabung Creek is expected to contain relatively shallow alluvium with a low potential for soft soils, conventional embankment construction would be likely within this area.

Embankments would traverse alluvium material at Fernbank Creek, Smiths Creek, Pipers Creek and Maria River. These areas are not expected to contain soft soils, and given the shallow depth of alluvium expected in these areas, conventional embankment construction would be likely.

Both the shallow creek and alluvial areas contain waterlogged ground as evidenced by the prominence of Melaleuca forests and grassed swamps. Bridging layers are likely to be required to cross the alluvial plains. Residual soil areas could also be seasonally waterlogged in the vicinity of drainage gullies and basins.

20.3.4 Management of impacts

Hillsides

Where construction of the Proposal involves cutting through hillsides, bank stabilisation would be undertaken at the earliest time to limit the potential for instability. Sub-surface drainage would be designed to suit local conditions. Drainage could be provided in the form of a rock fill drainage blanket (for sub-surface springs), trenches or pipe drains.

Cut slopes

Cut slopes would be finalised at the detailed design stage. The slope of the cuts would be varied to suit local conditions, and would range in ratio typically of 2:1 (2 metres horizontal to 1 metre vertical) to 4:1. These are referred to as batter ratios. Depending on the depth and width of the cuts through the slopes, more than one batter could be required, and the ratios would be varied. A flat bench could be provided in between multiple batters.

In some areas of instability, batters alone may not be sufficient to provide stability. In these areas measures such as rock bolting, wire mesh or shotcrete could be required. In areas where road reserve widths are narrow, such as in areas around interchanges and traffic arrangements, retaining structures could be utilised. The form of the retaining structures would be determined at the detailed design stage, and would include reinforced earth walls, gabion walls, crib walls and other forms of retaining walls. Detailed design would be undertaken in accordance with *RTA Guidelines R44 Earthworks* (RTA 2009) and *RTA Shotcrete Design Guideline* (RTA 2006d).

Erosion

The potential for erosion during the construction of the Proposal would be appropriately managed in accordance with the measures contained within *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and *Managing Urban Stormwater: Soils and Construction Volume 2D, Main Road Construction* (DECC 2008b).

All management of construction would be undertaken in accordance with RTA guidelines, including *RTA QA Specification G38 Soil and Water Management (Soil and Water Management Plan) (*RTA 2004b). Further details on proposed management measures are provided in **Chapter 13 Water quality**.

Acid sulfate soil

The potential engineering and environmental issues associated with the construction of a new road on acid sulfate soil materials have been considered during the development of the concept design for the Proposal. These issues would be further examined during the development of the detailed design and environmental management measures implemented during construction. The simplest management of acid sulfate soil would be avoidance and minimisation of disturbance to areas where there is a known potential for acid sulfate soil.

During the initial works onsite, further testing of soils for acid sulfate soil or potential acid sulfate soil across the floodplains would be undertaken to quantify the risk of disturbing acid sulfate soils with a particular focus on any excavations.

Where disturbance of these soils is unavoidable, an acid sulfate soil management plan would be developed in accordance with the *Acid Sulfate Soils Manual* (Stone, Ahern and Blunden 1998) prior to construction to address excavation, disturbance and dewatering during construction works on the floodplains of the Wilson, Maria and Hastings rivers to prevent release of acidic water from construction activities entering these watercourses.

Soft soils

Table 20-2 outlines the locations of soft soils, and the proposed treatments for these areas.

Table 20-2 Proposed treatments of soft soils

Location	Embankment height (m)	Likely settlement	Potential treatments
South floodplain, Hastings River	Heights would range from 2.8 m at the commencement of the embankment to 8 m at the bridge abutment.	100 mm – 320 mm	Preloading and wick drains. Also timber piling in vicinity of bridge abutment.
North floodplain Hastings River	Heights would range from 4.1 m to 5.2 m at the bridge abutment.	170 mm – 790 mm	Preloading and wick drains. Also timber piling in vicinity of bridge abutment. Northern floodplain embankment could require piling.
South floodplain Wilson River	Heights would range from 3.3 m at the commencement of the embankment to 8.5 m at the bridge abutment.	200 mm – 780 mm	Preloading and wick drains. Also timber piling in vicinity of bridge abutment.
North floodplain Wilson River	12 m at the bridge abutment.	Not known	Excavate soft soils and replace.

The final height of fill over the Hastings and Wilson river floodplains and areas of soft soils would be dependant upon further flood studies to be undertaken at the detailed design stage. Design would be in accordance with the *RTA Specification G38 Soil and Water Management (Soil and Water Management Plan) (*RTA 2004b).

20.4 Contamination

20.4.1 Methodology

A preliminary assessment of land contamination was undertaken to determine the potential for the Proposal to intersect areas with significant contamination issues. The assessment included:

- Review of topographic maps.
- Review of historical and current aerial photographs (1965, 1979 and present).
- Review RTA, Council, and former Department of Agriculture records.
- Site investigation of the Proposal alignment.

