NSW Roads and Maritime Services

WOOLGOOLGA TO BALLINA | PACIFIC HIGHWAY UPGRADE

SUBMISSIONS / PREFERRED INFRASTRUCTURE REPORT

Chapter 3

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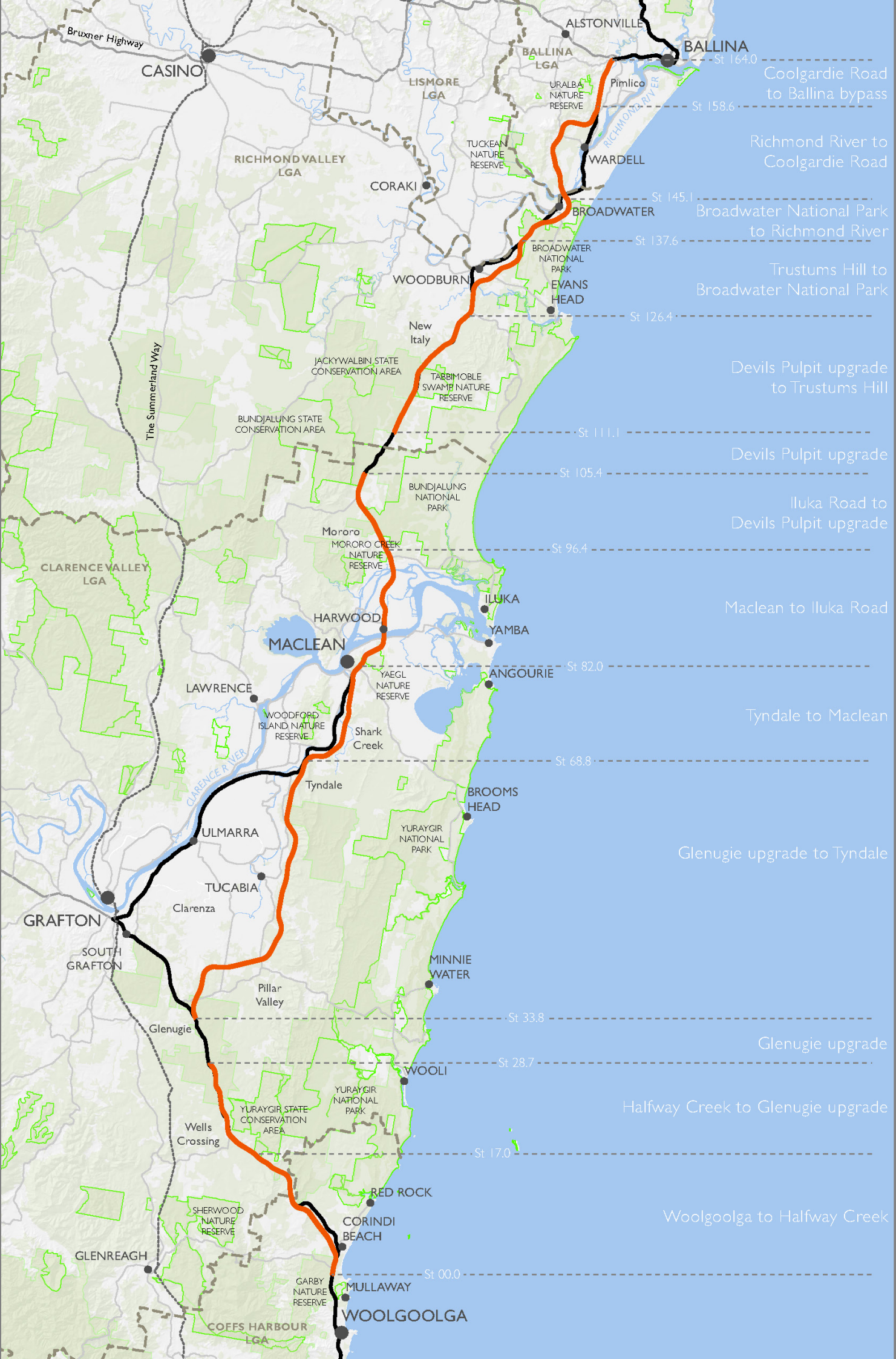
Bruxner Highway
CASINO
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LISMORE LGA
URALBA NATURE RESERVE
Pimlico
RICHMOND RIVER
TUCKEAN NATURE RESERVE
WARDELL
RICHMOND VALLEY LGA
CORAKI
BROADWATER
BROADWATER NATIONAL PARK
WOODBURN
EVANS HEAD
New Italy
JACKYWALBIN STATE CONSERVATION AREA
TABBIMOBLE SWAMP NATURE RESERVE
The Summerland Way
BUNDJALUNG STATE CONSERVATION AREA
BUNDJALUNG NATIONAL PARK
Mororo
MORORO CREEK NATURE RESERVE
CLARENCE VALLEY LGA
ILUKA
HARWOOD
YAMBA
MACLEAN
ANGOURIE
YAEGL NATURE RESERVE
LAWRENCE
WOODFORD ISLAND NATURE RESERVE
Shark Creek
CLARENCE RIVER
Tyndale
BROOMS HEAD
YURAYGIR NATIONAL PARK
ULMARRA
TUCABIA
Clarenza
GRAFTON
SOUTH GRAFTON
MINNIE WATER
Pillar Valley
Glenugie
WOOLI
YURAYGIR NATIONAL PARK
YURAYGIR STATE CONSERVATION AREA
Wells Crossing
RED ROCK
SHERWOOD NATURE RESERVE
CORINDI BEACH
GLENREAGH
GARBY NATURE RESERVE
MULLAWAY
WOOLGOOLGA
COFFS HARBOUR LGA
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Coolgardie Road to Ballina bypass
11
Richmond River to Coolgardie Road
10
Broadwater National Park to Richmond River
9
Trustums Hill to Broadwater National Park
8
Devils Pulpit upgrade to Trustums Hill
7
Devils Pulpit upgrade
Iluka Road to Devils Pulpit upgrade
6
Maclean to Iluka Road
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Tyndale to Maclean
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Glenugie upgrade to Tyndale
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Glenugie upgrade
Halfway Creek to Glenugie upgrade
2
Woolgoolga to Halfway Creek
1

Contents

Tables and Figures

3. Additional assessment

3.1 Introduction

This Chapter addresses the additional investigations or assessments undertaken during the EIS display period and preparation of this submissions/preferred infrastructure report. These additional assessments were undertaken to either address management measures made in the EIS, as a result of additional investigations, submissions made or feedback from the community and Government agencies. For ancillary facilities and design refinements, further biodiversity, historic heritage and Aboriginal heritage assessment were undertaken.

The additional investigations detailed in this Chapter include:

- Supplementary biodiversity assessment (to assess ancillary facilities and design refinements and update the biodiversity assessment for select species and communities). Refer to Section 3.2.
- Supplementary hydrology assessment (to address community submissions and feedback and evaluate the January 2013 flood event). Refer to Section 3.3.
- Review of groundwater data (to incorporate additional geotechnical information to re-evaluate cutting type). Refer to Section 3.4.
- Cane farm strategy (to address community and stakeholder feedback and facilitate the implementation of construction). Refer to Section 3.5.
- Fencing strategy (to address community feedback and facilitate the implementation of construction). Refer to Section 3.6.
- Water quality monitoring strategy (to address management measures in the EIS). Refer to Section 3.7.
- Proposed extension of construction hours (to address management measures in the EIS and community submissions and feedback). Refer to Section 3.8.
- Management of surplus material (to address Government agency feedback and facilitate the implementation of construction to suit the proponent's requirements). Refer to Section 3.9.
- Rest area strategy review (to address Government agency feedback). Refer to Section 3.10.
- Potential future service centre (to address Government agency feedback). Refer to Section 3.11.
- Ancillary facilities assessment (to address management measures in the EIS and facilitate the implementation of construction). This assessment also included historic (non-Aboriginal) heritage (further details provided in Appendix E), Aboriginal heritage (full Cultural Heritage Assessment Reports provided in Appendix D) and biodiversity assessments (refer to Appendix J for the Supplementary Biodiversity Assessment). Refer to Section 3.12.

Biodiversity, Aboriginal and historic heritage assessments were also undertaken for design refinements (refer to Chapter 4 and full assessments in Appendix J, D and E respectively).

3.2 Supplementary biodiversity assessment

This section addresses the supplementary investigations that were undertaken in response to Government agency feedback. The Supplementary Biodiversity Assessment (Appendix J) also assesses ancillary facilities (refer to Section 3.12) and design refinements (refer to Chapter 4).

3.2.1 Background

The further assessment was undertaken to address feedback on the Working paper - Biodiversity (SKM, 2012a). Full details are provided in the Supplementary Biodiversity Assessment (Appendix J).The supplementary biodiversity assessment consists of three parts:

- Survey effort for threatened species: The Commonwealth Department of Environment and NSW Department of Planning and Infrastructure requested a critical review of the survey effort in

relation to key threatened species (listed under the EPBC Act or TSC Act). In the EIS, these species and communities are considered to be significantly impacted by the project. Supplementary surveys were undertaken, and these are documented in Chapter 5.

- Impact assessment on threatened species, populations and communities: The Assessments of Significance in the EIS were reviewed to incorporate any additional findings from supplementary surveys, to assess changes in impact as a result of design refinements, to examine the suitability of the assessments for grouped species. The supplementary assessment also included proposed ancillary facility sites that were not assessed in the EIS. The supplementary assessment is documented in Chapter 6.
- Effectiveness of the proposed mitigation strategy: The adequacy and effectiveness of the mitigation measures proposed in the EIS were reviewed, specifically for those species that would be significantly impacted by the project. The supplementary mitigation measures are documented in Chapter 7 and in the threatened species management plans, which are appended to this report.

3.2.2 Scope

Survey effort

A critical review considered the survey effort of key threatened species (listed under the EPBC Act or TSC Act) was undertaken. The scope of the critical review was to:

- Identify gaps in survey effort for key species, considering the stratification of habitats and areas surveyed and the season or timing of the initial surveys (further information is provided in sections 4.2.1 and 4.2.2 of the Supplementary Biodiversity Assessment).
- Include new species listings or new survey criteria released since commencement of the study and not addressed previously.
- Consider where potential habitat (vegetation types) of a threatened species identified in the Working paper - Biodiversity were not subject to survey.
- Consider how the information gathered would inform the impact assessment and decision making process, in particular the measures proposed for addressing connectivity impacts (eg proposed koala (*Phascolarctos cinereus*) connectivity measures).

The critical review identified each species separately, providing a brief explanation of any gaps in survey effort and whether or not further survey was required. Further survey requirements were divided into two categories:

- Surveys required to inform the project assessment to more accurately identify the impact of the project on the species.
- Surveys that could be undertaken after assessment, as there is sufficient information to support the conclusions of the impact assessment in the EIS.

The results of the critical review indicated that, in general, the great majority of threatened species and ecological communities expected to occur in the study area were surveyed with sufficient sampling effort and appropriate timing to adequately inform the biodiversity assessment in the EIS, particularly Commonwealth listed species. Some gaps were identified and further surveys were undertaken (refer to Table 3-1) as part of this supplementary biodiversity assessment. Survey methodology for species and communities are provided in Chapter 5 of the Supplementary Biodiversity Assessment. The results of supplementary surveys are provided in Chapter 6 of the Supplementary Biodiversity Assessment and summarised in section 3.2.3 below.

For several key threatened flora and fauna species, additional targeted surveys would be undertaken prior to construction to document the status of populations and provide baseline data to determine the effectiveness of impact mitigation measures. The methods and timing of these surveys are documented in separate threatened species management plans prepared for this project (refer to Appendix K).

Table 3-1 Additional survey effort required to inform project assessment

Key issue	Scope of work
Lowland Rainforest of Subtropical Australia (Critically Endangered under the EPBC Act)	Targeted plot based surveys undertaken to address the new survey criteria for Lowland Rainforest of Subtropical Australia (Critically Endangered EPBC Act). This was to identify the Commonwealth listed community separately from the State listed community. Relevant to previous surveys undertaken in rainforest patches in Section 2, 3 and 10, surveyed under State criteria.
Littoral Rainforest and coastal vine thickets of eastern Australia	Targeted survey near design refinements in section 10 and 11 to accurately identify the extent of this community and distinguish from Lowland Rainforest. Survey northern parts of Section 9 on sandy soils where this community may occur.
Survey effort for threatened rainforest flora	Re-survey (previously surveyed) all potential rainforest habitats for threatened rainforest flora species and populations. Surveys were undertaken over a wider area beyond the road corridor to identify local population densities and extent.
Survey effort for select threatened flora (non-rainforest)	Address the spatial and temporal gaps in survey effort for select threatened plant species. In particular, surveys targeted under-surveyed locations in project sections 1 and 2 for cryptic flora species dependent on suitable conditions.
Survey during sub-optimal season or dry conditions	Re-survey cryptic flora and moisture dependent threatened flora species across all relevant sections, with a particular focus on wetter habitats.
Minor spatial gaps in other ecological communities mapping	Address spatial gaps and mapping in vegetation community in project sections 1 and 2. Conduct targeted surveys and mapping.
Koala habitat mapping	Address the *Interim koala referral advice for proponents* (DSEWPaC 2012a) with respect to classifying koala habitat and identifying important koala populations.
Broader surveys for Pink Underwing Moth	Targeted surveys to identify the distribution and abundance of the Pink Underwing Moth and identify the extent and condition of habitat for this species within and adjoining project sections 10 and 11.
Survey effort for Giant Barred Frog	Survey of the Giant Barred Frog in sections 1 and 2 due to spatial gaps and further details on the extent and condition of habitat for this species in sections 1-2 and 6-8.
Survey effort for Oxleyan Pygmy Perch	Survey of the Oxleyan Pygmy Perch in section 1 to 2 was done during dry periods and further surveys are required to confirm the predictions of this species.

Impact assessment

The scope of the critical review of the impact assessment was to:

- Consider how the information gathered from supplementary surveys would inform the impact assessment process.
- Revise the 'likelihood of occurrence' assessment for threatened species, considering any new survey information, and identify any species that may not have been assessed previously.
- Consider the assessment of significance carried out for species groups with similar ecological requirements and whether this had adequately assessed the potential impacts from the project.
- Review and update the assessment of significance for key species to account for design refinements or new information gathered from supplementary surveys. This would focus on those assessments of significance where changed impacts, including increases or decreases in impacts, were apparent.

The outcomes and scope of work from the review of the impact assessment is provided in Table 3-2.

Table 3-2 Additional impact assessment required

Key issue	Scope of work
Lowland rainforest and Littoral rainforest (critically endangered EPBC Act and endangered TSC Act) listings	Update assessment of significance due to reduced impacts resulting from the design refinement at the interchange at Wardell and incorporate findings from supplementary surveys.
Threatened Ecological Communities (endangered TSC Act)	Update assessment of significance due to various design refinements and to incorporate supplementary surveys
Threatened rainforest flora	Update assessment of significance due to reduced impacts resulting from the design refinement at the interchange at Wardell. Also needed to account for changed population size as determined by broader supplementary surveys.
Threatened flora (non-rainforest)	Update assessment of significance due to various design refinement and to incorporate results from supplementary surveys, particularly Quassia sp Moonee Creek
Square-stemmed Olax (Olax angulata) (vulnerable EPBC Act and TSC Act	Provision of a Commonwealth assessment of significance as it had not been included in the EIS.
Pink Underwing Moth (endangered EPBC Act and TSC Act) and Atlas Rainforest Ground Beetle (vulnerable TSC Act)	Update assessment of significance due to reduced impacts resulting from the design refinement at the interchange at Wardell.
Koala (vulnerable EPBC Act and TSC Act)	Update assessment of significance due to changed impacts resulting from design refinements, additional survey information and additional mitigation.
Giant Barred Frog (endangered EPBC Act and TSC Act)	Update assessment of significance to include information from supplementary surveys and habitat mapping, and predicted occurrence of the species in Section 3.
Oxleyan Pygmy Perch (endangered EPBC Act and TSC Act)	Review impact assessment to account for proposed design refinement at Lang Hill and additional information on proposed mitigation measures
Common Planigale (vulnerable TSC Act)	Assessment of significance to be reviewed to acknowledge that the species is widespread but uncommon throughout the Northern Rivers region and has been recorded in a diversity of habitat conditions.
Glossy Black Cockatoo (vulnerable TSC Act)	Review the conclusion of the assessment of significance considering the extent and magnitude of the impact including clearing of potential nest trees and feed trees.
Three-toed Snake Tooth Skink (vulnerable EPBC Act and TSC Act)	Provide additional information in relation to survey effort for the species to justify the assessment of significance.
White-crowned Snake (vulnerable TSC Act)	An assessment of significance is required given potential habitat and past records.
Varied Sittella (vulnerable TSC Act)	An assessment of significance is required given potential habitat and past records.
Eastern Pygmy Possum (vulnerable TSC Act)	Assessment of significance to be revised to further consider the magnitude of clearing by the project against the small home range of the species.
Green-thighed Frog (vulnerable TSC Act)	Assessment of significance to be reviewed to confirm whether a significant impact is likely.
Wetland and migratory bird species	Assessments to be reviewed, assessing species separately, or grouped according to their occupancy of microhabitats
Rainforest birds	Assessments to be reviewed, assessing species separately, or grouped according to their occupancy of microhabitats.

Key issue	Scope of work
Rufous Bettong and Brush-tailed Phascogale (vulnerable TSC Act)	Provide additional mapping along the project to identify the spatial distribution of potential habitat for these species and proposed targeted connectivity measures
Green and Golden Bell Frog (endangered EPBC Act and TSC Act)	Provide additional information in relation to survey effort for the species to justify the assessment of significance.
New Holland Mouse (vulnerable EPBC Act)	An Assessment of Significance is required given potential habitat and past records.
Groundwater impacts at cut sites	Provide an analysis of the location of cuttings (high risk areas for groundwater) and impacts to threatened species and groundwater dependent ecosystems.

Mitigation strategy

The scope for the review of mitigation measures was to:

- Detail the species specific mitigation measures proposed for threatened biota.
- Consider if the mitigation strategy targets key threatened species and communities and is sufficient to determine the likely effectiveness of the measures proposed.
- Consider how the information gathered from the supplementary surveys would inform the connectivity and mitigation measures proposed for koalas.
- Provide a critical review of the connectivity structures proposed in relation to spatial gaps along the project and assessment of vegetation gaps.

The scope of work from the mitigation strategy review is provided in Table 3-3.

Table 3-3 Mitigation strategy scope of works

Key issue	Scope of work
Species specific mitigation measure	The Working paper - Biodiversity presented a mitigation framework that included a biodiversity connectivity strategy. The connectivity strategy provided broad scale mitigation measures for terrestrial and aquatic flora and fauna to inform the project Flora and Fauna Management Plan. The strategy also provided the framework for development of a series of Threatened Species Management Plans to document species specific and site specific mitigation measures and a monitoring and adaptive management approach. Given the need to understand species-specific measures as part of the project approval assessment, agencies requested the development and inclusion of Threatened Species Management Plans as follows: • Rainforest Communities and Threatened Rainforest Plants Management Plan. • Threatened Plant Species (non-rainforest) Management Plan. • Koala Management Plan. • Threatened Invertebrates Management Plan. • Threatened Mammals Management Plan. • Threatened Gliders Management Plan. • Threatened Frogs Management Plan. • Coastal Emu Management Plan. • Threatened Fish Management Plan. These plans present the proposed specific mitigation and monitoring measures for key species and specific locations during the different stages of construction and operation. The plans outline proposed methods for monitoring the effectiveness of these mitigation measures and implementing corrective actions as part of an adaptive management process. This would particularly apply where there is uncertainty around the effectiveness of measures.

Key issue	Scope of work
	Each of the plans was reviewed by independent experts specialising in the target species or groups. The results of the review are provided in the plan, and these plans would be updated to reflect these recommendations. A summary of the species specific mitigation measures provided in these plans is provided in Section 7.1 of the Supplementary Biodiversity Assessment.
Review of connectivity strategy	The review addresses the following three issues relating the effectiveness of the proposed connectivity mitigation measures: • The likely effectiveness of mitigation measures for the Koala considering the results of supplementary surveys. • The location of proposed connectivity structures against current gaps in vegetation. • Identification of any spatial gaps along the project where structures are absent that may impact on the effectiveness of the strategy. The results of this review and further recommendations is provided in Section 3.2.5 below.
Effectiveness of mitigation measures	The Working paper - Biodiversity reported on the effectiveness of fauna crossing measures (underpasses, overpasses and arboreal structures) based on a review of published studies on other highway upgrades. Further work has since been undertaken to expand this to a range of other mitigation measures and is provided in Section 3.2.5. This includes background on the effectiveness (suitability) of the proposed measures based on previous road construction and recent Roads and Maritime monitoring experience and outcomes.

3.2.3 Survey findings

Lowland Rainforest

Six patches of Lowland Rainforest in Section 10 of the project were identified as conforming to the condition thresholds for EPBC Act listed Lowland Rainforest of Subtropical Australia (refer to Figure 3-1 to Figure 3-3). Three of these rainforest patches are within the project boundary.

Patches of Lowland Rainforest were also identified within sections 1 to 3 within the project boundary, but do not meet the condition requirements for the EPBC Act listing due to lower floristic diversity. However, these patches do comply with floristic descriptions for Lowland Rainforest on Coastal Floodplains, which is a listed threatened ecological community on the TSC Act.

Further discussion on the potential impact on the project are described in section 3.2.5.

Littoral Rainforest

A total of five patches of littoral rainforest were identified in Sections 9, 10 and 11 within and adjoining the project boundary (refer to Figure 3-4). These included several small patches surrounding Coolgardie Road in Section 10, a small patch within the existing road corridor in Section 11, and a large patch to the east of the project in Section 9 in the Broadwater National Park. Two of the small patches of littoral rainforest identified in the boundary in sections 10 and 11 are consistent with Littoral Rainforests and Coastal Vine Thickets, listed as critically endangered under the EPBC Act.