20.4.2 Existing environment

A desktop assessment of the potential for contaminated land along or adjacent to the Proposal was undertaken during the development of the concept design. This assessment identified potential contamination that could be the result of historical land uses and activities. The assessment identified the potential for ground contamination and the likely contaminants that could be encountered during the detailed design and construction phases. The locality and types of contamination at these sites are shown in **Table 20-3**.

Some areas not assessed include state forests, residential dwellings, small hobby farms and larger farms primarily used for grazing. It is expected that at these sites any contamination would be minor and not significantly impact the construction of the Proposal. There are no known tick dip sites within or adjacent to the Proposal.

20.4.3 Impacts resulting from potential contamination

Table 20-3 identifies specific locations that have the potential to be contaminated, and identifies the potential impacts of the Proposal.

Table 20-3 Potential contaminated sites and impacts

Locality	Land use	Potential contamination type	Potential impact / comment
Orchard Between Bushland Drive and Pacific Highway	Agricultural	Arsenic, pesticides and herbicides	Western portion of site lies within the Proposal boundary and could be disturbed.
Industrial spares parts business Sancrox Road, on the western side of the existing highway	Industrial/ Commercial	Hydrocarbons from petrochemicals	Western portion of site lies within the Proposal boundary and could be disturbed.
RTA Depot Fernbank Creek Road, Sancrox, on the eastern side of the existing highway	Industrial/ Commercial	Hydrocarbons from petrochemicals	Eastern portion of site used for parking lies within the Proposal boundary and could be disturbed.
North of Fernbank Creek Road, Sancrox, on the eastern side of the existing highway	Agricultural	Pesticides and herbicides	Western portion of site lies within the Proposal boundary and could be disturbed.
Sand mining Southern side of the Hastings River	Industrial	Hydrocarbons from petrochemicals	Would not be impacted.
Slipway Southern side of the Hastings River	Industrial/ Commercial	Heavy metals and hydrocarbons from petrochemicals	Would not be impacted.
Dairy Southern side of Hacks Ferry Road to the east of the existing highway	Agricultural	Pesticides and herbicides	Would not be impacted.
Aquaculture Adjacent to Cooperabung Creek, Cooperabung, on the eastern side of the existing highway	Agricultural	Pesticides and herbicides	Western portion of site lies within the Proposal boundary and could be disturbed.
Possible aquaculture Along Rodeo Drive, Kundabung, on the western side of the existing highway	Agricultural	Pesticides and herbicides	Would not be impacted.
Chicken farm Along Ravenswood Road, Kundabung, on the western side of the existing highway	Agricultural	Pesticides and herbicides	Would not be impacted.

Locality	Land use	Potential contamination type	Potential impact / comment
Service station Along Ravenswood Road, Kundabung, on the western side of the existing highway	Industrial/ Commercial	Hydrocarbons from petrochemicals	Would not be impacted.

Based on the above assessment, it is considered that the potential risks to human health and the environment as a result of encountering contaminated soils during the construction of the Proposal is low due to:

- The low potential for contaminants of concern being identified during construction works.
- The proposed change in land use along the Proposal would be to a less sensitive use (eg from rural to road).

20.4.4 Management of potential contamination impacts

Targeted soil contamination investigations would be carried out in some areas during the detailed design phase. Only those areas likely to be disturbed by excavation would be subject to further investigation. This investigation would be carried out with reference to the relevant DECCW guidelines.

Where site contamination is confirmed, the appropriate management measures would be developed in accordance with the RTA's Environmental Management Policy, *Contaminated Land Management Act 1997* and the relevant DECCW guidelines. If contamination is found to pose an unacceptable risk to either humans or the environment, a remedial action plan would be developed and remediation works would take place in consultation with DECCW.

20.5 Waste

Construction and operation of the Proposal would generate various waste streams. Disposal of wastes is regulated by the *Waste Avoidance and Resource Recovery Act 2001.* This Act establishes a hierarchy of waste management (avoid, recover, dispose) encouraging efficient use of resources and minimising waste.

The *Waste Avoidance and Resource Recovery Strategy* (DEC 2007b) provides guidance to key groups within NSW regarding the minimisation of environmental harm from waste disposal and through the conservation and efficient use of resources.

Waste generating activities during construction include earthworks, drainage, clearing, restoration works, maintenance, refuelling and litter. Wastes typically fall into a number of key streams including but not limited to, soil and rock, wastewater, sewerage from site compound, litter, fuels and oils.

Where practicable, wastes would be re-used onsite. Where this cannot occur, alternatives such as disposal or use offsite would be considered.