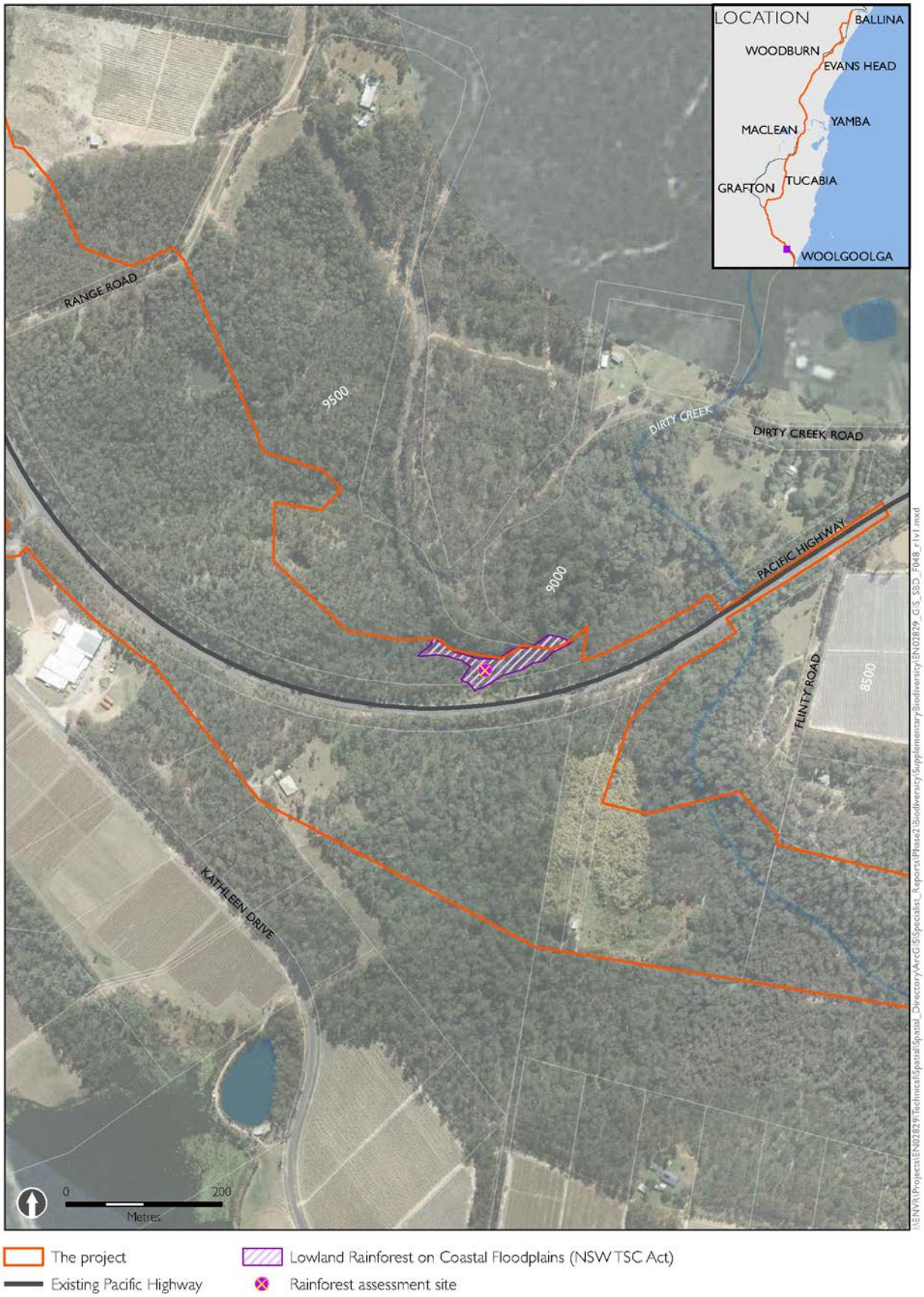

Figure 3-1: Lowland Rainforest patches – Section 1

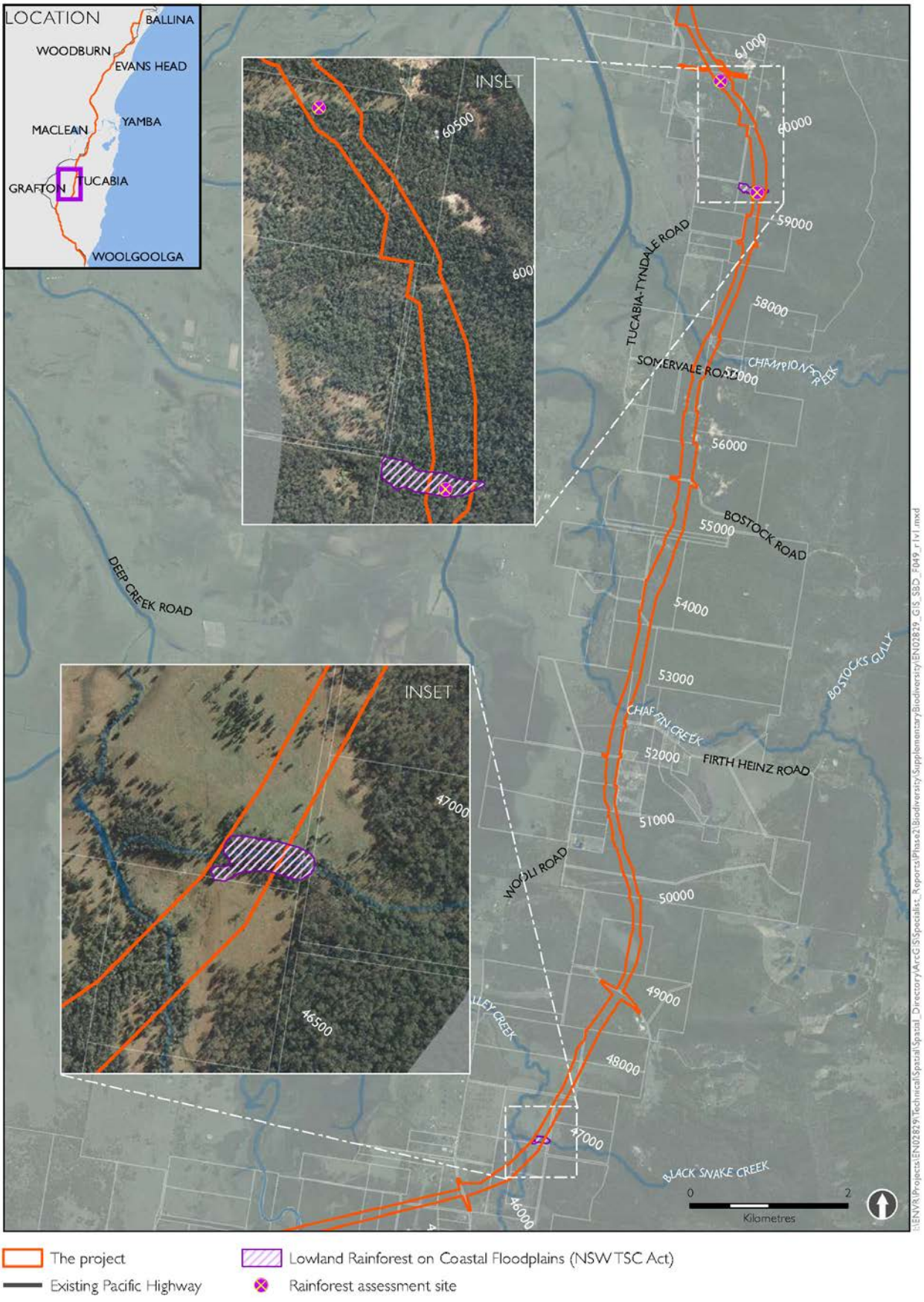

Figure 3-2: Lowland Rainforest patches – Section 3

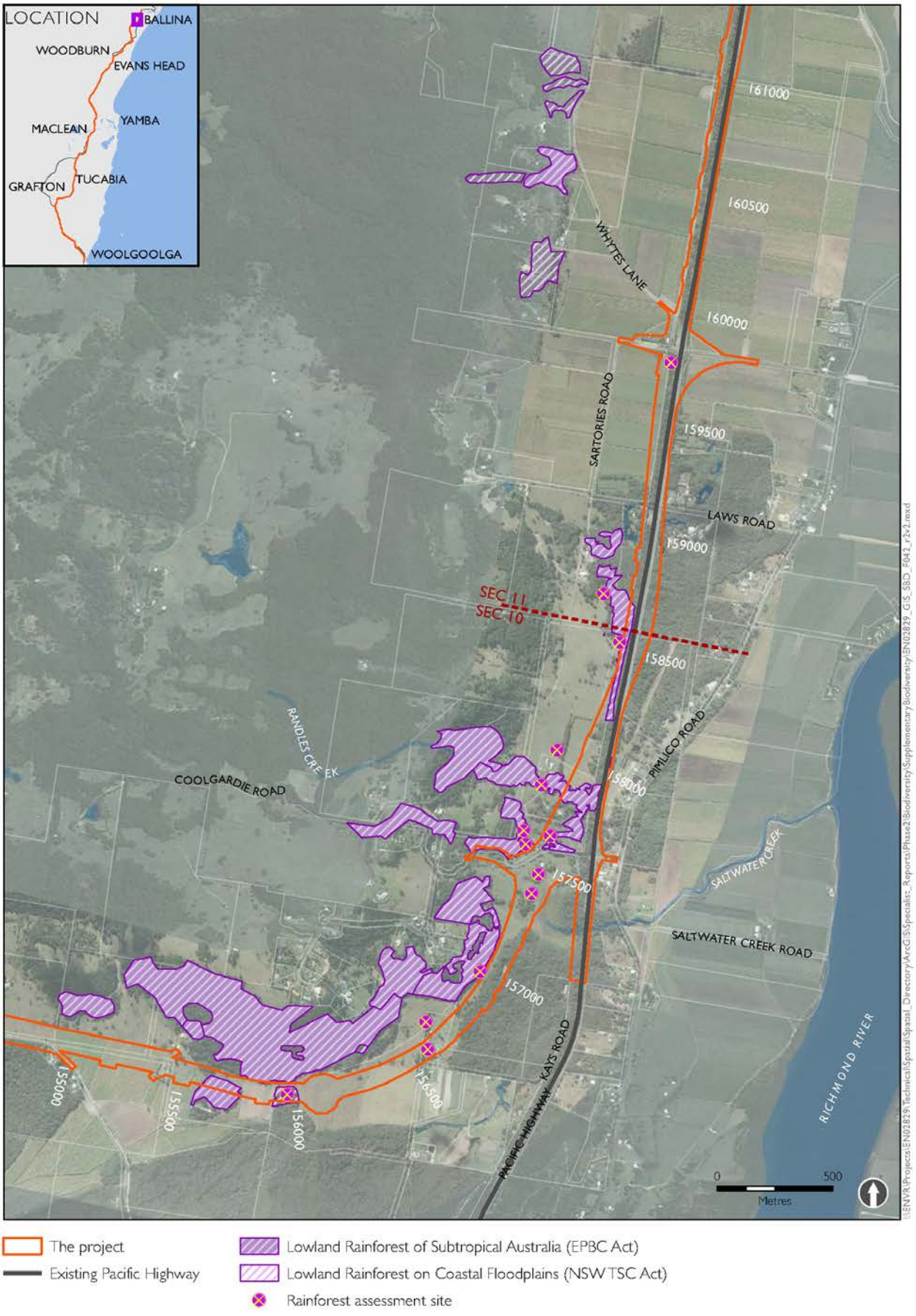

Figure 3-3: Lowland Rainforest patches – Sections 10 and 11

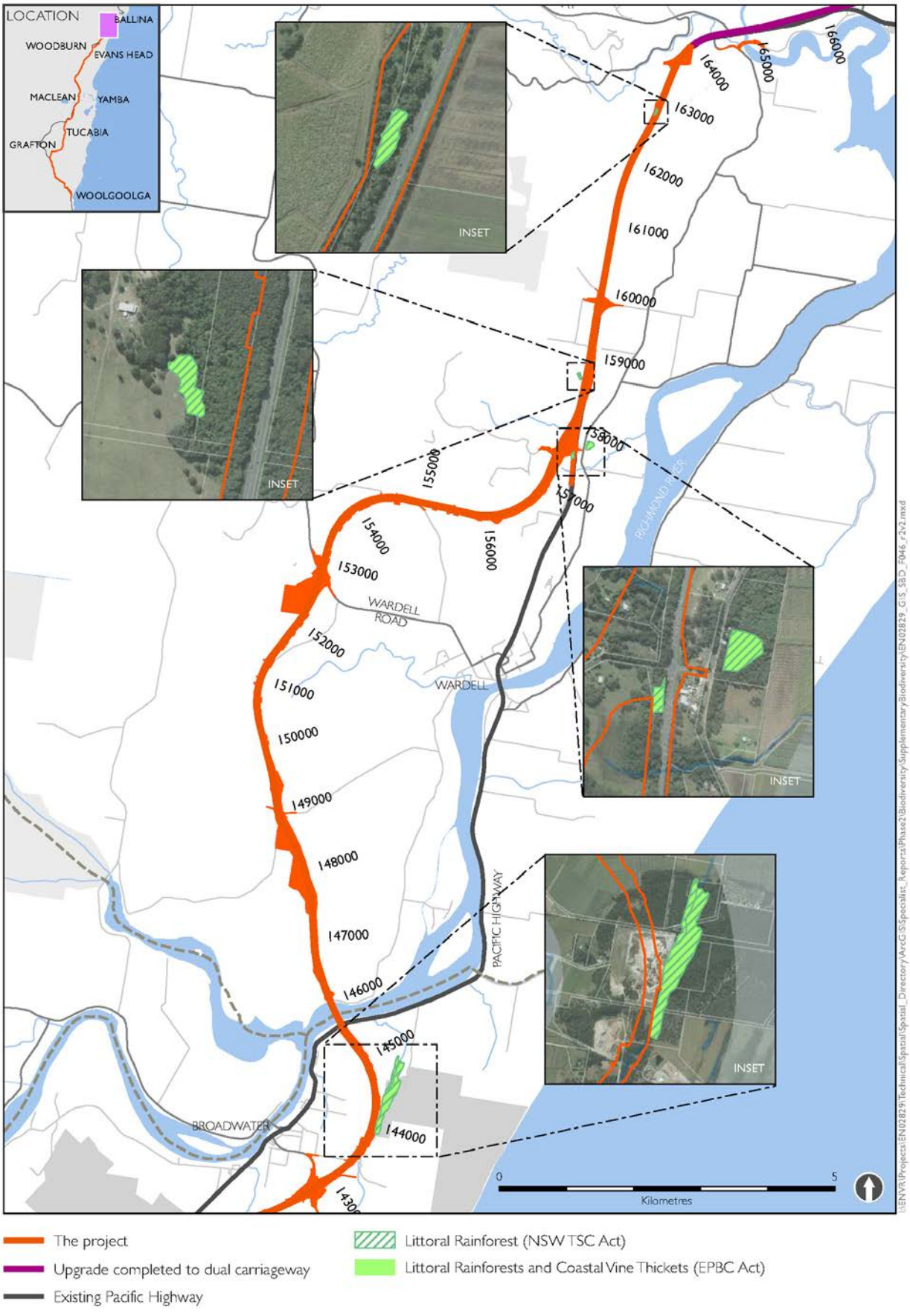

Figure 3-4: Littoral Rainforest patches – Sections 9 to and 11

Other vegetation communities

Ground-truthing of vegetation communities has resulted in a revision of the extent of communities and the overall impacts on habitats and vegetation. The results of the ground-truthing are provided in Table 3-4 (all communities) and Table 3-7 (threatened ecological communities).

The adjusted area of each biometric vegetation type impacted by the project is provided below in Table 3-4. These areas are based on the proposed project design, including design refinements, and vegetation communities identified from the most recent supplementary surveys.

Table 3-4 Results of vegetation communities ground truthing

BioMetric vegetation association	EPBC Act	TSC Act	EIS - direct loss (hectares)	Revised direct loss (hectares)
Black Bean - Weeping Lilly Pilly Riparian Rainforest of the North Coast		E	1.4	1.7
Blackbutt - Bloodwood Dry Heathy Open Forest on Sandstones of the Northern North Coast			79.7	93.6
Blackbutt Grassy Open Forest of the Lower Clarence Valley of the North Coast			46.2	37.6
Coast Cypress Pine Shrubby Open Forest of the North Coast Bioregion		E	27.4	3.3
Coastal Floodplain Sedgelands, Rushlands, and Forblands		E	3.0	5.1
Coastal Heath on Sands of the North Coast			0.2	14.9
Flooded Gum - Tallowwood - Brush Box Moist Open Forest of the Coastal Ranges of the North Coast			2.0	1.4
Forest Red Gum - Swamp Box of the Clarence Valley Lowlands of the North Coast		E	73.9	53.7
Grey Gum - Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast			48.2	69.5
Hoop Pine - Yellow Tulipwood Dry Rainforest of the North Coast	CE	E	0.5	0.0
Mangrove - Grey Mangrove Low Closed Forest of the NSW Coastal Bioregions			1.5	5.8
Narrow-Leaved Red Gum Woodlands of the Lowlands of the North Coast		E	34.7	21.2
Needlebark Stringybark - Red Bloodwood Heathy Woodland on Sandstones of the Lower Clarence of the North Coast			58.2	58.6
Orange Gum (Eucalyptus bancroftii) Open Forest of the North Coast			11.5	5.6
Paperbark Swamp Forest of the Coastal Lowlands of the North Coast		E	49.5	64.5
Red Mahogany Open Forest of the Coastal Lowlands of the North Coast			46.2	42.0
Scribbly Gum - Needlebark Stringybark Heathy Open Forest of Coastal Lowlands of the Northern North Coast			71.9	66.2
Spotted Gum - Grey Box - Grey Ironbark Dry Open Forest of the Clarence Valley Lowlands of the North Coast			2.1	2.1
Spotted Gum - Grey Ironbark - Pink Bloodwood Open Forest of the Clarence Valley Lowlands of the North Coast			144.8	163.8
Swamp Box Swamp Forest of the Coastal Lowlands of the		E	28.5	19.0

BioMetric vegetation association	EPBC Act	TSC Act	EIS - direct loss (hectares)	Revised direct loss (hectares)
North Coast				
Swamp Mahogany Swamp Forest of the Coastal Lowlands of the North Coast		E	44.2	47.6
Swamp Oak Swamp Forest of the Coastal Lowlands of the North Coast		E	56.2	43.1
Tallowwood Dry Grassy Forest of the Far Northern Ranges of the North Coast			53.0	54.4
Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast	CE	E	0.0	0.2
Turpentine Moist Open Forest of the Coastal Hills and Ranges of the North Coast			44.5	42.7
Wet Heathland and Shrubland of Coastal Lowlands of the North Coast			10.0	11.5
White Booyong - Fig Subtropical Rainforest of the North Coast	CE	E	8.6	2.6
Cleared and modified habitats			870.1	891.0
Total vegetation direct and indirect impact (excluding cleared and modified habitats)			**948**	**931.7**

A key finding of the survey results is that the extent of the endangered Coastal Cypress Pine Forest of the North Coast Bioregion (listed under TSC Act) is substantially less than originally identified. The majority of this community is more aligned to Coastal Heath on Sands of the North Coast vegetation community. The extent of floodplain vegetation communities is also less than identified in the EIS, due to the previous mapping of these communities in non-floodplain areas in some locations. Updated floodplain boundaries and terrain elevation data has enabled more accurate delineation of these communities from non-floodplain vegetation types.

Rainforest flora populations

Two additional threatened species were identified within the project boundary in section 10 during the supplementary surveys. These species were: *Streblus pendulinus* and *Acronychia littoralis*. Additionally, as the survey area extended outside of the project corridor, there was an increase in the number of threatened species identified overall. This has resulted in increased known population counts for several species (refer to Table 3-5).

Table 3-5 Results of supplementary surveys for rainforest plant species

Species	EPBC Act	TSC Act	No. recorded in project boundary	Total known population in study area
Acalypha eremorum (Acalypha)		E	0	71
Acronychia littoralis (Scented Acronychia)	E	E	1 (125 stems)	1 (125 stems)
Archidendron hendersonii (White Lace Flower)		V	0	20
Belvisia mucronata (Needle-leaf Fern)		E	0	53
Coatesia paniculata syn. *Geijera paniculata* (Axe-breaker)		E	0	25
Cryptocarya foetida (Stinking Cryptocarya)	V	V	13	88
Davidsonia johnsonii (Smooth Davidson's Plum)	E	E	0	1 (25 stems)
Endiandra hayesii (Rusty Rose Walnut)	V	V	3	30
Endiandra muelleri subsp. bracteata (Green-leaved Rose		E	0	44

Species	EPBC Act	TSC Act	No. recorded in project boundary	Total known population in study area
Walnut)				
Macadamia tetraphylla (Rough-shelled Bush Nut)	V	V	1	99
Ochrosia moorei (Southern Ochrosia)	E	E	0	1
Streblus pendulinus syn. S. Brunonianus (Whalebone Tree)	E	E	8	43
Syzygium hodgkinsoniae (Red Lilly Pilly)	V	V	0	8
Tinospora tinosporoides (Arrow-head Vine)	V	V	0	60

Threatened flora populations

The supplementary surveys identified several threatened flora populations additional to those identified in the EIS in or adjacent to the corridor. The most significant findings were two species not previously identified in the study area- the Square-stemmed Spike-rush (*Eleocharis tetraquetra*) (Endangered TSC Act) and Moonee Quassia (*Quassia* sp. Moonee Creek) (endangered EPBC Act, TSC Act), both recorded in Section 1 of the project.

The findings from the supplementary surveys are provided in Table 3-6.

Table 3-6 Results of supplementary targeted flora surveys

Species	EPBC Act	TSC Act	Section	No / area in project boundary	Total known population[1]
Angophora robur (Sandstone Rough-barked Apple)	V	V	3	7,056	125,076 (Clarence-Moreton Basin)
Arthraxon hispidus (Hairy Joint-grass)	V	V	10	8.4 ha	21.3 ha (between Lumleys Lane and Coolgardie Road)
Eleocharis tetraquetra (Square-stemmed Spike-rush)		E	1	6 population clusters	11 population clusters (between Post Office Lane and Flinty Road)
Eucalyptus tetrapleura (Square-fruited Ironbark)	V	V	2	760	159,629 local population (Glenugie and Chambigne NR)
*Grevillea quadricauda (*Four-tailed Grevillea)	V	V	3	8	218 (north of Somervale Road, Tucabia)
Marsdenia longiloba (Slender Marsdenia)	V	E	10	0	3 (between Wardell and Coolgardie)
Maundia triglochinoides		V	1	0.23 ha	3.15 ha (Halfway Creek, Wells Crossing, Coldstream, Tucabia, Tabbimoble, New Italy)
Phaius australis (Southern Swamp Orchid)	E	E	9	0	68
Quassia sp. Moonee Creek (Moonee Quassia)	E	E	1	64	274 (between Corindi and Dirty Creek)

[1] Details on location of species populations identified in the table are provided in the supplementary biodiversity assessment (refer to Appendix J) and the Working paper – Biodiversity (SKM, 2012).

Pink Underwing Moth

A total of 61 additional point records of *Carronia multisepalea*, the host vine for Pink Underwing Moth, were obtained during the survey over a wider survey area than the EIS surveys. Records of the moth itself were restricted to a single property block with a record of 45 larvae and nine eggs in association with the host vine.

Koala

Surveys were undertaken during the preferred route, the EIS and as part of the supplementary surveys (over 100 sites were surveyed). A review of the data from these surveys showed koala scat records confirmed and mapped at seventeen sites. These sites are located within project sections 1, 3, 5, 7, 9 and 10 (refer to section 5.5 of the Supplementary Biodiversity Assessment for further details). The species was also confirmed at another six sites in Section 9 and 10, although spatial coordinates are not available and these have not been mapped.

There are over 11,000 recorded koala sightings in the NSW Atlas for the NSW North Coast Bioregion, spread over all local government areas in a wide range of topographies and habitats, including reserves, State forest and private land. The data indicates that koalas could occur in all project sections in a range of habitats that would be impacted by the project and is confirmed from the field data.

The main centre of high density koala records in relation to the project occur in the Richmond Valley LGA between Woodburn and Wardell (project sections 9, 10) particularly around Wardell to Coolgardie and Bagotville (Section 10) and south of the river from Rileys Hill to Broadwater National Park (Section 9). These northern populations are considered 'important populations' according to categories provided within the Commonwealth interim referral advice. The review of the data from scat searches across all project sections supports the view of high density koala populations close to the project boundary in sections 9 and 10 and low density populations in sections 1, 3, 6 and 7.

Other important koala populations in the study area have been identified from Ashby, Iluka and Woombah (Clarence Valley Council, 2010). Until relatively recently, the Iluka Peninsula supported a renowned high-density koala population; a recent drastic decline over the last 10 years or so has left this sub-population functionally extinct (Clarence Valley Council 2010). This population occurs to the east of the Pacific Highway near the township of Iluka.

Several koala food tree species listed for the NSW North Coast (DECC 2008a) were identified from the habitat assessment plots, including the primary species Swamp Mahogany (*Eucalyptus robusta*), Forest Red Gum (*E.tereticornis*), Tallowwood (*E.microcorys*), and Orange Gum (*E.bancrofti*). Secondary food tree species are represented by Red Mahogany (*E.resinfera*), Small fruited Grey-Gum (*E.propinqua*), and Narrow-leaved Red Gum (*E.seena*). Supplementary tree species included the stringybarks (*E.tindaliae* and *E.globodiaea*). Up to thirteen vegetation types have been identified as supporting habitat critical to the survival of koalas in the study area, including primary and secondary habitat.

There is around 375.4 hectares of "habitat critical to the survival of koalas" (as defined in DSEWPaC 2012a) within the project boundary (a reduction from 557.2 identified in the EIS).

Giant Barred Frog

The results of the targeted survey for Giant Barred Frog (Lewis Ecological Surveys 2013a) confirmed the previous account of this species in the Corindi River, as identified by Ecotone (2007) during the preferred route studies. The results also confirm the importance of this site for the species. Seven individuals were reported in 2007 and 10 individuals at the same site in 2013. The EIS also identified and assessed potential habitat for this species in Dirty Creek (Section 1) and Halfway Creek (Section 2) and the species has now been confirmed at both sites from the targeted survey (Lewis Ecological Surveys 2013a; 2013b). The surveys also report a moderate likelihood of the species occurring at Boney Creek (station 13.3) and a tributary of Arrawarra Creek (station 0.3) both in Section 1. The remaining areas of sections 1 and 2 were confirmed as having a low potential for this species (as concluded in the EIS).

The species was not identified from the targeted surveys in Section 3, although habitat was considered moderately suitable at Chaffin Creek (Station 52.5). There are previous records of this species on the Coldstream River around three kilometres upstream of Sandy Crossing. Potential habitat for this species is likely in the upper reaches of the Coldstream River upstream from the project on the basis of the dense wet sclerophyll riparian habitats and presence of pools along the stream.

The species was not identified in Sections 6-8 and was considered to have a low likelihood occurrence of due to the absence of important habitat characteristics. Tabbimoble Creek (station 101.6) and Sawpit Creek (station 125.5) provide some of these habitat attributes, although their highly disturbed state as a result of cattle grazing, clearing and logging suggests the Giant Barred Frog probably does not occur in the study area. The nearest recorded location for this species is around three kilometres west of New Italy in Doubleduke State Forest, with more occurrences further to the west in the Bungawalbin Catchment (Lewis and Rohweder 2005; Atlas data). Sawpit Creek is to the east of the project and does not cross under the highway.

Oxleyan Pygmy Perch

The EIS identifies risks to populations of the threatened Oxleyan Pygmy Perch (OPP) in project sections 1 to 2 and 6-9. Targeted survey for the OPP was conducted in Sections 6 to 8 (Iluka Road to Woodburn) for the EIS under optimum conditions. The need for additional surveys was noted in critical review for Sections 1 to 2 due to the poor conditions experienced in the previous surveys conducted for the preferred route investigations.

The two targeted surveys did not find any OPP or Purple-spotted Gudgeon (PSG) in 16 significant waterways crossed by the project between Woolgoolga and Glenugie. Although there are some sites that are suitable for these species in terms of water quality and habitat availability, it is considered unlikely that there are any populations of these species along the project corridor in Sections 1 and 2 (Aquatic Science and Management 2013).

3.2.4 Impact assessment

Threatened ecological communities

Further survey to identify and refine the edges of threatened ecological communities in the project boundary, as well as avoidance of Lowland Rainforest by the design in section 10, has resulted in changes to the impacts on these communities. Overall, the project would have a reduced impact on threatened ecological communities of around 75 hectares compared with the EIS (impacting on 261.9 hectares). While most communities would have a reduction in impact, there is an increased impact in two vegetation communities (Littoral Rainforest and Swamp Sclerophyll Forest). The impacts to all of these ecological communities are detailed in Table 3-7. Where a change in impact is noted, the assessment of significance has also been revised.

Table 3-7 Comparison of direct impacts to threatened ecological communities from the EIS and the supplementary surveys

Threatened ecological communities (listed status)	EPBC Act	TSC Act	EIS - direct impact (hectares)	Supplementary - direct impact (hectares)
Lowland Rainforest in NSW North Coast and Sydney Basin Bioregions (Endangered, TSC Act) *Lowland Rainforest in Sub-tropical Australia (Critically Endangered, EPBC Act)	CE	E	10.3 (5.8*)	4.2 (2.0*)
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered, TSC Act) *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (Critically Endangered, EPBC Act)	CE	E	0.0	0.2 (0*)

Threatened ecological communities (listed status)	EPBC Act	TSC Act	EIS - direct impact (hectares)	Supplementary - direct impact (hectares)
Coastal Cypress Pine Forest of the NSW North Coast Bioregion		E	27.4	3.3
Freshwater Wetlands On Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		E	13.0	5.1
Subtropical Coastal Floodplain Forest of the NSW North Coast Bioregion		E	137.1	93.9
Swamp Sclerophyll Forest On Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner		E	93.7	112.1
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin And South East Corner Bioregions		E	56.2	43.1
Total			**337.7**	**261.9**

Lowland Rainforest of Subtropical Australia

The impact assessment for Lowland Rainforest communities has been revised from that provided in the EIS based on further targeted surveys and design refinements reported in this supplementary assessment. The revised assessment incorporates the results of further survey in the project boundary and changes in the footprint around the interchange at Wardell design refinement.

The EIS assessment noted an impact to 10.3 hectares of Lowland Rainforest that would fit the criteria for listing on the TSC Act. Of the 10.3 hectares, 5.8 hectares would fit the criteria of a critically endangered ecological community listing on the EPBC Act. The 5.8 hectares impact was made up of six discrete patches.

A total of 81.4 hectares of Lowland Rainforest (TSC Act listed) has been identified in the study area from targeted surveys up to 400 metres from the project boundary. As a result of the design refinement, the direct impact on Lowland Rainforest would reduce to 4.2 hectares that is listed under the TSC Act occurring in seven patches (refer to Table 3-8) . Of these 4.2 hectares, three patches meet the criteria for listing under the EPBC Act. The project would impact on around two hectares of these patches.

Table 3-8 Impacts to Lowland Rainforest patches

Project section	Patch number / (approximate St)	Total patch area (ha)	Area impacted (ha)	Area remaining following impact (ha)	Proportion of patch remaining
Lowland Rainforest (EPBC Act and TSC Act listed)					
10	1 (155.5 to 156.0)	1.9	0.5	1.4	73%
10	2 (157.5 to 158.0)	10.5	1.0	9.5	90%
10 & 11	3 (158.0 to 159.0)	3.0	0.5	2.5	81%
	TOTAL	**15.4**	**2.0**	**13.4**	**87% in total**
Lowland Rainforest (TSC Act listed only)					
1	4 (8.9 to 9.1)	0.4	0.3	0.1	25%
3	5 (46.7 to 46.8)	1.5	0.7	0.8	53%
3	6 (59.3 to 59.5)	2.8	0.7	2.1	75%
10	7 (156.0 to 156.2)	0.7	0.5	0.2	29%
	TOTAL	**5.4**	**2.2**	**3.2**	**59% in total**

The combination of additional field data and design refinement has resulted in changes to the number and proportion of patches of Lowland Rainforest that would remain following construction. The majority of the three EPBC Act listed patches identified would remain following construction (73-90 per cent) with an overall proportion of 87 per cent of these patches remaining.

A total of 68.5 hectares of Lowland Rainforest (EPBC Act listed) has been identified in the study area from targeted surveys up to 400 metres from the project boundary. Therefore the direct impact of two hectares is around 2.9 per cent of the total known population in the study area. The largest patch (patch 2) would be fragmented by the project with remnants remaining on the eastern (1.5 hectares) and western (8.0 hectares) sides of the project.

Potential indirect impacts to Lowland Rainforest could include:

- Weed invasion.
- Increased light and exposure (drying).
- Decreased humidity.
- Altered hydrology and increased nutrients which could result in weed (and/or pathogen) invasion, particularly Camphor Laurel.
- Fragmentation.
- Polluted surface runoff.
- Increased dust during construction.

In Section 10, the project alignment has avoided to the greatest extent possible, areas of rainforest and has targeted cleared areas. These cleared areas adjoin remnant Lowland Rainforest, and as such, the areas that could be subject to indirect impacts from the project are already subject to edge effects. Indirect impacts to previously unaffected areas would be limited to the three patches directly impacted where new edges would be created. To manage the potential for edge effects mitigation measures include appropriate landscaping adjacent to impacted rainforest patches, sedimentation and erosion control and weed management. These measures have been described in the Threatened Rainforest Communities and Rainforest Plants Management Plan.

Indirect impacts from surface run-off are expected to be minimal as the majority of the Lowland Rainforest patches are mostly situated on higher ground to the west of the project and the road would drain away from much of the remaining rainforest areas. However, portions of the patches of Lowland Rainforest that would be directly impacted are situated downstream (or on relatively flat ground) of the highway and appropriate design of culverts, bridges, sedimentation basins and water quality ponds would be installed to minimise alteration of the existing hydrological regimes and manage runoff during construction and operation (respectively).

The assessments of significance for Lowland Rainforest has been updated to reflect the additional survey work. As a result, the project is unlikely to result in a significant impact to the TSC Act listed ecological community. However, due to potential indirect impacts and the critically endangered status, a precautionary approach has been taken and a significant impact assumed for patches that meet the criteria for listing under the EPBC Act. (refer to the Supplementary biodiversity assessment for the full assessment of significance)

Littoral Rainforest communities

Littoral Rainforest (Endangered, TSC Act and Critically Endangered, EPBC Act) was identified in the EIS and supplementary surveys in areas surrounding the project. One small patch (0.2 hectares) was identified in the clearing boundary within a modified area of swamp forest in project Section 11. The other four patches were not previously identified due to their location outside of the project boundary. These five patches comprise a total of 14.4 hectares. Two of these five patches would be impacted by the project comprising a total of 0.23 hectares (around 1.6 per cent of the known areas of Littoral Rainforest surrounding the project). Refer to Table 3-9.

Table 3-9 Impacts to Littoral Rainforest patches

Patch number / (approximate St)	Total patch area (ha)	Area impacted (ha)	Area remaining following impact (ha)	Proportion of patch remaining
1 (157.5 to 157.6)	0.3	0.03	0.27	99%
2 (162.8 to 163)	0.2	0.2	0	0%
Total	**0.5**	**0.23**	**0.27**	**90% in total**

Patch 2, located wholly within the project boundary in section 11, would be removed. Patch 1 would be partially removed, with 99 per cent of the population remaining after construction. The entire area of Littoral Rainforest retained in surrounding areas comprises greater than 97 per cent of the known distribution.

The potential for indirect impacts would be limited to the remaining area of Patch 1. Other patches surrounding the alignment are unlikely to be indirectly impacted (refer to Table 3-9). This patch is currently situated in the road reserve between the existing highway and Kays Road with a small power easement at the northern end. Given its current location, existing edge effects to the community are evident; including a reduced canopy, low recruitment and abundant weeds. The project would contribute to these impacts although the actual direct contribution would be very low given edge effects are likely to be ongoing in the absence of the upgrade.

The assessments of significance for Littoral Rainforest has been updated to reflect the additional survey work (refer to the Supplementary biodiversity assessment for the full assessments of significance). The project would only directly impact and potentially indirectly impact a small area (0.4 hectares over two patches) of this community (relative to the known 14.4 hectare extent in the study area). Given this, and the modified condition of these patches due to high levels of indirect impacts from existing infrastructure, the project is not considered to have a significant impact to this ecological community.

Other threatened ecological communities

The impact assessment and assessments of significance for all threatened ecological communities have been revised from the assessment provided in the EIS to incorporate further the results from additional ground-truthing of vegetation communities in selected areas of the project boundary (as detailed in section 3.2.4). The impact assessment for each of the threatened ecological communities is detailed in Table 3-10 below. Indirect impacts to the ecological communities are similar and could include:

- Changing habitat attributes through altering hydrological and nutrient regimes in habitats downstream of the proposed development. Changes to local hydrological regimes may result in water being contained for longer periods of time or lowering the water table, which would potentially result in changes to understorey floristics and die-back in the canopy.
- Edge effects, such as increased light availability, which may result in altered understorey floristics, structure of the vegetation and lower the condition for flora and fauna. These effects could result in increases in weed abundance, altered soil conditions and sedimentation.

Mitigation measures during construction and the incorporation of specific design features into the proposed development are likely to minimise these indirect impacts.

Further impact assessment and the assessment of significance for these communities are provided in the Supplementary biodiversity assessment.

Table 3-10 Assessment for threatened ecological communities

Threatened ecological community	Direct impact assessment	Indirect impact assessment	Assessment of significance
Coastal Cypress Pine Forest (Endangered TSC Act)	Further surveys found 26.6 hectares of Coastal Cypress Pine Forest within and surrounding the project. The project would only impact around 3.3 hectares of this community in various conditions of quality. The NSW Scientific Committee final determination for Coastal Cypress Pine Forest in the North Coast Bioregion (OEH 2011) states the total distribution of Coastal Cypress Pine Forest covers around 150 hectares to 200 hectares. As such, the project would result in impacts on up to 2.2 per cent of the estimated extent (150 hectares) and around 1.7 per cent of the upper estimated extent (200 hectares).	Many of the patches impacted by the project comprise small fragmented patches which are currently highly edge affected. Although the project would contribute to these effects, it is unlikely to result in substantial further modification to these habitats. The project would result in around 270 metres of newly affected edge, resulting in 0.8 hectares of this community potentially being indirectly impacted.	Due to the moderate level of direct impacts, the limited known extent of the community and the potential indirect impacts, the project would potentially have a significant impact to the Coastal Cypress Pine Forest community. This is consistent with the conclusion from the EIS.
Freshwater Wetlands (Endangered TSC Act)	A total of 46.5 hectares of Freshwater Wetlands has been identified within and surrounding the study area. The project would directly impact around 5.1 hectares of this community in various conditions of quality. The majority of Freshwater Wetlands in the project boundary are in a low condition comprising depressions and drainage lines within cleared paddocks open to grazing livestock. The CRAFTI mapping has identified about 3051 hectares of vegetation with affinities to Freshwater Wetlands within a 10 kilometre radius of the project boundary. The project would potentially result in the removal of 0.2 per cent of this estimated local distribution of this community.	Indirect impacts to Freshwater Wetlands from altered hydrology regimes is difficult to quantify for the project considering indirect impacts may result in areas downstream remote from the project boundary. As the majority of Freshwater Wetlands in the project boundary are in a low condition any potential indirect impacts that would result in weed invasion, altered vegetation structure and loss of native diversity are unlikely to substantially exacerbate existing conditions. Potential indirect impacts to Freshwater Wetlands would be in Section 3 in tributaries and billabongs of the Coldstream River (Stations 42.7 to 43.5). This would cover an area of around three hectares of Freshwater Wetlands are susceptible to indirect impacts.	Due to the relatively small impact to the estimated local population and the low condition of many areas of the community, the project is unlikely to have a significant impact, provided mitigation measures are adequately implemented and maintained. This is consistent with the conclusion from the EIS.
Subtropical Coastal Floodplain Forest (Endangered TSC Act)	A total of 1158 hectares of Subtropical Coastal Floodplain Forest has been identified within and surrounding the study area, of which the project would directly impact on 93.9 hectares. The condition of this community varies, however a large majority of the community is likely to be in a moderate condition including various remnants within agricultural landscapes open to grazing and thin strips of riparian	A total of 40.2 hectares of this community could be vulnerable to indirect impacts, occurring close to the project or in downslope areas adjoining the project.	Due to the relatively small proportion of the community directly and indirectly impacted by the project, no significance impact to the community is likely.

Threatened ecological community	Direct impact assessment	Indirect impact assessment	Assessment of significance
	vegetation. CRAFTI mapping has broadly mapped about 14,287 hectares of vegetation with affinities to Subtropical Coastal Floodplain Forest within a 10 kilometre radius of the project. The project would result in the removal of about 0.6 per cent of the local distribution of this community.		This is a changed conclusion from the EIS and reflect the additional areas of community and reduced impacts of the project.
Swamp Sclerophyll Forest (Endangered TSC Act)	A total of 1254 hectares of Swamp Sclerophyll Forest has been identified within and surrounding the study area, of which the project would impact around 112.1 hectares in various condition states. The project would impact on 9 per cent of the known local distribution of this community.	A total of 44.2 hectares of this community could be vulnerable to indirect impacts. Areas of this community outside of the project boundary may potentially be affected by indirect impacts. Several identified areas of this community surrounding the project are also designated areas of SEPP 14 coastal wetlands.	Given the scale and magnitude of the impact across all project sections and the high potential for indirect impacts on an additional 44 hectares, the project has potential to significantly impact this ecological community. This is consistent with the conclusions of the EIS.
Swamp Oak Floodplain Forest (Endangered TSC Act)	A total of 426.8 hectares of Swamp Oak Floodplain Forest has been identified within and surrounding the study area. The project would impact on around 43.1 hectares of this community in various condition states. The project would result in the removal of 10 per cent of the known local distribution of these communities.	This community is susceptible to indirect impacts of altering hydrological and nutrient regime as it occurs in very low-lying land subject to periodic inundation and impacts from surrounding run-off from cleared land and surfaces such as roads. A total of 16.6 hectares of this community has been identified as being susceptible to indirect impacts, although these habitats show evidence of indirect impacts mainly from agricultural drainage and altered surface and groundwater regimes. Areas of this community outside of the project boundary may potentially be affected by indirect impacts. Several identified areas of this community surrounding the project are also designated areas of SEPP 14 coastal wetlands.	Considering the relatively small proportion of the community impacted the project and the current high levels of disturbance from indirect impacts, the project is unlikely to result in a significant additional impact to this ecological community. This is consistent with the conclusions of the EIS.

Threatened flora species

Rainforest flora populations

Two additional threatened species were identified in the project boundary in section 10 (*Streblus pendulinus* and *Acronychia littoralis*).The widening of the search area beyond the project boundary revealed several threatened species not previously identified and increased the known population size for several other species as shown in Table 3-11. For several species, the proportion of the population that would be impact by the project is now known to be lower than reported in the EIS.

In addition, impacts were further reduced through the design refinement at the interchange at Wardell (refer to Chapter 4). There remains the potential for indirect impacts to individuals in close proximity to the project boundary and these are identified in Table 3-11. These individuals are generally in habitats where new edges would be created and/or are downstream of the project boundary.

The design refinement has reduced the impact to around 2.5 hectares of subtropical rainforest habitat and 0.23 hectares of Littoral Rainforest which provides potential habitat for threatened rainforest flora species. There would be direct and indirect impacts to five threatened flora species (refer to Table 3-11).

Table 3-11 Comparison of impacts to threatened rainforest plants between the EIS and the supplementary surveys

Species	EPBC Act	TSC Act	Directly impacted		No. indirectly impacted	Total known population in study area
			EIS	Supplementary		
Acalypha eremorum (Acalypha)		E	0	0	0	71
Acronychia littoralis (Scented Acronychia)	E	E	0	1 (125 stems)	0	1 (125 stems)
Archidendron hendersonii (White Lace Flower)		V	6	0	**10**	20
Belvisia mucronata (Needle-leaf Fern)		E	0	0	0	53
Coatesia paniculata syn. *Geijera paniculata* (Axe-breaker)		E	0	0	0	25
Cryptocarya foetida (Stinking Cryptocarya)	V	V	13	13	0	88
Davidsonia johnsonii (Smooth Davidson's Plum)	E	E	0	0	0	1 (25 stems)
Endiandra hayesii (Rusty Rose Walnut)	V	V	5	3	**4**	30
Endiandra muelleri subsp. bracteata (Green-leaved Rose Walnut)		E	6	0	**2**	44
Macadamia tetraphylla (Rough-shelled Bush Nut)	V	V	37	1	0	99
Ochrosia moorei (Southern Ochrosia)	E	E	0	0	0	1
Streblus pendulinus syn. S. Brunonianus (Whalebone Tree)	E		0 (not listed at time)	8	**1**	43
Syzygium hodgkinsoniae (Red Lilly Pilly)	V	V	1	0	**1**	8
Tinospora tinosporoides (Arrow-head Vine)	V	V	0	0	0	60

The revised impact assessment including assessments of significance is provided in the Supplementary Biodiversity Assessment.

The following species were reported as not being impacted in the EIS and although the total number in the population estimates has been revised (refer Table 6-13) the impact from the project is unchanged:

- *Acalypha eremorum* (Acalypha).
- *Belvisia mucronata* (Needle-leaf Fern).
- *Ochrosia moorei* (Southern Ochrosia).
- *Geijera paniculata* (Axe-breaker).
- *Tinospora tinosporoides* (Arrow-head Vine).

Table 3-12 below provides a summary of the direct and indirect impacts (including design refinements which are detailed in Chapter 4 of this report) to the other identified flora species.

Potential impacts on these rainforest flora species and rainforest habitats would be mitigated through rehabilitation and management of remaining areas of rainforest habitat retained within the road boundary and proposed offset sites. The details of which are provided within the Lowland Rainforest and Threatened Rainforest Flora Management Plan in Appendix K.