20.5.1 Potential impacts

Construction

Some of the potential waste material generated during the construction of the Proposal would include:

- Excess excavated material, including soils and rock.
- Vegetative matter (green waste) produced during clearing operations prior to and during construction.
- Demolition waste from pavements and structures (including asphalt, concrete and road base).
- Construction materials (including concrete, road base, steel and timber).
- Packaging materials (eg cardboard and plastics).
- Liquid wastes (eg waste fuels, oils and chemicals).
- Wastewater from dewatering activities.
- Sewage effluent from the site compounds.
- General putrescible waste and recyclable materials from site compounds.

Operation

A small quantity of waste would be generated by road maintenance and repair activities. These wastes would include vegetation trimmed from remnant vegetation and landscaped areas, asphalt from pavement repairs, and oils and greases from maintenance vehicles. Road users would also generate litter along the highway and at rest areas.

Staging implications

Consideration has been given to the potential waste impacts of the possible staging option described in **Section 7.3.2**, in comparison to the construction of the entire Proposal to a full motorway standard.

There would potentially be an increase in resource use and waste generation associated with two separate construction periods, including the need for possible relocation, replacement or upgrade of some infrastructure such as fauna exclusion fencing and drainage infrastructure. However, the waste management measures discussed in **Section 20.5.2** would be implemented for both this staging option and ultimate motorway standard upgrade.

Should the Proposal be delivered in stages, the staging report described in **Section 7.3.3** would detail the waste impacts of the staging option. If any additional or altered impacts are identified, the staging report would further assess these impacts and identify appropriate management measures.

20.5.2 Management of waste impacts

Management measures that would be implemented to minimise waste impacts would include:

- Waste material generated onsite would be classified and managed in accordance with the *Protection of the Environment Operations Act 1997*.
- Waste minimisation and management measures would be developed and implemented during construction. The measures would be developed based on the principles of the waste management hierarchy referred to in the *Waste Avoidance and Resource Recovery Act 2001* and the NSW Government's *Waste Reduction and Purchasing Policy*. Procedures would be developed to avoid, minimise, reuse/recycle, treat or dispose of waste streams during construction and would cover transport and disposal arrangements, including suitable facilities for: segregation of recyclable wastes; storage of waste; and monitoring of waste control measures.
- The use of recycled products in construction works would be investigated.
- The construction contractor would be required to re-use materials, where feasible. This would include the re-use of material collected onsite (eg re-use of concrete formwork, use of surplus concrete pours for pavements).
- Training in waste minimisation principles and measures would be provided as part of site inductions.
- Containers for litter and other wastes would be provided, with contents to be disposed of offsite at a suitable waste disposal station on a regular basis.
- Chemical, fuel and lubricant containers and solid and liquid wastes would be disposed of in accordance with DECCW requirements.
- A waste register would be maintained, detailing types of waste collected, amounts, date/time and details of disposal.
- Regular visual inspections would be conducted to ensure that work sites are kept tidy and to identify opportunities for reuse/recycling.

20.6 Hazards

20.6.1 Potential hazards

Environmental

The environmental risk analysis presented in **Chapter 9 Environmental risk analysis** identified a number of potential environmental hazards during the construction and operation of the Proposal. These hazards and their associated risk have been addressed in a number of different sections within this Environmental Assessment. For example flooding risk is discussed in **Chapter 12 Hydrology**, traffic safety issues are discussed in **Chapter 18 Traffic and transport**, the risks associated with impacts on water quality are discussed in **Chapter 13 Water quality** and the risk of impacts on threatened flora and fauna is discussed in **Chapter 15 Flora and fauna**.

Human health

The potential hazards and risks to human health during the construction of the Proposal include:

- Possible injury of construction or maintenance staff.
- Possible collision with construction or maintenance vehicles and equipment.

- Possible contact with hazardous materials.
- Possible spills of hazardous materials.
- Possible bushfire event endangering life and property.

There are also potential hazards and risks associated with vehicle crashes and other incidents during operation of the upgraded highway.

20.6.2 Hazard management and safeguards

Environmental

Hazards and risk management plans would be prepared and implemented as part of the construction environmental management plan. These plans would include:

- Details of the hazards and risks associated with the construction activities.
- Management measures including those identified in this Environmental Assessment.
- Contingency plans as required.

Human health

A site-specific safety management plan along with safe work method statements would be prepared and implemented to apply to all construction personnel and site visitors. The plan would identify hazards associated with work on the site and the hazard control measures or controls to be implemented to ensure that people are adequately protected from risk of injury or illness, including:

- Procedures to comply with all legislative and industry standard requirements for the safe handling and storage of hazardous substances and dangerous goods.
- Procedures for manual handling of heavy loads.
- Procedures to minimise risk of ignition of a bushfire and for response to a bushfire event.

In addition, legislative occupational health and safety requirements would be met.