Table 3-12 Assessment for threatened rainforest flora species

Species	EPBC Act	TSC Act	Direct and indirect impacts	Assessment of significance
Acronychia littoralis (Scented Acronychia)	E	E	This species was not assessed in the EIS. Due to the design refinement at the interchange at Wardell, this species was identified through field surveys and is newly impacted. A stand of *Acronychia sp*. was identified within a drainage line on the edge of the existing highway, north of Coolgardie Road. This stand appeared entirely clonal (estimated 125 stems). Due to uncertainty over the species, this plant is considered to be the threatened species *A. littoralis*. Due to its clonal nature, the 125 stems are one individual and not considered a population. The project would directly impact on this one individual. Around 14.4 hectares of potential Littoral Rainforest habitat for this species has been identified within and surrounding the project boundary in addition to marginal habitat types including Lowland Rainforest (81.4 hectares) and swamp sclerophyll forest (1254 hectares). Up to four hectares of potential habitat would be impacted by the project in this area including Littoral Rainforest, Lowland Rainforest and swamp sclerophyll forest.	The project would result in a significant impact on the species under Commonwealth and State assessment criteria. This is a changed conclusion from the EIS and reflect the additional population found during surveys.
Archidendron hendersonii (White Lace Flower)		V	Supplementary surveys revised the number of known individuals in the local population from 11 to 20. Due to design refinements, the project avoids direct impact to all individuals of this species. The EIS design directly impacted six individuals. The design refinement has also reduced the impact to the potential habitat (Lowland Rainforest) for the species. Ninety six hectares of potential Lowland and Littoral rainforest habitats for the species has been identified within and surrounding the project boundary. The project would result in the removal of 4.2 hectares of potential habitat for this species. There is potential for indirect impacts to 10 of the remaining individuals (within 25 metres of the project) due to edge effects from habitat removal and changes to hydrological regimes. Two of the 10 individuals are within four metres of the project construction footprint with the remaining eight individuals within 25 metres. The remainder of the population are situated over 50 metres from the project are would not be indirectly impacted.	The project would not result in a significant impact on this species.
Cryptocarya foetida (Stinking Cryptocarya)	V	V	The project would directly impact on 13 individuals of this species. In the EIS, surveys had only identified 17 individuals in the local population, resulting in an impact of 76 per cent of the population. Additional surveys undertaken outside the project boundary revised the known extent of the local population to 88 individuals. This has revised the project impact down to only 15 per cent of the local population. However the local population is likely to include additional individuals outside of the study area that have not been identified. Ninety six hectares of potential Lowland and Littoral rainforest habitats for the species within the area has been identified within and surrounding the project boundary. The project (including design refinements) has reduced the clearing for potential habitat of the species. The project would result in the removal of 0.23 hectares of littoral rainforest, 4.2 hectares of Lowland Rainforest, and 1.5 hectares of adjacent swamp sclerophyll habitats. The remaining individuals of the species are located in another Lowland Rainforest patch that is not directly impacted by the project and already subject to edge effects. As such, indirect impacts on this species from edge effects are not anticipated to be exacerbated by the project. As these individuals are located upstream of the project, indirect	The project would result in a significant impact on this species under Commonwealth and State assessment criteria.

Species	EPBC Act	TSC Act	Direct and indirect impacts	Assessment of significance
			impacts from altered hydrology regimes are not anticipated. The 13 individuals within the project boundary north of Coolgardie Road are separated by around 1.3 kilometres from other known locations of this species south of Coolgardie Road. These individuals could be regarded as a subpopulation within the local population. Removal of these individuals would potentially remove an existing 'stepping stone' for genetic exchange between subpopulations. Therefore there may be some impacts to the exchange of genetic material within the local population which may lead to a decrease in genetic diversity potentially decreasing the health and vigour of the population.	
Endiandra hayesii (Rusty Rose Walnut)	V	V	Supplementary surveys undertaken increased the known number of individuals in the local population of *Endiandra hayesii* from eight (as assessed in the EIS) to 30. The design refinements to the project have also reduced the number of individuals directly impacted from five to three individuals. As such, the project would directly impact 10 per cent of the known population in the study area. However the local population is likely to include additional individuals outside of the study area. Around 81.4 hectares of potential rainforest habitat for this species has been identified within and surrounding the project boundary, of which around 4.2 hectares would be impacted. The project would remove part of a vegetation patch that contain individuals of the species. Indirect impacts from edge effects are expected to occur to individuals up to 25 metres away, comprising four individuals. These individuals occur on relatively flat terrain and therefore are vulnerable to changes to hydrological regimes as a result of the project. The remaining 23 individuals are greater than 80 metres upstream of the project and no further clearing of habitat where these 23 remaining individuals are present would occur. Therefore indirect impacts from altered hydrological regimes and edge effects to these individuals are not anticipated to be exacerbated by the project.	The project would result in a significant impact on this species under the Commonwealth and state assessment criteria. These results are consistent with the conclusions from the EIS.
Endiandra muelleri subsp. bracteata (Green-leaved Rose Walnut)		E	Supplementary surveys undertaken further afield of the project, has increased the number of known individuals in the local population from eight (reported in the EIS) to 44 individuals. With the design refinements, the project has avoided impacting on any individuals. Around 84.1 hectares of potential rainforest habitat for this species has been identified within and surrounding the project boundary, with the project removing 4.2 hectares of potential habitat for this species and could indirectly impact two individuals within 25 metres of the project. These two individuals are potentially vulnerable to new edge effects from clearing of the rainforest patch where these individuals occur, as well as potential changes to hydrological regimes. The remaining 42 individuals are greater than 70 metres upstream of the project and would not be subject to indirect impacts.	The project is unlikely to result in a significant impact on this species under State assessment criteria.
Macadamia tetraphylla (Rough-shelled Bush Nut)	V	V	Supplementary surveys undertaken beyond the project boundary increased the number of individuals in the local population from 68 (reported in the EIS) to 99 individuals. The design refinements to the project have reduced the impacts from 37 individuals to one individual and reduced the impacts to the Lowland Rainforest habitat of the species down to 4.2 hectares (from 81.4 hectares of potential habitat within and surrounding the project boundary). The project would therefore impact on only one per cent of the local population. The remaining 98 individuals in the local population are located in habitat patches 24 metres upstream of the	The project is unlikely to result in a significant impact on this species under Commonwealth and State assessment criteria.

Species	EPBC Act	TSC Act	Direct and indirect impacts	Assessment of significance
			project and would not be directly impacted by the project. The subject habitat patch is subject to existing edge effects and the project would not create any new edges in these habitats and hydrological regimes are unlikely to be modified as a result of the project.	
Streblus pendulinus syn. S. Brunonianus (Whalebone Tree)	E		The listing under the EPBC Act for the species *Streblus pendulinus*, treated the species as being endemic to Norfolk Island and islands of the Pacific Ocean. However, recent taxonomic changes have resulted in the mainland species *Streblus brunonianus* being included with *Streblus pendulinus*. Previous surveys for rainforest plants in the study area were conducted prior to these changes and therefore the species was not assessed in the EIS. Supplementary surveys targeted this species in the study area, and recorded 43 individuals. Design refinements have increased the number of individuals of this species that would be directly impacted from seven individuals to eight. This impact constitutes around 19 per cent of the known population in the study area, although the local population is likely to include additional individuals outside of the study area. The project would result in the removal of 4.2 hectares of potential habitat for this species (from an identified 96 hectares within and surrounding the project boundary). The occupied area of habitat for this species within the project boundary comprises less than 0.1 hectares of rainforest. Rainforest habitats within and surrounding the project boundary are regarded as being critical to the survival of this species and around 19-21% is proposed to be directly and indirectly impacted. The project would create new edge effects due to partial removal of a vegetation patch that could indirectly impact one of the remaining individuals in close proximity (3.5 metres) to the project boundary. This single individual would potentially be impacted by edge effects due to removal of part of the rainforest patch where it occurs and as a result of altered hydrological regimes. The remaining 34 individuals are greater than 50 metres up slope of the project footprint and the project would not result in further clearing of the patch of rainforest habitat where they occur. Indirect impacts from altered hydrological regimes and edge effects are therefore not anticipated to be exacerbated by the project.	The project is unlikely to result in a significant impact to the local population.
Syzygium hodgkinsoniae (Red Lilly Pilly)	V	V	Supplementary surveys undertaken beyond the project boundary identified eight individuals of *Syzygium hodgkinsoniae*, compared to the one individual identified in the EIS. Design refinements have avoided direct impacts on this species. However, one individual occurs less than one metre from the project boundary and is likely to be indirectly impacted. Indirect impacts could consist of edge effects and altered hydrological regimes. An additional eight individuals occur around 4.5 kilometres to the north of this individual on the edge of the project boundary and are likely to be part of a separate subpopulation. These additional eight individuals occur around 175 metres upstream of the project and indirect impacts are not anticipated. This impact constitutes around 11% of the known population in the study area, however the local population is likely to include additional individuals outside of the study area. The design refinement would result in the removal of 4.2 hectares of potential habitat for this species (from around 81.4 hectares of potential rainforest habitat within and surrounding the project boundary).	The project would result in a significant impact on this species under Commonwealth and State assessment criteria. These results are consistent with the conclusions from the EIS.

Threatened flora populations

The impact assessment for threatened flora was revised from the EIS to incorporate further surveys undertaken in areas inside and outside of the project boundary. A number of additional threatened species were identified in the project boundary (including *Quassia sp. Mooney Creek* and *Eleocharis tetraquetra*). As expected, the widening of the search area beyond the project boundary revealed several threatened species not previously identified and increased the known population size for several other species. The comparison of impacts on threatened flora populations is provided in Table 3-12.

Table 3-13 Comparison of impacts on threatened flora populations

Species	EPBC Act	TSC Act	Section	No. impacted (EIS)	No / area impacted (Supp)	Total known population[1]
Angophora robur (Sandstone Rough-barked Apple)	V	V	3	6,893	7,056	125,076 (Clarence-Moreton Basin)
Arthraxon hispidus (Hairy Joint-grass)	V	V	10	9.8 ha	8.4 ha	21.3 ha (between Lumleys Lane and Coolgardie Road)
Eleocharis tetraquetra (Square-stemmed Spike-rush)		E	1	0	6 population clusters	11 population clusters (between Post Office Lane and Flinty Road)
Eucalyptus tetrapleura (Square-fruited Ironbark)	V	V	2	1,213	760	159,629 local population (Glenugie and Chambigne NR)
Grevillea quadricauda (Four-tailed Grevillea)	V	V	3	8	8	218 (north of Somervale Road, Tucabia)
Lindsaea incisa (Slender Screw Fern)		E	3	0.4 ha	0.4 ha	2.7 ha (Halfway Creek, Tucabia, and Mororo State Forest)
Marsdenia longiloba (Slender Marsdenia)	V	E	10	0	0	6 (between Wardell and Coolgardie)
Maundia triglochinoides		V	1	0.21 ha	0.23 ha	3.15 ha (Halfway Creek, Wells Crossing, Coldstream, Tucabia, Tabbimoble, New Italy)
Olax angulata (Square stemmed Olax)		V	2	1	1	Only one identified, no population found.
Phaius australis (Southern Swamp Orchid)	E	E	9	0	0	68
Quassia sp. Mooney Creek (Moonee Quassia)	E	E	1	0	35	899 (between Corindi and Dirty Creek)

The revised impact assessment including assessments of significance is provided in the Supplementary Biodiversity Assessment. Table 3-14 below provides a summary of the direct and indirect impacts to each of the species as a result of the project (including design refinements which are detailed in Chapter 4 of this report).

Table 3-14 Assessment for threatened flora populations

Species	EPBC Act	TSC Act	Direct and indirect impacts	Assessment of significance
Angophora robur (Sandstone Rough-barked Apple)	V	V	The project would see a small overall increase in the impact from 6,893 individuals to 7,056 individuals (an additional 163 individuals) on the listed Sandstone Rough-barked Apple (*Angophora robur*) (vulnerable TSC Act and EPBC Act). This is as a result of design refinements (refer to Chapter 4) and additional individuals identified in the project boundary during supplementary surveys. Impacts to individual *Angophora robur* patches are detailed in the Supplementary Biodiversity Assessment. This impact on 7,056 individuals represents 5.6 per cent of the local known population (125,076 individuals). Indirect impacts to the remaining individuals of *Angophora robur* adjacent to the project boundary may involve weed and disease invasion and impacts from potential contaminated surface runoff. These effects are not anticipated to be substantial and mitigation measures would manage these potential impacts. The project would be downstream of the majority of the retained individuals and indirect impacts from altered hydrological and soil conditions would be limited. Considering *Angophora robur* has been observed growing in edge affected habitats throughout the study area including roadsides, impacts from edge effects are not anticipated to significantly affect the growth or health of individuals. Indirect impacts to habitat for the species may extend up to 30 metres from the edge of the project, with around 20 kilometres of new edges being created through *Angophora robur* populations resulting in potential impacts to up to 60 hectares of habitat for *Angophora robur*. However, much of this area of habitat is up slope of the project and substantial indirect impacts are unlikely to occur.	The project would result in a significant impact to the species under the Commonwealth and state assessment criteria. These results are consistent with the conclusions from the EIS.
Arthraxon hispidus (Hairy Joint-grass)	V	V	Several large populations of *Arthraxon hispidus* have been recorded in Section 10 between Lumleys Lane and Coolgardie Road during the supplementary surveys (BAAM 2012). No additional populations or individuals were identified during the supplementary surveys during 2013. Design refinements in Section 10 have minimised impacts on known habitat for *Arthraxon hispidus* from 9.8 hectares to 8.4 hectares. The total area of occupied habitat identified in the study area comprises 20.9 hectares of which the project would directly clear around 40 per cent of the local population. Four distinct subpopulations have been identified, with all occupied habitats within 150 metres each other regarded as being part of the same subpopulation. The potential impacts on each subpopulation are summarised in the Supplementary Biodiversity Assessment. A relatively significant proportion of occupied habitat would be potentially impacted from the project, particularly for subpopulations 1, 2 and 3 with up to 37 to 69 per cent of these subpopulations being impacted. Only 16 per cent of the largest population (4) would be potentially impacted by the project. There is potential for the genetic diversity of these subpopulations to be depleted particularly for subpopulations 1, 2 and 3 which could lead to an inbreeding depression. There are opportunities to mitigate impacts on this species through the maintenance, restoration and management of the remaining population within the road boundary, and translocation of plants or soil-stored seed bank within the project boundary.	The project would still result in a significant impact to the local population of *Arthraxon hispidus* under Commonwealth and state assessment criteria. These results are consistent with the conclusions from the EIS.

Species	EPBC Act	TSC Act	Direct and indirect impacts	Assessment of significance
			Potential restoration and management measures may include seed collection and propagation, appropriate landscaping for the project, weed management and ongoing monitoring. There is potential for indirect impacts to modify the habitat attributes of the remaining areas of habitat that adjoin the project footprint. Some drying out of land around the population could result, but as the site is low lying on the floodplain, soil moisture is expected to remain damp enough for germination and growth of the species. There is potential for indirect impacts to at least five hectares of the remaining areas of occupied habitat. The total direct impact and potential indirect impact comprises 13.4 hectares. However this species favours disturbed and modified habitats and has potential to colonise areas disturbed by the project but there could be increased weed abundance and competition with the species.	
Eleocharis tetraquetra (Square-stemmed Spike-rush)		E	A population of *Eleocharis tetraquetra* was recorded in Section 1 during the supplementary surveys along tributaries of Redbank Creek. It had not been detected during earlier surveys and as such not assessed within the EIS. The species was found in two different populations. The two populations comprise five sub-population clusters along the edges of Redbank Creek and six population clusters along a tributary of Redbank Creek. The population number was difficult to determine due to the growth habit of this species. It was recorded in around 11 locations in moderate to high abundance. There are potentially other locations of this species upstream and downstream of the project boundary outside of the study area which would form part of the same populations. A total of six of the 11 population clusters would be directly impacted by the project and there is potential for indirect impacts on the remaining individuals. One of the two populations is completely within the project footprint on Redbank Creek and comprises five clusters. One cluster of the other population on the tributary of Redbank Creek is within the project footprint and the remaining five clusters are downstream of the project. Plants would be within the project boundary but not removed by construction, where practicable. Assuming all plants within the project boundary would be directly impacted the project would result in the removal of 100 per cent of the population on Redbank Creek and 17 per cent of the population on the tributary of Redbank Creek and the remaining population is susceptible to indirect impacts downstream of the project. Potential indirect impacts would mainly comprise altered hydrological conditions along drainage lines and pools where the remaining individuals occur. The known remaining individuals are downstream of the project on a tributary of Redbank Creek. There are several drainage lines crossing the project in this area and a mix of bridge and culvert structures would be used. Swamp forest habitats upstream of the remaining individuals feed water into the drainage line where this species occurs, and a culvert structure is proposed in this area. This is likely to alter the hydrological regimes of this creek line altering habitat conditions. The indirect impacts to the remaining five clusters of *Eleocharis tetraquetra* are largely unknown due to the potential changes in microhabitat features are not able to be accurately predicted as a result of altered hydrological regimes.	The project would potentially have a significant impact on this species.

Species	EPBC Act	TSC Act	Direct and indirect impacts	Assessment of significance
Eucalyptus tetrapleura (Square-fruited Ironbark)	V	V	The total number of individuals estimated to be impacted by the project was estimated in the EIS to be 1213 individuals. A detailed supplementary survey of the population number in Wells Crossing Flora Reserve was undertaken to confirm individuals present. Impacts to the population in the Wells Crossing Flora Reserve were reported in the EIS to comprise about 495 individuals based on available data. Direct counts within and directly adjacent to the project boundary during the supplementary surveys confirmed the presence of 272 individuals in Wells Crossing Flora Reserve of which only 137 would be directly impacted by the project. Overall, the project would impact on 855 individuals. The local population size is estimated to comprise 159,629 individuals, with an estimated proportion of the population impacted being 0.5 per cent. This project would have impacts to the local distribution of the species, removing part of the local gene pool and 22.2 hectares of known habitat for *Eucalyptus tetrapleura*. It is considered that there would be significant genetic diversity in the remaining 95 per cent of the population and sufficient habitat for pollinator species to avoid inbreeding depressions. While the project could result in indirect impacts to the species, considering the persistence of the species in edge effected habitats, indirect impacts not envisaged to be substantial particularly with the implementation of the proposed mitigation measures.	The project is unlikely to result in a significant impact on the species. When considering the cumulative impacts from the Glenugie upgrade and the project, however, there would be a significant impact. This is consistent with the conclusions of the EIS.
Grevillea quadricauda Four-tailed Grevillea	V	V	The EIS identified 208 individuals of this species in two sub populations. Supplementary surveys of the species have increased this number to 218 individuals. However, additionally identified plants would not be impacted by the project. The impact to the species remains as identified in Table 10-15 of the EIS, with only contain 8 individuals within the project boundary.	The project would not result in a significant impact on the species, which is consistent with the conclusions from the EIS.
Lindsaea incisa (Slender Screw Fern)		E	The EIS identified an impact on 0.4 ha of this species, with a known 2.7 hectare population. Through supplementary surveys, an additional small population of *Lindsaea incisa* was identified in the study area along an access track to a proposed ancillary site and well outside the project corridor in Section 3. The plants are able to be avoided through management measures and will therefore not be impacted by the project. As such, there would be no change in impact from the EIS and a revised Assessment of Significance is not required.	The project would result in a significant impact on the species, which is consistent with the conclusions from the EIS.
Marsdenia longiloba (Slender Marsdenia)	V	E	In the EIS, the project would not impact on any individuals of the species. Supplementary surveys identified an additional small population of *Marsdenia longiloba* outside the Section 10 project corridor and not expected to be indirectly impacted by the project. There has been no change in potential impact to the species. A revised assessment of significance is not required for this species.	There is no impact on this species, so no assessment of significance is required.
Maundia triglochinoides		V	Supplementary surveys identified additional populations of *Maundia triglochinoides* in Section 1 along tributaries of Redbank Creek and Cassons Creek and associated areas of swamp forest. This resulted in a small increase to the known population area of occupied habitat comprising an additional 1843 square	The project would potentially result in a significant impact to the

Species	EPBC Act	TSC Act	Direct and indirect impacts	Assessment of significance
			metres, and an increased direct impact to around 98 square metres. The project would involve direct impacts to around seven per cent of the known extent of the species in the study area, with 10 of the 16 population clusters being directly impacted of which two would be 100 per cent directly impacted and the remaining eight population clusters impacting between two and 60 per cent of the population cluster. Impacts to the individual population clusters are detailed in the Supplementary Biodiversity Assessment. The design refinement at Firth Heinz Road (refer to Chapter 4 of this report) would avoid direct impact to a known population. However, there is potential for indirect impacts. Potential indirect impacts to this species could arise from altered hydrological regimes in drainage lines and associated areas of swamp forest and billabongs, particularly populations and habitat downstream of the project. The indirect impacts to the remaining individuals are largely unknown as potential changes to microhabitat features are not able to be accurately predicted as a result of altered hydrological regimes. The remaining area of occupied habitat (an additional 9322 square metres) is downstream of the project and therefore at greatest risk of indirect impact. The total impact including direct impacts and potential indirect impacts comprises 11,603 square metres representing around 37 per cent of the known population in the study area. During detailed design, further refinement to the design in the areas around population 12 and 14 (sections 1 and 7) should be investigated to avoid or minimise impacts on these populations.	species.
Olax angulata (Square stemmed Olax)		V	The EIS assessed the potential impacts of the project on the Square-stemmed Olax (*Olax angulata*) considering the Department of Environment and Conservation/ Department of Primary Industries (2005) draft *Guidelines for Threatened Species Assessment*. The critical review has identified that an assessment of significance was not undertaken for this species under the EPBC Act according to the DEWHA (2009) assessment guidelines. The assessment of significance is provided in the Supplementary Biodiversity Assessment. One individual plant was identified in the construction boundary north of Halfway Creek at Section 2. Intensive general traverses were undertaken in areas radiating out from this single location in all directions to identify the spatial distribution and abundance. These surveys confirmed that this is an isolated individual and not part of an important population. The fleshy fruit of this species is potentially attractive to fruit-eating bird species and it is likely that the individual has established from dispersal of seed from population in proximity although not identified in the study area. The project will directly remove the individual identified, and around 60 hectares of comparable habitat in surrounding areas. The extent of comparable habitat outside the project corridor has not been identified although is considered extensive and well represented. A large population (5500 plants) is known from a small area east of Grafton, near Minnie Water and Wooli, mainly in Yuraygir National Park and on nearby leasehold land. Also known from an area north of Grafton in Ban Yabba Nature Reserve, Fortis Creek National Park and adjoining freehold land.	The project would not result in a significant impact on this species. This is consistent with the conclusion of the EIS.

Species	EPBC Act	TSC Act	Direct and indirect impacts	Assessment of significance
Phaius australis (Southern Swamp Orchid)	E	E	This species was not impacted in the EIS and not assessed. Supplementary surveys have identified a new population of the *Phaius australis* identified in Broadwater National Park to the east of the project in Section 9. This conserved population is at a suitable distance from the project where indirect impacts are not expected and as such an Assessment of Significance is not required.	There is no impact on this species, so no assessment of significance is required.
Quassia sp. Mooney Creek (Moonee Quassia)	E	E	Supplementary surveys identified a new population of Moonee Quassia (*Quassia sp. Moonee Creek*) within Section 1 of the project at station 8.5. The species had been previously identified through surveys in Section 3 of the project and had been assessed in the EIS. As a result of the finding of the new population in Section 1, a design refinement was undertaken to reduce the impact to the population. The detailed survey recorded a total of 899 stems of which 35 would be directly impacted (3.9 per cent of the local population) by the project. A smaller population was also identified further south and upslope of the known location and outside of the impact area. The total population consists of two clusters around 250 metres apart, which are considered to constitute a single population. The remaining individuals are all within 50 metres of the project, with up to 167 stems within 10 metres of the construction edge. There is potential for indirect impacts from the project to affect plants within 10 metres of the project. Indirect impacts could result from altered exposure and light levels, changed hydrological conditions and increased potential for competition from weeds and other flora due to the altered conditions. Including potential indirect impacts the project would potentially result in impacts to 22 per cent of the known population in this area comprising 202 stems.	The project would potentially result in a significant impact to this population. This is different from the conclusions of the EIS to reflect the impacts to the additional population.

Threatened fauna species

Pink Underwing Moth

This impact assessment has incorporated the findings of the supplementary surveys and the changes to impact from design refinements

The EIS design impacted directly on 6.4 hectares of known and potential habitat for the Pink Underwing Moth. Design refinements have reduced the direct impact to potential habitat to 2.5 hectares (Table 3-8) and no direct impact on known habitat and areas with the host plant of the moth (*Carronia multisepalea*).

The known and potential habitat are currently exposed to edge effects. The edge affected zone appears in the form of a denser understorey, more open canopy in parts and higher density of weeds, mostly Camphor Laurel and Lantana. There are no impacts from run-off at the site due to the slope of the site uphill from the cleared areas. Grazing impacts are evident in part of the rainforest (not impacted by the project) inhabited by the moth. Despite the existing edge effects the host plant (*Carronia multisepalea),* eggs and larvae of the Pink Underwing Moth were located within the edge zones.

The presence of the highway would contribute to indirect impacts at the current edge affected zone although it may be difficult to distinguish these from the existing impacts particularly where weed invasion is concerned. Additional indirect impact could result from dust settling on habitat areas and inhibit egg and/or larvae viability and changes in habitat structure (canopy and shade) that could also lead to competition with the host plant and decreased suitability for breeding and feeding.

However, altered night-time lights (vehicle and street lighting) and noise would be new impacts that may negatively impact on the species. There is no published research on the effects of lights on the Pink Underwing Moth. However, lights are not particularly attractive to species of *Phyllodes* moths (Dr Don Sands, pers.comm). Other artificial light sources, such as vehicle headlights are not expected to pose a significant threat to the moth, as these are transient rather than fixed. Nonetheless, the project has been relocated further east to minimise potential impacts from lighting to the habitat of the Pink Underwing Moth and the need for lighting reduced.

While the presence of the road corridor and traffic would inhibit movements of the moth, the environment currently has limited opportunities for dispersal to the east, largely due to the absence of preferred habitat.

The assessment of significance has been updated (refer to the Supplementary Biodiversity Assessment) and identified that the project would result in a significant impact to the Pink Underwing Moth. This is consistent with the conclusion in the EIS.

Koala

The koala populations noted in the EIS occurring north and south of the river (Section 9 and Section 10) are considered separate sub-populations. The northern sub-population is constrained by the river to the east however there is contiguous habitat to the west towards Tuckean Nature Reserve and north to Alstonville where there are other known koala populations. It is recognised that the highway would remove areas of known and potential foraging habitat in Section 10 and create a barrier for movements to the east and west near Coolgardie.

A further important population occurs in Section 7 to the east of the project and may use habitat in proximity to the highway south of Bundjalung National Park (Clarence Valley Council 2010). The distribution of koala activity for the Woombah sub-population shows an area of habitat with low koala use around 500 metres east of the Pacific Highway at this location. The current highway is a barrier to movements of koalas east and west in this location, and this barrier would be widened by the project with limited opportunities for crossing. The additional impact of habitat loss may occur on the west side of the highway, although would be minimal in this area.

Vegetation types containing koala feed trees within the project boundary are detailed in the Supplementary Biodiversity Assessment. The vegetation types are around 375.4 hectares of the vegetation to be removed as a result of the project (including primary and secondary habitat). In addition to the direct loss of feed trees and habitats, further adverse indirect impacts within a portion of the areas could be anticipated associated with edge effects, mainly weeds and run-off and altered microclimate conditions leading to small-scale dieback or reduced recruitment of new feed trees.

The assessment of significance has been updated for koalas (refer to Chapter 6 of the Supplementary Biodiversity Assessment) and has concluded that the project has potential to significantly impact on the important population identified in the Coolgardie-Bagotville area in project Section 10. This is consistent with the conclusions in the EIS.

Giant Barred Frog

The impact assessment has been updated to incorporate findings from the supplementary surveys. The project would cross over three waterways known to contain populations of the Giant Barred Frog and two other waterways which have suitable habitat (as detailed in section 3.2.4). The crossing of the waterways would involve the removal of riparian vegetation across the project boundary and therefore reduce the potential area of occupancy for the population. Indirect impacts may be associated with increased noise near the roadway, affecting the calling of breeding males and a temporary or even permanent disruption to breeding success. Other indirect impacts may be associated with road-run-off of pollutants form the road surface or sediment entering known habitats. The barrier effect of the highway may also negatively affect dispersal of individuals between home range areas.

The assessment has concluded that the project has potential to significantly impact on three identified populations in project sections 1 and 2.

Revised assessments of significance for fauna

The findings of the EIS assessment of significance for a number of species have been reviewed. The review has considered:

- The importance of the populations known to occur in the study area and the vulnerability of the species to the threats identified in the EIS.
- Whether the assessment of significance carried out for species groups with similar ecological requirements had adequately assessed the potential impacts from the project.
- Assessment of significance where changed impacts, including increases or decreases in impacts, or new information gathered from supplementary surveys were apparent.

Full details on the assessment of significance for all species is provided in section 6.4 of the Supplementary Biodiversity Assessment and also in Appendix E of the Working paper – Biodiversity.

The conclusions for the revised assessments of significance for fauna are provided in Table 3-2. Note the table only includes those species where only new work undertaken was to revise the assessments of significance.

Table 3-15 Revised assessments of significance for fauna

Fauna species	EPBC Act	TSC Act	Key changes to the assessments of significance
Atlas Rainforest Ground Beetle			Design refinements have reduced the direct impact to 2.5 hectares of potential habitat between stations 158.4 and 159.4. This habitat is considered to be marginal habitat. The alignment would fragment a patch of rainforest to the east of the road (1.5 ha) and isolate this patch for this flightless beetle. The total impacts may then equate to around 4 hectares with further indirect impact on the western patch remaining adjacent to the project. Indirect impacts may involve disruption of movement corridors or general disorientation due to artificial lighting, as well as the potential compromise of areas of known habitat adjacent to the project through a variety of indirect 'edge effects' (including, but not limited to, artificial lighting, road noise, dust and weeds). The assessment of significance for this species has been updated and identified that the project would have a significant impact due to potential impacts on lifecycle activities of the beetle.
Oxleyan Pygmy Perch	E	E	The impact assessment and assessment of significance has been updated for the Oxleyan Pygmy Perch due to changes to the project design. These design refinements (refer to Chapter 4 of this report) do not increase the impact on Oxleyan Pygmy Perch. As such the overall impact of the project on the Oxleyan Pygmy Perch has not changed from the EIS design. A revised assessment of significance is not required. However, the assessment of significance in the EIS did identify that the project would result in a significant impact to the species.
Common Planigale		V	Although the Common Planigale inhabits diverse habitats, the loss of over 925 hectares of vegetation represents a significant amount of potential habitat loss for the regional population. The Common Planigale has a small home range which may limit the size and distribution of local populations. Fragmentation of habitats and the barrier effect of the project may affect dispersal of individuals and reduce the opportunities to colonise currently unoccupied areas. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The impact is likely to be significant for a number of local populations; however the long-term impact on the regional population is unknown. In the absence of this information, as a precaution the project would have a significant impact.
Glossy Black Cockatoo		V	The range of vegetation types in the project area that support potential foraging and breeding habitat for the species includes 11 vegetation types. Around 650 hectares would be directly impacted by the project. The number of pairs that would be affected by the project is unknown, however the scale of habitat loss associated with the project would likely directly remove a number of current nest sites and a large area of feeding habitat. This species has a low birth rate, and impacts may lead to reduced breeding success and affect recruitment to local populations on a number of scales, which may take some years to recover. The assessment of significance has been updated from that identified in the EIS considering the extent and magnitude of the impact including clearing of potential nest trees and feed trees. The conclusion of the revised assessment of significance has confirmed that the project would not have a longer term significant impact to the regional population.
Three-toed Snake Tooth Skink	V	V	The potential habitat linked to this species and the area within the project is limited (with only 5.6 hectares present). The current information on this species suggests that only these select few habitat types may be occupied and Atlas data for the northern rivers region shows there are no records along the project boundary. The nearest record to the project occurs near Section 10 in sub-tropical rainforest habitat at Marom Creek several kilometres to the west of Wardell. As the species was not recorded in the study area and was only considered a low likelihood of occurring, an Assessment of Significance

Fauna species	EPBC Act	TSC Act	Key changes to the assessments of significance
			is not required.
White-crowned Snake		V	The range of habitat types potentially occupied by the species across the project is extensive and includes dry and moist sclerophyll forests and swamp forest types. Within the project corridor, these habitat types comprises 828.7 hectares of vegetation removal. If present, populations would be impacted by vegetation clearing and the loss of and isolation of suitable habitat. This would directly reduce the availability of foraging and sheltering habitat and reduce breeding success. Indirect impacts may be associated with weeds in edge affected zones as well as a potential change in the fire regime cause by accidental fires near the road. Altered fire regimes may also affect foraging and sheltering habitat. Suitable habitat is very widespread and impacts may affect low density local populations. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). However, the project is unlikely to be significant for the regional populations.
Varied Sittella		V	The Varied Sittella and its favoured habitat are likely to be very widespread across the project which would include the drier eucalypt forests. Across the project, there is 734.7 hectares of suitable habitat. The native vegetation cleared by the project would contribute to a reduction in prey availability on a local scale. Given the species favours habitats that are well–represented and widespread, the project would likely have minimal impact to the regional population and only a small number of local populations may be significantly impacted. Persistence and recovery of populations surrounding the project could be expected. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The assessment of significance indicates that the project is unlikely to have a significant impact for the regional populations.
Eastern Pygmy Possum		V	The Eastern Pygmy Possum (*Cercartetus nanus*) and its favoured habitat are likely to be very widespread across the project (comprising 931.7 hectares) which would include the drier eucalypt forests, heath and rainforest habitats. This clearing would remove shelter and food resources and reduce breeding success, and dispersal between populations. As the species has a very small home range, if the project has the potential to completely remove and / or isolate populations over multiple areas, if populations are present in the project area. The project has potential to impact on multiple local populations at a range of scales by directly clearing suitable habitat, altering the home range and dispersal capabilities of individuals and removing shelter and food resources. This species is expected to be widespread, however on a localised scale; these losses may be significant and lead to a reduction in population viability through isolation, competition for resources and stress. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The project is not anticipated to have a significant impact on the species.
Green-thighed Frog		V	A critical review of the biodiversity working paper has identified that the assessment of significance for the Green-thighed Frog under the EP&A Act indicates that a significant impact is likely however a non-significant conclusion has been reported in the summary (Chapter 6 of the Working paper – Biodiversity). This conclusion in Chapter 6 is incorrect and should indicate a significant impact for this species.
Australasian Bittern	E	E	The project traverses around 5.1 hectares of freshwater wetlands, which is favoured habitat for the species. In addition, around 41.4 hectares of wetland were identified in surrounding areas immediately adjoining the project that may be indirectly impacted from run-off of sediment or pollutants during construction and operation. However, it is noted that this species exhibits some resilience by occupying