Emergency services

The RTA has a well-developed framework for managing risk associated with highway incidents. The RTA holds memoranda of understanding with the NSW Fire Brigade and the NSW Police Service in relation to emergency response. Consultation with the Rural Fire Service and emergency services regarding access requirements would continue during the detailed design phase.

As discussed in **Section 6.4.11**, combined emergency crossover and U-turn facilities are proposed to allow U-turns by the RTA, police and emergency vehicles and for diversion of traffic to the opposing carriageway in the case of an emergency.

20.7 Greenhouse gas assessment

20.7.1 Assessment approach

The Proposal would generate greenhouse gases during both the construction and operation phases, and would result in greenhouse gas savings during the operation phase brought about through improved travel efficiencies, in particular for heavy vehicles.

This greenhouse gas assessment has considered all relevant sources of greenhouse gases to estimate the overall greenhouse gas impact / benefit of the Proposal, and identifies management measures to further reduce greenhouse gas generation.

Methodology

The greenhouse gas assessment for the Proposal was conducted with reference to:

- *The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard* developed by the World Resources Institute and World Business Council for Sustainable Development (2001).
- The Department of Planning's Draft Guidelines *Energy and Greenhouse in EIA,* (Department of Planning 2002; formerly known as the Department of Infrastructure, Planning and Natural Resources and Department of Energy).
- The Federal Department of Climate Change *National Greenhouse Accounts Factors*, (DCC 2009).

The Department of Planning's Draft Guidelines *Energy and Greenhouse in EIA* indicate two possible levels of assessment:

- Level 1 assessment – a simplified assessment based on a limited number of energy sources and generation potential.
- Level 2 assessment – a more detailed assessment including a larger range of possible emissions including 'upstream' and 'downstream' emissions.

A level 2 assessment was undertaken for the construction and operation of the Proposal and considered a range of emissions and energy use associated with:

- Extraction and processing of major construction raw materials, such as aggregate, concrete, steel and bitumen.
- Transportation of major construction materials from their extraction and processing locations to the Proposal.
- Fuel use by plant and equipment during the construction phase.
- Removal of vegetation.
- Electricity imported from the grid during the operation of the Proposal (eg for highway lighting).
- Fuel consumed by vehicles using the upgraded highway during the operation phase.

The greenhouse gases considered in the assessment include carbon dioxide, nitrous oxides and methane. The Proposal is unlikely to store or generate any perfluorocarbons and sulfur hexafluoride, and would use negligible quantities of hydrofluorocarbons for refrigeration during construction. These gases have therefore been excluded from the assessment.

Emissions scope

Scope 1, 2 and 3 emissions are defined in the *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (World Resources Institute and World Business Council for Sustainable Development 2004). The concept of scope 1, 2 and 3 emissions has been carried over into Australian publications, such as those produced by the Department of Climate Change and the draft guidelines that are applicable to the greenhouse gas assessment for this Proposal. These guidelines specifically require emissions to be expressed in terms of Scope 1, 2 and 3.

For this assessment, the scopes are defined as follows:

- Scope 1 – emissions created directly by a person or business from sources that are owned or controlled by that person or business.
- Scope 2 – emissions created as a result of the generation of electricity, heating, cooling or steam that is purchased and consumed by a person or business. These are indirect emissions as they arise from sources that are not owned or controlled by the person or business that consumes the electricity.
- Scope 3 – emissions that are generated in the wider economy as a consequence of a person or business's activities. These are indirect emissions as they arise from sources that are not owned or controlled by that person or business but they exclude Scope 2.

20.7.2 Greenhouse gas impacts during the construction phase

The major sources of greenhouse gas emissions associated with the Proposal during the construction phase would be:

- Fuel used by construction plant and equipment.
- Vegetation clearance.
- Embodied emissions in construction materials.
- Transportation of materials to the construction site.

The assumptions and emission factors used to calculate the emissions associated with these potential sources are provided in the following sections.

The following emission sources were considered negligible compared to the overall construction related emissions and were not included in the assessment:

- Minor construction materials.
- Waste generated during construction.
- Electricity consumed in site offices during the construction period.
- Changes to traffic arrangements during construction.
- Revegetation activities during or following construction.
- The consumption, treatment and disposal of water and wastewater during construction.
- The maintenance of construction vehicles and machinery and the use of oils, grease, lubricants and replacement parts.
- The manufacturing of construction plant and equipment and their transportation to site given that the life of construction plant and equipment is significantly greater than the time for which they will be required for construction of the Proposal.

Fuel use by construction plant and equipment

The greenhouse gas assessment undertaken for the *Upgrading the Pacific Highway Banora Point Environmental Assessment* (RTA 2008) developed an average fuel consumption per kilometre of road constructed based on the average fuel consumption from other Pacific Highway Upgrade Program projects.

An average fuel consumption of 481 kilolitres of diesel fuel per kilometre was determined and it was assumed this would comprise close to 100 per cent diesel-fuelled plant and equipment, due to the nature of the works. This average fuel consumption factor was adopted in this assessment to estimate fuel consumption from construction of the Proposal.