Fauna species	EPBC Act	TSC Act	Key changes to the assessments of significance
			wetlands modified by draining, grazing impacts and weeds. Impacts may be associated with removal of nesting, foraging and roosting habitat and have an indirect impact on breeding success and dispersal as well as indirect impacts on habitat associated with edge effects, lights and noise, these would be localised in relation to home range and territory. The number of pairs potentially affected is not known. There is expected to be several pairs in the floodplain areas of the Clarence River. Fragmentation of habitat may occur through the crossing the Coldstream wetlands, however in general, the potential habitat of the species has been avoided such that the areas impacted are those located on either side of the project. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The project would not significantly impact local populations.
Australian Painted Snipe	V	E	The Australian Painted Snipe has been recorded in the Coldstream and Clarence River floodplains wetlands in Section 3 and in Section 4 Impacts may be associated with the removal of nesting, foraging and sheltering habitat of around two hectares of wetlands on the Clarence and Coldstream River floodplains. There may be indirect impacts on breeding success and dispersal as well as indirect impacts on habitat associated with edge effects, lights and noise, these would be localised. As the project would only have a low direct impact on the habitat of the species compared to remaining areas of suitable habitat, and the species tolerance of modified habitats, it is likely that the project would not significantly impact local populations.
Black-necked Stork and Brolga		E / V	Both species are tolerant of and frequent modified habitats which includes wetlands modified by draining, grazing impacts and weeds. As the project traverses a portion of the floodplains of the Clarence River, Richmond River and Corindi River, this would result in direct impacts to around 5.1 hectares of freshwater wetlands. Around 46 hectares of wetland were identified in surrounding areas immediately adjoining the project that may be indirectly impacted from run-off of sediment or pollutants during construction and operation. Potential habitat for these wetland bird species is widespread through the study area and adjacent to the project boundary including dense vegetation on the margins of freshwater creeks, rivers and natural or artificial wetlands. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The project would not have significant long term widespread impacts to the local and regional populations.
Black Bittern		V	The distribution of the Black Bittern is difficult to determine. The project would cross 20 class 1 waterways and seventy-four class 2 waterways which could constitute potential habitat for this species. Impacts would be associated with the crossing of these waterways and the direct clearing of riparian vegetation and potential indirect impact to adjacent areas through edge effects. The noise and lights associated with the road may make areas of habitat in proximity of the project no longer suitable and therefore impact on the territory and spatial distribution of individuals or established pairs. Indirect impacts would be associated with the potential for increase run-off in the catchment and sediment and nutrient loads into the waterway habitats and the effect on food resources. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The impact of the project on these populations would not be significant.
Magpie Goose, Freckled Duck and Comb-crested Jacana		V	All three species share similar habitats and prefer shallow freshwater wetlands with dense growth of rushes or sedges, particularly floating vegetation for the Comb-crested Jacana. The project would result in direct impacts to around 5.1 hectares of freshwater wetlands. These species exhibits some resilience by occupying wetlands modified by draining, grazing impacts and weeds. Impacts may be associated with removal of nesting, foraging and roosting habitat and have an indirect impact on breeding success and dispersal as well as indirect impacts on habitat associated with edge effects, lights and noise, these would be localised in relation to

Fauna species	EPBC Act	TSC Act	Key changes to the assessments of significance
			home range and territory. The number of pairs potentially affected is not known. There is expected to be several pairs in the floodplain areas of the Clarence River. Fragmentation of habitat may occur through the crossing the Coldstream wetlands, however in general the potential habitat of the species has been avoided such that the areas impacted are those located on either side of the project. For this reason the isolation of populations is not expected and is further supported by the mobility of the species and ability to disperse cleared lands to access suitable habitat. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The project would not significantly impact these species.
Pale-vented Bush Hen		V	The range of potential habitats and possible distribution for the Pale-vented Bush-hen species in the study area is extensive. If present, populations would occur in floodplain areas, which may include cleared land or low-lying forests and rainforest near waterways. This would suggest that habitat near Eversons Creek in Section 9 and Randle Creek in Section 10 would be suitable and potentially also within Broadwater National Park (Section 9). Impacts may be associated with the removal of nesting, foraging and sheltering habitat which is difficult to quantify given the range of habitats used and known occurrence in modified and cleared landscapes. There may be indirect impacts on breeding success and dispersal. Edge effects are not expected to significantly impact on the species which is reportedly adapted to dense weedy habitats and disturbed land and may favour this disturbance for shelter, refuge and breeding. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The project is not expected to have a significant impact on this species.
Double-eyed Fig Parrot	E	CE	The species is associated with five discrete populations, all of which occur outside the study area, mainly north and west of Ballina and is considered unlikely to be resident or heavily dependent on smaller fragments of rainforest within or around the project boundary. The clearing of habitat for the project, in particular Lowland Rainforest (4.2 hectares) and some wet/moist sclerophyll forest (225 hectares) would affect the current availability of food resources and therefore may have a minor impact on the foraging and roosting activities of the species. As the documented breeding populations all occur outside of the study area any impacts from the loss of habitat along the project boundary is more than likely affecting foraging resources rather than a significant breeding/nesting area. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The project would not have a significant impact on the species.
Barred Cuckoo-shrike		V	The range of potential habitat for the Barred Cuckoo-shrike in the region is extensive and it is difficult to predict or quantify the potential direct and indirect impacts. It is a wide-ranging species that feeds on fruits and insects and may move nomadically in response to changing food resources which are widespread. There is no reliance on tree hollows for nesting. The project would include extensive clearing of habitat that could provide food resources, shelter and breeding habitat for the species. However, given the broad habitat needs of the species the impact would likely be low, localised and of short-term duration. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment). The project would not have a significant impact on the species.
Wompoo Fruit-Dove, Rose-crowned Fruit-Dove and Suberb Fruit		V	The birds are locally nomadic, travelling large distances to access seasonally available ripening fruit which may be available in large remnants or across a network of smaller fragmented remnants in floodplain areas such as the study area. The preference is for larger mature fruit-bearing trees. There are no documented local populations in the study area and any use of the habitats along the project would be temporary and to access available food resources. The clearing of habitat for the project in particular, Lowland Rainforest (4.2 hectares) and wet/moist

Fauna species	EPBC Act	TSC Act	Key changes to the assessments of significance
Dove			sclerophyll forest (225 hectares) would affect the availability of food resources for local populations. The distribution of the fruit-doves is very widespread across the region reflecting their nomadic movements in relation to spatially and temporally separated food resources. However, due to design refinements to minimise impacts to rainforest communities, the project is unlikely to result in a significant impact on this species. The assessment of significance has been updated based on these findings (refer to Chapter 6 of the Supplementary Biodiversity Assessment).
Rufous Bettong and Brush-tailed Phascogale		V	Mapping of the potential habitat of these two species across the project boundary has been provided in the Supplementary Biodiversity Assessment to guide future fauna surveys and development of the connectivity strategy and ecological monitoring programs.
Green and Golden Bell Frog	E	E	The EIS biodiversity assessment reported a low likelihood of occurrence for the endangered Green and Golden Bell Frog (*Litoria aurea*) (EPBC Act and TSC Act) across all project sections. This is supported by the results of the field surveys conducted for the EIS and most recently, during detailed design studies for project Sections 1 and 2 and the lack of records from the NSW Atlas of Wildlife. There are no populations recorded in the study area and the species likelihood of occurrence is considered low or unlikely on the basis that it was not recorded during the preferred route field surveys and fits one or more of the following criteria: • Has not been recorded previously in the project study area/ surrounds and for which the study area would be beyond the current coastal distributional range. • Requires species specific habitats or resources that have not been identified in the study area. Therefore, based on the above it is concluded that the project would not impact on a local or regional population of the Green and Golden Bell Frog and no Assessment of Significance is required.
New Holland Mouse	V		The habitat of the New Holland Mouse (*Pseudomys novaehollandiae*) is restricted in the project corridor (only 26.4 hectares), but is well represented in surrounding coastal areas in particular Bundjalung National Park, Broadwater National Park, Yuraygir National Park, and the east of the project corridor near Wardell in open sandy heath country. The project has potential to clear relatively small areas of suitable habitat, mainly along the edge affected areas of Broadwater National Park in section 9. The distribution of populations is not known. This clearing would remove shelter and food resources and reduce breeding success, and dispersal opportunities between populations. As the species has a very small home range, the project has the potential to completely remove and / or isolate populations. However for the Broadwater National Park, it is possible that populations are already fragmented by the existing highway and that the inclusion of four key connectivity structures (two overpasses and two underpasses) to re-establish a link will significantly improve connectivity for this species. The assessment of significance has identified that the project would not have a significant impact on the species.

Groundwater impacts at cutting sites

An analysis of the impacts on groundwater dependents ecosystems (GDEs) (including threatened terrestrial and aquatic species and ecological communities) from deep cuttings on the project has been undertaken. Those cutting sites (known as Type A cuttings) have a high risk of intersecting groundwater were identified in the EIS (Working paper – Groundwater). These cuttings, before mitigation, have the potential to reduce groundwater flow to adjoining local creeks, streams, springs and local water resources in the vicinity of the cut (within around 100 metres of the cutting).

To assess how this potential impact may indirectly affect threatened species and GDEs, a review was undertaken of all Type A cuttings. This assessment identified potential habitats within two hundred metres of a cutting, including Matters of National Environmental Significance (MNES), state-listed wetlands, and known or potential threatened species habitat. Each cutting was ranked for risk for impacts.

The potential risks at each site are identified in Table 3-16. Table 3-16 identifies those sites (6) with a moderate to high risk of impacts to GDEs. The review of Type A cuttings near GDEs is provided in section 6.5 of the Supplementary Biodiversity Assessment.

Discussion of impacts at these sites is provided in the following sections.

Threatened ecological communities

There are a number of threatened ecological communities (TECs) occurring on the floodplains that are watercourse and groundwater related GDEs. A number of these occur within two kilometres of a cut site, although none with 200 metres and therefore the risk to these communities is considered low. There are no groundwater reliant Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East bioregions TEC within this category.

All areas of identified floodplain TECs on the project exhibit current disturbance regimes associated with a history of altered surface and groundwater hydrology, broad-scale clearing of the floodplain and fragmentation and weed invasion leading to a general degradation of the vegetation. The drawdown of groundwater has potential for further impacts on these TECs associated with stress on mature trees leading to changed structure and community floristics potentially towards drier habitats. This increases their vulnerability to weed infestation and dieback. There may be a flow-on effect for water dependent biodiversity, including threatened flora and fauna. The impact is likely to be localised around cut areas (up to 100 metres as discussed) and is able to be mitigated to a degree, to reduce the short-term and long-term impacts.

SEPP 14 Wetlands

The review has identified a number of the gazetted SEPP14 wetlands in Table 3-16 that occur within a range of between 240 metres to 1.6 kilometres from a cut site. There are no SEPP14 wetlands within 100 metres from a cut site and the risk of indirect impacts is considered low. Two wetlands are located at 240 metres which is also expected to be outside the zone of impact.

Threatened aquatic species

With the exception of one cutting site, all other Type A cuttings are located beyond 200 metres of potential habitat of Oxleyan Pygmy Perch and are considered low risk.

A sites at Station 114.1 is considered high risk and would need to be monitored. Station 114.090 is located within 100 metres of a known population of the Oxleyan Pygmy Perch. This is a small unnamed watercourse and localised drawdown has the potential to isolate pools along the creek. The isolation of pools along this creek occurs naturally, as already noted from the targeted surveys, and Oxleyan Pygmy Perch were already noted from one large pool. The species is adapted to this natural ecological process throughout its range and relies on flooding events for dispersal. Proposed mitigation would assist in managing this impact.

Table 3-16 Moderate to high risk cutting sites for impacts to groundwater dependent ecosystems

Stations	Over or next to aquatic systems	Threatened ecological community (within 1 km)	Biodiversity values including MNES within 2km	Risk category
Section 5				
95.1	Mororo Creek (135 m W)	Close to Subtropical Coastal Floodplain Forest on Coastal Floodplain	Habitat critical to the survival of Koalas Known Koala Habitat Mororo Creek Nature Reserve	Moderate, mitigation and monitoring impacts required
Section 7				
114.1-114.6	No	Partially Subtropical Coastal Floodplain Forest on Coastal Floodplain	Known OPP habitat (unnamed streams) (90 m S) Tabbimoble Swamp Nature Reserve Tabbimoble Floodway No.1 (Potential OPP habitat) Habitat critical to the survival of Koalas	High, mitigation and monitoring of impacts required
125.3-125.4	Adjacent to floodplain wetland	Close to Swamp Sclerophyll Forest on Coastal Floodplain	Habitat critical to the survival of Koalas Potential habitat for Australasian Bittern and Painted Snipe	Moderate mitigation and monitoring of impact required
Section 9				
144.8-144.9	Richmond River (800m N)	Swamp Sclerophyll Forest of Coastal Floodplain	SEPP No. 14 wetland 118, 118a (>1 km) Habitat critical to the survival of Koalas High density Koala population, and koala feed tree species	Moderate, mitigation and monitoring of impacts
149.0-149.1	No		SEPP No.14 wetland 118 (>1km) Habitat critical to the survival of Koalas High density Koala population and Koala feed trees species present	Moderate, mitigation and monitoring of impacts required
157.1-157.6	No	Partially Lowland Rainforest of Subtropical Australia and Lowland Rainforest on Coastal Floodplains Partially Subtropical Coastal Floodplain Forest on Coastal Floodplains Partially Swamp Oak Floodplain Forests on Coastal Floodplains	SEPP No. 14 wetland 112a (1.3 km) Habitat critical to the survival of Koalas High density Koala population Known habitat for Pink Underwing Moth (upslope) Lowland Rainforest of Subtropical Australia (upslope) *Arthraxon hispidus*, *Cryptocarya foetida, Endiandra hayesii, Macadamia tetraphylla*, *Syzygium hodgkinsoniae*	Moderate, mitigation and monitoring of impacts required.

Threatened terrestrial species

Non-gazetted wetlands do occur closer to the project although none of the proposed cut sites would occur directly over an aquatic habitat. There are a number of sites that would occur within proximity to a wetland or waterbody. However, from most of the site, these risks are considered to be low due to the distance between the cutting and the wetland or waterbody.

However, the cutting at station 125.3 to 125.4 is located within 200 metres of a floodplain wetland. This shallow wetland was observed during the assessment field surveys and found to be dry at the time, indicative of a natural wetting and drying regime. The wetland is densely vegetated and provides potential habitat for wetland birds including the Australasian Bittern and Australian Painted Snipe during wet periods. Construction of the cutting at Station 123.5 to 123.9 would need to consider how this wetting and drying regime would be maintained.

Habitat critical the survival of Koalas was identified as widespread across all project sections and related to the presence of Koala feed tree species at suitable densities within the canopy. Those habitats that are associated with Subtropical Coastal Floodplain Forest and Swamp Sclerophyll Forest can contain the primary feed tree species Swamp Mahogany (*Eucalyptus robusta*) and Forest Red Gum (*E.tereticornis*). These habitats may be susceptible to changes in groundwater flows as a result of drawdown from cutting sites across the project.

The sites that are considered a potential moderate to high impact to koala habitat are detailed below.

- Cutting at station 95.1 to 95.4 is located within 100 metres of Mororo Creek which flows through the Mororo Creek Nature Reserve that contains GDEs and critical habitat for the Koala. There is potential is localised impacts along the watercourse given its proximity to the project boundary, this is a high risk site.
- Cutting at station 144.8 is located over an isolated patch of Swamp Mahogany dominated forest that is known habitat for the Broadwater Koala population (Section 9). This is a small cutting and the road would dissect this habitat patch potentially affecting future use by Koalas despite the targeted placement of crossing structures. Potential impacts may arise from long-term draw down of groundwater in proximity to the site, that may cause dieback of koala feed tree species located here including possible home range trees.
- Cutting at station 149.1 is located with 150 metres of a large area of Swamp Mahogany dominated forest stretching north and south of the Old Bagotville Road on the eastern side of the project (Section 10) and within the range of the Bagotville-Coolgardie Koala population. Impacts may be localised and include dieback of koala feed trees, including home rage trees. Although this swamp forest stretching over a large area several hundred metres from the project outside of the zone of influence and is not restricted to the impact area.
- Cutting at station 157.1 is located immediately adjacent to large patch of Forest Red Gum and Swamp Mahogany dominated swamp forest that is known Koala habitat south of the Wardell interchange. This habitat is a GDE and there may be localised drawdown impacts adjacent to the road. The habitat extends beyond 100 metres from the road.

3.2.5 Recommendations and management measures

Review of effectiveness of management measures

A review of the proposed connectivity structures and other management measures for the project was undertaken to assess their effectiveness. This assessment addressed:

- Review of koala connectivity structures
- Location of connectivity structures in cleared areas.
- Appropriate number and location of connectivity structures.

Koala connectivity structures

The proposed connectivity structures were reviewed in light of recent monitoring and studies undertaken on the Pacific Highway (refer to section 7.2.1 of the Supplementary Biodiversity Assessment). The review focuses on mitigation measures provided in Section 5, 9 and 10 aimed at the important populations identified and specially targeted at koalas. The review considered the location, landscape, use of fencing and dimensions and type of structure.

Based on the additional information from the supplementary surveys, a review of the suitability of connectivity structures to the important koala populations in the north was undertaken, as shown in Table 3-17.

Further details (particularly on structures through sections 9 and 10) are provided in section 7.2.1 of the Supplementary Biodiversity Assessment.