Greenhouse gas emissions associated with fuel consumption were estimated by multiplying the total estimated fuel consumption by the current *National Greenhouse Accounts Factor* (DCC 2009) for diesel emission factors (scope 1 = 2.698 tonnes $CO_{2\text{-}e}$ per kilolitre and scope 3 = 0.205 tonnes $CO_{2\text{-}e}$ per kilolitre).

Based on the approximately 37 kilometre length for the Proposal, it is estimated that approximately 18,000 kilolitres of diesel fuel would be consumed during construction. This would result in the generation of an estimated 52,300 tonnes $CO_{2\text{-}e}$.

Carbon dioxide equivalent ($CO_{2\text{-}e}$):

$CO_{2\text{-}e}$ is an abbreviation of 'carbon dioxide equivalent' and is the internationally recognised measure of greenhouse emissions. There are many types of greenhouse gases and each of these gases has a different capacity to heat the atmosphere. Using $CO_{2\text{-}e}$ as a measure of greenhouse emissions allows a comparison of the greenhouse impact of a variety of greenhouse emissions sources.

Vegetation clearance

Clearing vegetated areas for the Proposal would result in a number of changes in the biomass of the area, and in turn result in the emission of greenhouse gases to the atmosphere. To assess the greenhouse gas emissions generated as a result of vegetation clearance for the construction of the Proposal, the type and extent of the current vegetation cover was identified from the ecological assessment in **Chapter 15 Flora and fauna**.

Forest biomass in the Proposal area was determined by estimating above ground biomass surface using the *National Carbon Accounting System* and *Full Carbon Accounting Model* (Department of Climate Change 2009). Below ground biomass was then estimated for each of the forest vegetation types identified in **Table 20-4** based on below ground allocation proportions presented in *Greenhouse Gas Emissions From Land Use Change in Australia* (Table 8) (Australian Greenhouse Office 2003).

For the purpose of this assessment only those areas that meet the Australian definition of a forest for emissions accounting purposes have been included in this assessment. A forest is defined as woody trees with a minimum potential height of 2 metres, a minimum canopy cover of 20 per cent and occurs in patches greater than 0.2 hectares. On the basis of this definition, pasture, cropland, gardens and wetlands were excluded from the assessment.

For simplicity it was assumed that all biomass affected by the Proposal would be immediately oxidised to carbon dioxide. This may result in overestimation of emissions if some of the biomass were to be converted to a relatively inert form such as char through combustion. This assumption may also result in underestimation if some of the biomass were to reach a landfill where it could result in the production of methane. However, given the majority of native vegetation to be cleared would be re-used as part of the habitat rehabilitation for the Proposal, I immediate conversion to carbon dioxide was considered to be the most appropriate approach.

It has also been assumed that all vegetated areas to be cleared by the Proposal would be permanently converted to non-forest land use. As the Proposal includes a comprehensive program for revegetation and rehabilitation of impacted areas, this assessment would tend to overestimate the potential emissions.

Table 20-4 Greenhouse gas emission estimates from proposed vegetation clearance

Vegetation type	Hectares cleared	Vegetation classification	Tonnes CO_{2-e} emissions
Cleared - scattered trees	18.6	80% pasture, 20% forest	8,700
Dry ridgetop forest	39.3	Callitris forest and woodlands	18,400
Moist floodplain closed forest with rainforest elements	3.9	Rain forest and vine thickets	1,500
Moist floodplain forest	27.8	Eucalyptus low open forest	12,400
Moist gully forest	25.8	Eucalyptus low open forest	11,500
Moist slopes forest	73.9	Eucalyptus low open forest	33,100
Paperbark swamp forest	9.5	Melaleuca forest and woodland	4,400
Riparian forest	7.8	Rain forest and vine thickets	2,900
Swamp mahogany / forest red gum swamp forest	10.4	Eucalyptus low open forest	4,700
Swamp oak forest	0.9	Casuarina forest and woodland	400
Total	**218.0**		**98,000**

It is estimated that a total of approximately 98,000 tonnes CO_{2-e} would be produced from clearing vegetation for the Proposal. The estimated greenhouse gas emissions generated during the clearing operations for the Proposal are shown in **Table 20-4**.

It should be noted that, as discussed in **Chapter 10 Land use and property**, should the RTA and Forests NSW enter into a land swap agreement as part of the overall Pacific Highway Upgrade Program for Forests NSW estate to be purchased for the Proposal, then the overall greenhouse gas emissions from vegetation clearing could be offset.

Embodied emissions in construction materials

Embodied emissions represent the total life cycle emissions produced in the collection, manufacture, transportation, assembly, recycling and disposal of given materials or products. Emissions from materials estimated to be used in this Proposal have been assessed using emission factors from the SimaPro Australian Life Cycle Assessment Database (Pre Consultants 2008).

Estimates of construction quantities and the embodied energy in tonnes of carbon dioxide are provided in **Table 20-5**. The quantities have been rounded for this assessment and are subject to refinement during the detailed design phase.

Table 20-5 Greenhouse gas emissions from embodied energy

Material	Quantity (tonnes)	Tonnes CO2-e emissions	Percentage of total embodied energy emissions
Aggregate	24,000	400	0.3%
Asphalt	15,000	700	0.6%
Bitumen	1400	600	0.5%

Material	Quantity (tonnes)	Tonnes CO2-e emissions	Percentage of total embodied energy emissions
Concrete - general	170,000	24,000	20.1%
Concrete - lean mix sub base	276,000	12,900	10.8%
Concrete - jointed concrete base	456,000	51,600	43.3%
Steel	14,000	29,000	24.3%
Total		**119,200**	

Transportation of material to the Proposal

It was assumed that the aggregate, asphalt, bitumen, and concrete would be sourced from local suppliers within 50 kilometres of the Proposal. Steel was assumed to be sourced from manufacturers in Newcastle and diesel was assumed to be sourced from suppliers in Sydney. The emissions associated with the transportation of major construction equipment and fuel to site was estimated using an emissions factor for rigid trucks (0.245 kilograms $CO_{2\text{-}e}$ per tonne per kilometre) from the SimaPro Australian Life Cycle Assessment Database (Pre Consultants, 2008).

Based on these assumptions the estimated emissions from the transportation of construction materials to the Proposal would be approximately 14,200 tonnes $CO_{2\text{-}e}$.

Staging implications

Consideration has been given to the potential greenhouse gas impacts during the construction phase of the possible staging option described in **Section 7.3.2**, in comparison to the construction of the entire Proposal to a full motorway standard.

In this regard, there is the potential for increased greenhouse gas emissions during the construction phase as a result of having two separate construction periods. However, the greenhouse gas management measures discussed in **Section 20.7.5** would be implemented for both this staging option and ultimate motorway standard upgrade.

Should the Proposal be delivered in stages, the staging report described in **Section 7.3.3** would detail the construction greenhouse gas emission impacts of the staging option. If any additional or altered impacts are identified, the staging report would further assess these impacts and identify appropriate management measures.

20.7.3 Greenhouse gas impacts during the operational phase

The major source of greenhouse gas emissions during the operation of the Proposal would be from highway traffic. There are a number of factors that can affect the level of vehicle emissions, including vehicle type, fuel type, fuel consumption, traffic volume, grade of hills and pavement type. The key factor affecting fuel consumption is vehicle speed, with the optimum speed for fuel efficiency being approximately 80 kilometres per hour in both small vehicles and heavy vehicles.

Lighting at key locations such as interchanges, while relatively minor, has been included in the assessment of operational emissions.

Highway maintenance activities would be undertaken on an as-needed basis and would include activities such as clearing litter, trimming vegetation, pavement maintenance and maintaining road furniture such as signage and lighting. Greenhouse gas emissions from maintenance activities would be relatively negligible and have been excluded from this assessment.

The assumptions and emission factors used to calculate the emissions associated with the above sources are provided in the following sections.

Greenhouse gas emissions from vehicle movements

A rural evaluation system analysis was undertaken by the RTA to predict the fuel (diesel and petrol) savings brought about by the Proposal when compared with the existing highway.

This analysis included a calculation of the annual average change in fuel use over 30 years, from the nominal year of opening in 2016 to 2045. These calculations consider a number of factors, including the predicted increases in traffic volume (including a breakdown of vehicle and fuel type) based on historical data, improved vertical grades, improved access and reduced conflict between through and local traffic. However this assessment does not include consideration of changed travel patterns such as other road network upgrades, provision of public transport alternatives, changes to road user behaviours (eg those resulting from fuel prices), changes to technology or introduction of different vehicle types.

The analysis estimates that the annual fuel (diesel and petrol) savings as a result of the Proposal would be 3119 kilolitres in 2016 and an average of 6950 kilolitres per year in the subsequent 30 years (2016 to 2045). Fuel consumption would reduce as a result of improving the vertical grades, improving access and reducing conflict between local and highway traffic.

Greenhouse gas emissions were calculated using an emission factor of 2.6 tonnes $CO_{2\text{-}e}$ per kilolitre for petrol and 2.9 tonnes $CO_{2\text{-}e}$ per kilolitre for diesel (DCC 2009). This assessment estimates that the savings in greenhouse gas emissions as a result of the Proposal would be an average of approximately 20,200 tonnes $CO_{2\text{-}e}$ per year between 2016 and 2045 through improved highway conditions.

Emissions associated with wider development and induced demand

The improvement in travel time along the Proposal and as part of the overall Pacific Highway Upgrade Program may result in increased residential, commercial and/or industrial development accessing the upgraded Pacific Highway. The greenhouse gas emissions associated with such developments may be in some part attributable to the Pacific Highway Upgrade Program, however, the impetus associated with such developments incorporate many different factors not related to the Pacific Highway Upgrade Program or the Proposal. Associated emissions are difficult to quantify and therefore have not been considered for this assessment.

Lighting infrastructure

A lighting scheme would be developed in accordance with the *Pacific Highway Design Guidelines* (RTA 2005a) during detailed design. The aim of the design guidelines in this respect is to minimise the use of lighting. The lighting for the Proposal requires power. The generation of this power would contribute to greenhouse gas emissions. For the purpose of this assessment it has been assumed that lighting would be installed at two interchanges and is estimated to consume 275,000 kilowatt-hours of electricity per year. The greenhouse gas emissions associated with the lighting (based on 1.07 kilograms $CO_{2\text{-}e}$ per kilowatt-hour) would be approximately 300 tonnes $CO_{2\text{-}e}$ per year.

Staging implications

Consideration has been given to the potential greenhouse gas impacts during the operational phase of the possible staging option described in **Section 7.3.2**, in comparison to the construction of the entire Proposal to a full motorway standard.

In this situation, some at-grade intersections and access points would be retained on the upgraded highway for this staging option, resulting in a slightly higher level of conflict between local and through traffic in compared to the ultimate motorway standard upgrade. As a result, the savings in greenhouse gas emissions estimated above would also be slightly reduced, however savings in these emissions would still be achieved for this staging option in comparison with the existing conditions.

Should the Proposal be delivered in stages, the staging report described in **Section 7.3.3** would detail the operational greenhouse gas emission impacts of the staging option. If any additional or altered impacts are identified, the staging report would further assess these impacts and identify appropriate management measures.

20.7.4 Overall greenhouse gas impact / benefit

The estimated greenhouse gas emissions from the construction and operation of the Proposal are summarised in **Table 20-6**.

By comparing the overall estimated greenhouse gas emission savings from operation of the Proposal with the estimated greenhouse gas emission generation during construction of the Proposal, a breakeven point would be achieved in approximately 15 years. This breakeven point would be the point at which the greenhouse gas emission savings from operation of the Proposal exceeds the greenhouse gas emissions generated during its construction.

Table 20-6 Summary of estimated greenhouse gas emissions from the Proposal

Construction	Emissions (tonnes CO_{2-e})	Operation	Emissions (tonnes CO_{2-e})
Fuel use by construction plant and equipment	52,300	Vehicle movements – estimated emissions savings	-20,200 per year (2016 – 2045)
Vegetation clearance	98,000	Lighting infrastructure	300 per year
Embodied emissions in construction materials	119,200		
Transportation of materials to the Proposal	14,200		
Total construction emissions	**283,700**	**Total operation savings (per year 2016 - 2045)**	**-19,900**

20.7.5 Management of impacts

Construction phase

Greenhouse gas emissions would be reduced during the construction phase of the Proposal through the implementation of the following management measures.

Vegetation clearance

- Restrict the area of vegetation clearance to only that required for safe completion of construction and replant vegetation where feasible.

Energy consumption and material usage

- Where feasible, assess fuel and energy efficiency when selecting construction equipment, machinery and infrastructure.
- Maintain construction machinery in accordance with manufacturer's requirements to maintain operating (and fuel) efficiency.
- Where feasible, use biofuels (such as biodiesel, ethanol or blends such as e10 and b80) to reduce the greenhouse gas emissions from construction plant and equipment.
- Use local material and personnel where possible to reduce transport-related emissions.
- Appropriately locate and manage stockpiles sites and other ancillary sites to reduce transport-related emissions.
- Optimise cut and fill balances to reduce haulage distances and need to import fill material.
- Use recycled materials where possible to minimise the greenhouse gas emissions associated with construction materials. This would be undertaken where reasonable and feasible, in accordance with the RTA's specifications, particularly "design, construct, maintain" requirements.

The whole of life greenhouse gas emissions would need to be considered when assessing the feasibility of the above measures.

Operational phase

As discussed in **Sections 20.7.3** and **20.7.4**, the Proposal is likely to result in a reduction in greenhouse gas emissions from vehicles using the upgraded highway due to improved alignment, reduced grades and smoother traffic flows than the existing highway alignment.

Greenhouse gas emissions associated with maintenance of the upgraded highway would be managed by ensuring maintenance activities are carried out as required to maintain the condition of the upgraded highway. Where practical this is likely to involve use of local maintenance staff to minimise travel to and from the site.

A lighting scheme would be developed in accordance with the *Pacific Highway Design Guidelines* (RTA 2005a) during detailed design. The aim of the design guidelines is to minimise the use of lighting. Where technically and economically feasible, the most efficient lighting technology would be used to minimise energy consumption and off site light spill and glare.

20.8 Climate change

The Director-General's environmental assessment requirements listed the assessment of climate change under the key issue of surface and groundwater. **Chapter 12 Hydrology** assessed the potential impact of the Proposal on the hydrology and flooding characteristics of the area, and also included an assessment of the potential impacts of climate change in terms of changed flood regimes. This section assesses the potential impacts of climate change on the Proposal with regard to possible changed weather patterns.

20.8.1 Overview

Climate change refers to the warming temperatures and altered climatic conditions associated with the concentration of gases in the atmosphere known as greenhouse gases. Greenhouse gases are naturally occurring in the atmosphere, and absorb solar radiation to maintain the temperature of the atmosphere. This is known as the 'greenhouse effect', keeping temperatures higher than they would otherwise be, like a glasshouse keeping plants warm. Human activity and industry have contributed to increased volumes of greenhouse gasses entering the atmosphere. Most greenhouse gases have a long lifetime in the atmosphere which means that even with reductions in greenhouse gas emissions now and into the future, there would be a delay of several decades before the reductions have a significant effect on greenhouse gas levels in the atmosphere. It is recognised that there is a need to understand these potential changes to future climatic conditions and the effect they could have on existing and potential new projects and infrastructure.

Summary of current climate change modelling

The Intergovernmental Panel on Climate Change 2007 (*Climate Change 2007: The physical science basis,* Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change) produced climate change projections, including for Australia. In Australia both the Commonwealth Scientific and Industrial Research Organisation and the Bureau of Meteorology have produced regional downscaled projections for Australia from the Intergovernmental Panel on Climate Change projections. In 2008 the NSW Government published refined climate change projections for each region in NSW including the North Coast Region, in the *Summary of Climate Change Impacts North Coast Region* (DECC 2008). These revised projections used the global climate models for assessing climate change in the NSW context, which are based on greenhouse gas emissions scenarios that reflect the latest emerging trends in emissions.

The projected regional climatic changes by 2050 for the North Coast Region (DECC 2008) in summary show "*a reduction in winter rainfall and a decrease in soil moisture in winter and spring. Sea levels will rise, changing flood patterns and affecting the coast. Minimum temperatures across all seasons are projected to be warmer, with winter maximum temperatures rising more than summer maximum temperatures*".

Regional precipitation variation can be quite sensitive to small differences in air circulation and other processes, as is evident from the large natural variability of precipitation. Therefore caution has been exercised when interpreting regional climate predictions for application at a local level for the Proposal.

20.8.2 Climate change impacts on the Proposal

The potential changes in climate predicted for the North Coast Region may result in impacts on the Proposal. These potential impacts are based upon the DECC (2008) published projections and not on a Proposal specific assessment and are therefore illustrative only.

Changes in temperature are predicted as days are projected to be hotter over all seasons (1 to 3 degrees Celsius). The greatest increases are projected for winter (2 to 3 degrees Celsius) and the smallest in summer (1 to 1.5 degrees Celsius). If construction of the Proposal occurs in a longer time horizon (ie does not commence for another 10-15 years) and these temperature changes eventuate then it could:

- Affect the integrity of pavement, bridges and other infrastructure, either directly or through evaporative changes and subsequent changes to soil moisture content and soil instability, which could impact on foundations of structures and result in softening of pavements.
- Result in reduced work capacity and increased risk of heat stress for employees.
- Result in increased dust generation during construction.

As a result of changes in rainfall, summer and autumn are projected to be wetter, while winter and spring are projected to be drier. When combined with projected evaporation increases for all seasons, if these changes eventuate they could:

- Increase erosion impacts and result in increased sediment loss from construction areas.
- Result in seasonal shortages of water for construction.
- Result in construction delays due to wet weather.

Along the coast, storm events and sea level rise are projected to have a significant impact. Sea level rise and the potential for increased storm frequency and/or intensity may exacerbate the risks of coastal erosion, as well as subsequent inundation of low lying areas. Sea level is projected to rise up to 40 centimetres above the 1990 mean sea level by 2020 and by 90 centimetres by 2100 (DECC 2008). These changes could:

- Result in localised flooding impacts in the vicinity of creeks and rivers.
- Exceed the capacity of road drainage infrastructure.
- Result in changes to pest and weed species and their distribution and alterations to the natural ecosystems.
- Result in changes to the alignment and condition of watercourses.
- During extreme rainfall events, create the potential for sedimentation basins to overtop.

20.8.3 Management measures

The Proposal has been developed to cater for known design rainfall and flood events. This includes provision for passage of flood waters, management of flow velocities to minimise erosion and scour in watercourses and collection and management of runoff waters. These would be further refined during the detailed design phase.

Due to the uncertainty in expected impacts due to climate change, the RTA considers that an adaptive management approach is appropriate to manage climate change impacts.