Table 3-17 Review of koala connectivity structures for important koala populations

Project section	Proposed structure	Assessment of suitability and recommendations
5	Mororo Creek area (Woombah)	The distribution of koala activity for the Woombah sub-population reported in CVC (2010) shows an area of habitat with low koala use around 500 metres east of the Pacific Highway between station 95.7 and station 97.1. The connectivity strategy considered the need to provide connectivity between Bundjalung National Park and Mororo Creek Nature Reserve and was constrained by the presence of the existing Iuka Road intersection and proposed new interchange which sits directly at this location and is not suited to directing animals. The nearest structure to this is a dedicated underpass that has been located north at Station 99.7 (3 x 2.4 metres RCBC 44 metres in length) to provide connectivity for fauna across an important regional corridor while this structure is appropriately located it leaves a gap between Station 95.7 and Station 97.1 where there are no structures proposed. Much of the land on the western side of the highway in this location is cleared, however there are two possibilities for connectivity which should be considered further in the detailed design. It should be noted that there are very low fill heights in this area which would constrain design capabilities. As such other locations could be considered appropriate. Station 96.7 – there is a narrow riparian strip of vegetation connecting Mororo Creek which continues to the Reserve. Station 95.8 to 96.0. This sits adjacent to a proposed Ancillary Facility site (Section 5, site 6). This site reported koala activity as did the adjoining reserve and was suggested to be revegetated post construction and added to the reserve system
9	South of the Richmond River, a proposed Broadwater viaduct is planned, at station 145.1 and fauna exclusion fencing from 142.80 to 145.120	A small area of known koala habitat would become isolated on the western side of the highway between station 143.7 and 145.0 which is currently connected with Broadwater National Park. The proposed viaduct is too far north and outside of koala habitat to provide viable connectivity here. A review of the structures proposed in this location has identified an opportunity to upsize two drainage structures located at Station

Project section	Proposed structure	Assessment of suitability and recommendations
		144.2 and 144.7 both to a 3.0 m x 3.0 m box culvert, which would provide improved connectivity for koalas in this location. This would require an increase in the grade of the highway at both locations and would be considered further during detailed design. Fauna exclusion fencing is appropriate in length. It is recommended that strategic planting of koala habitat within the current sand-quarry site (station 144.4) post-construction should be considered in consultation with the property owner to reinforce connectivity on both sides of the highway.
9	Broadwater National Park, two overpasses planned at 138.7 and 139.9	Location of structures is appropriate based on koala activity reported at these locations on both sides of the highway and known Koala population in Broadwater National Park to Riley's Hill.
10	Too few structures between Richmond River and Thurgates Lane and structures placed too far apart. Fencing length is appropriate	A review of the structures proposed in this location has identified an opportunity to place additional structures and upsize existing structures to close the gap. The list of structures proposed now are: 146.3 – 3x 3 metre box culvert (existing) length 44 metres. 146.6 – 3x3 metre box culvert (up-sized) length 55 metres. 147.6 – Fauna land bridge (new structure) 120 metres x 30 metres. 148.6 – 3x3 metre box culvert (new structure) length 60 metres. Also recommend strategic planting of koala habitat post-construction to reinforce connectivity.
10	North Wardell fauna overpass bridge at station156.0	Location of structure has been moved about 100 metres east as part of the design refinement, however, would still be appropriate for koala connectivity. Connects large areas of koala habitat and known population in the Wardell area through to the north in an important corridor linking with habitat in the Meerschaum Vale and Coolgardie area and provides for dispersal of koalas north and south (Richmond to Lismore). Revegetation of the approaches to this bridge is required, particularly on the south side which is currently cleared.
10	Kays Road south of the Wardell Interchange 156.3 a combined drainage, fauna underpass is planned (3.3 x 1.2m high) and 156.9 combined culvert 1.8 x 1.2m high, with koala fencing from station 146.1 to 159.7.	These structures are planned in low-lying land with limited fill heights. The design refinement at Coolgardie interchange has seen the road raised slightly and can accommodate larger structures and this is recommended. Koala activity was reported on either side of Kays Road and also south of Laws Road near the existing highway. These locations would be fragmented to the east of the new road between station 156.7 and 157.4. The culvert at station 156.9 should be revised and upsized if possible. Further connectivity consideration is required here at detailed design. The fauna exclusion fence extends to station 159.7 and is considered appropriate in this location.

Connectivity structures in cleared areas

The EIS recognised that some cleared land occurs adjacent to proposed crossing structures and discussed the need to restore connectivity where possible through strategic revegetation in these areas. This would only be feasible in a few locations such as on Roads and Maritime land, within the road reserve or on acquired properties. The effectiveness of the remaining structures located adjacent to privately owned land may be compromised. This is a summary of the assessment undertaken. Further detail on the review against all combined and dedicated structures on the project is provided in Chapter 7 of the Supplementary Biodiversity Assessment.

Of the 112 dedicated and combined connectivity structures proposed, 79 structures (70 per cent) adjoin vegetation on both sides of the road. The remaining structures adjoin cleared land on at least one side of the road. These include 27 structures (24 per cent) on private land and six structures (five per cent) on land owned by Roads and Maritime. Of the 27 structures adjoining private cleared land, three of these are targeted at Coastal Emus where the approaches need to be kept clear to provide the birds with a clear line of sight in order to attract use of the structures. Four structures are targeted at Oxleyan Pygmy Perch and therefore the degree of vegetation on the land is considered unlikely to negatively influence the effectiveness of the structure for this species. Connectivity structures that front onto cleared land owned by Roads and Maritime are able to be re-vegetated to improve the effectiveness of the structures.

In summary, the review identified that 82 per cent of the structures proposed would retain the existing vegetation or would be re-vegetated are considered optimum for the target species. The remaining 18 per cent (20 structures) would require additional strategic revegetation in the road reserve to improve their effectiveness, as described in section 7.2.2 in the EIS. It is worth noting that, of these 20 structures, seven are targeted at Rufous Bettong and Brush-tailed Phascogale, both species known habitat in the study area consists of cleared and modified land. The apparent lack of vegetation at these structures would not reduce the effectiveness of these structures for these target species.

Appropriate number and location of connectivity structures

The EIS reports significant regional links in the landscape that would be intersected by the project in Sections 1 and 2 and Sections 6 and 7. This includes several named regional corridors recognised in DEC 2003. A review of the number and types of structures in these key project areas has been undertaken (refer to Table 3-18).

Table 3-18 Review of connectivity structures in Sections 1-2 and 6-7

Project section	Proposed connectivity structures
1-2	• Five bridges with fauna passage beneath and retained along river banks. • Twenty combined drainage / fauna passage culverts in wet areas. • Four dedicated underpasses in dry sclerophyll forest for fauna movements. • One dedicated underpass in swamp forest. • Five arboreal crossings targeting gliders. • A central median specifically made wider for arboreal mammal crossing.
6-7	• One dedicated overpass structure linking Tabbimoble Swamp Nature Reserve (80 metres x 30 metres). • Three bridges including two across identified major waterways and potential habitat for Oxleyan Pygmy Perch. • A dedicated dry sclerophyll forest underpass structure, within known wildlife crossing location linking Mororo State Forest. • One dedicated culvert structure in dry sclerophyll forest for fauna movements. • Two arboreal crossing structures targeted at gliders. • Three combined culverts in wet areas designed for combined drainage and fauna capabilities. • A central median specifically made wider for arboreal mammal crossing.

The review has identified two key issues where landscape linkages and connectivity structures in regional corridors are deficient and would need to be addressed in detailed design:

- There are only 11 structures and one widened median in Sections 6-7 over a distance of 24 kilometres. This equates to one structure every two kilometres, which is not consistent with the connectivity goal presented in the EIS of maintaining and improving movement pathways for all fauna groups.
- The targeted strategy for threatened gliders over the entire project provides seven arboreal crossings, three widened medians and five land bridges with glider poles over a distance of 155 kilometres. This equates to around one structure every 11 kilometres. Even with the subtraction of

5.4 kilometres of habitat in Section 11 and large portions of Section 5 that both are sections considered unsuitable for threatened gliders, it is likely that this would be insufficient.

The connectivity strategy (EIS) and threatened species management plans have described the need to refine locations of connectivity structures based on the findings of the targeted surveys to be undertaken at detailed design stage. This process would address the shortfalls identified above, with a view to adding additional structures, where feasible.

Management plans

Included as Appendix K to this report are a number of threatened species management plans. These plans address management measure B11 in the EIS. These plans provide species specific management measures and monitoring required for a range of threatened flora and fauna species.

The management plans prepared are:

- Threatened flora management plan.
- Rainforest invertebrate management plan.
- Emu management plan.
- Purple-spotted Gudgeon and Oxleyan Pygmy Perch management plan.
- Threatened frog management plan.
- Koala management plan.
- Threatened mammal management plan.
- Glider management plan.
- Lowland Rainforest and threatened rainforest plants management plan.

The plans are dynamic documents that would be refined and further developed during detailed design to incorporate new design work and findings of the proposed baseline monitoring to be undertaken. Roads and Maritime will finalise the management plans in consultation with the Department of Planning & Infrastructure, NSW Office of Environment and Heritage, Commonwealth Department of Environment and Department of Primary Industries (Fisheries), as relevant.

As the project progresses to construction, the management plans would be tailored (where required) for the individual construction stage (which could consist of a number of project sections or one single project). Following approval of the plans and identification of staging priorities, the Roads and Maritime, the construction contractor and the contractors ecologist engaged for the relevant project sections would be responsible for the implementation of the plans.

Given the development of the management plans since completion of the EIS, the project management measures relating to the management plans have been updated (refer to Table 3-19).

Table 3-19: Mitigation measure for threatened species management plans

Issue	ID number	Mitigation measure	Timing	Relevant section
Threatened species management sub-plans	B11	The threatened species management plans prepared for the project will be finalised, as relevant to the element of the project to be constructed. Development of the plans will include responding, where feasible and reasonable to: • Recommendations from expert review undertaken as part of the Submissions / Preferred Infrastructure Report (and detailed in section 1.4 of the management plans). • Any conditions of approval. • Results from baseline monitoring undertaken. The threatened species management plans will be finalised in consultation with the relevant State and Federal government agencies.	Pre-construction	All
Maundia triglochinoides	B61	Detailed design will investigate measures to reduce impacts to *Maundia triglochinoides*: • Near Redbank Creek (population 14). • Near North of New Italy (population 12).	Pre-construction	1 and 7

Biodiversity offsets

The Woolgoolga to Ballina upgrade EIS (Roads and Maritime, 2013) identified that biodiversity offsets would be required for the project for Commonwealth and NSW listed threatened species. A preliminary strategy ('Biodiversity Offset Strategy') was included within the Working paper – Biodiversity to outline the process.

Since exhibition of the EIS, Roads and Maritime has undertaken further investigations into the required offsets, with a focus on those significantly impacted and high priority Commonwealth listed species. High priority species are those MNES that are cryptic, less mobile, or more threatened. The EPBC offset calculator was used to calculate the required offset for these species.

EPBC Act Offsets Policy

The EPBC Act Environmental Offsets Policy (the policy) (DSEWPaC 2012b) was published in November 2012 and provides a methodology for the calculation of offset requirements for MNES. The policy relates to all MNES including heritage items, with offsets required only if there is a significant residual impact. While the EIS did discuss a biodiversity offset strategy (refer to section 10.4.2 of the EIS), it did not incorporate the policy document as it was released too late to be considered in the EIS.

The policy is accompanied by an offsets assessment guide. This guide explains a 'balance sheet' approach to estimating impacts and offsets for EPBC Act listed threatened species and ecological communities.

Suitable offsets under the policy must be specific to the particular area, habitat type (ie foraging or roosting habitat) and habitat condition or number of individuals of impacted MNES. The offsets must result in an overall conservation outcome that improves or maintains the viability of a protected matter (a MNES). The offset package should contain a minimum of 90 per cent direct offsets of the total offset requirement, and a maximum of 10 per cent, comprising other compensatory measures such as contributions towards research or particular threat abatement works.

A total of 17 MNES would potentially be significantly impacted by the project (refer to Table 3-20). For these MNES, additional assessment has been undertaken to address the policy through the application of the EPBC Act offsets calculator. Full assessments for each of the species are provided in the Supplementary Biodiversity Assessment (Chapter 8).

Table 3-20: MNES potentially significantly impacted by the project

Protected matter	Common name	EPBC Act status
Threatened ecological communities		
Lowland Rainforest of Subtropical Australia[1]		Critically Endangered
Threatened flora species		
Acronychia littoralis[1]	Scented Acronychia	Endangered
Angophora robur[1]	Sandstone Rough Barked Apple	Vulnerable
Arthraxon hispidus[1]	Hairy Joint-grass	Vulnerable
Cryptocarya foetida[1]	Stinking Cryptocarya	Vulnerable
Endiandra hayesii[1]	Rusty Rose Walnut	Vulnerable
Quassia sp. 'Moonee Creek'[1]	Moonie Quassia	Endangered
Prostanthera cineolifera[1]	Singleton Mint Bush	Vulnerable
Syzygium hodgkinsoniae[1]	Red Lily Pilly	Vulnerable
Threatened fauna species		
Mixophyes iteratus[1]	Giant Barred Frog	Endangered
Phascolarctos cinereus	Koala	Vulnerable
Nannoperca oxleyana[1]	Oxleyan Pygmy Perch	Endangered
Phyllodes imperialis[1]	Pink Underwing Moth	Endangered
Xanthomyza phrygia	Regent Honeyeater	Endangered
Dasyurus maculatus maculatus	Spotted-tail Quoll	Endangered
Lathamus discolor	Swift Parrot	Endangered

[1] These species are subject to current investigations for suitable offset properties.

Biodiversity Offset Strategy / Package

Identification of the offsets required for the project would continue to be developed during detailed design for both NSW and Commonwealth listed species in consultation with government agencies. The Woolgoolga to Ballina Offset Strategy (as included in draft form within Appendix H of the Supplementary Biodiversity Assessment (Appendix J)) would be developed into a Biodiversity Offset Package.

The Strategy, will confirm:

- Area and type of vegetation communities/ habitat to be offset and the size of offsets required.
- Offset measures that would be used to compensate for the biodiversity impacts, such as:
  - compensatory land options
  - contributions towards biodiversity programs for high conservation value areas on nearby lands (including research programs).
- The decision-making framework that would be used to select the final suite of offset measures to achieve the aims and objectives of the Strategy, including the ranking of offset measures.
- A process for addressing and incorporating offset measures for changes to impact (where these changes are subject to other environmental approvals), including:
  - Additional impacts associated with design changes, including ancillary facilities.

  - Changes to predicted impacts resulting from changes to mitigation measures.
  - Identification of additional species/habitat through pre-clearance surveys.

- Options for the securing of biodiversity values in perpetuity.

The Strategy is submitted to, and approved by, the Director General and/or Minister prior to the commencement of construction unless otherwise agreed by the Director General or Minister.

Once the strategy is approved, within two years Roads and Maritime would develop the Biodiversity Offset Package that would identify the final suite of offset measures to be implemented for the project. The Biodiversity Offset Package would provide details of:

- The final suite of the biodiversity offset measures selected for the project demonstrating how it achieves the requirements and aims of the Biodiversity Offset Strategy (including specified offset ratios or calculations).
- The final selected means of securing the biodiversity values of the offset package in perpetuity including ongoing management, monitoring and maintenance requirements.
- Timing and responsibilities for the implementation of the provisions of the package over time.

Once the Offset Package is approved, Roads and Maritime is required to implement the package according to the timeframes set out in the Package.

Roads and Maritime is currently investigating properties within the project area to determine their suitability to provide offsets against the loss of biodiversity values for those high priority, significantly impacted Commonwealth listed species (as indicated in Table 3-20).

Further information on the biodiversity offset process and details of the preliminary findings for these property investigations is provided in Appendix J.

3.3 Supplementary hydrology assessments

3.3.1 Background

Following the submission of the EIS, several supplementary hydrology and flooding assessments were undertaken to provide further detail to a range of identified issues. These assessments were triggered by issues arising out of consultation with private land owners, EIS submissions or from the January 2013 flood event which provided an opportunity for gathering further data for the Clarence River floodplains.

These assessments have included and are described in more detail in the following sections:

- Corindi River flood impact re-assessment.
- Debris blockage assessment during the January 2013 flood event.
- Clarence River flood model verification of the January 2013 flood event.
- Shark Creek cane drain network assessment.
- James Creek drainage network assessment.
- Fauna fencing trial assessment of flood velocities.

Further information on these assessments has been included in Appendix C.

3.3.2 Corindi River flood impact re-assessment

Cumulative assessment

Safety works were undertaken on the Pacific Highway at Blackadder Creek in 2011. A number of submissions were received during the exhibition of the EIS regarding the impacts of the safety works. These submissions claimed that areas of Corindi, particularly Corindi Park Drive, were flooded during the January 2012 floods as a result. Submissions also expressed concerns that the safety work was not taken into consideration for this project's EIS flood modelling.

As a result of these submissions, a cumulative assessment of the Corindi River floodplain was undertaken to incorporate the safety works.

The purpose of a cumulative flood assessment is to consider the combined impacts of all recent major infrastructure works which would have an impact on flood levels and behaviour in conjunction with the project.

This form of assessment is important due to the episodic nature of flooding (ie major floods occur irregularly, and there is generally a long period of time between events). As a result, the actual impacts experienced as a result of infrastructure works on the floodplain in a real flood event may be resultant of several pieces of infrastructure that have been constructed within a short timeframe.

To account for this, a cumulative assessment takes into consideration the flooding behaviour prior to other recent infrastructure works (ie it takes a 'base case' that is representative of the floodplain condition before recent infrastructure that may already be on the ground). Therefore, the reported impacts of this assessment are the cumulative impacts from two or more infrastructure works – in this case the Blackadder Creek Safety Works and the project.

This approach is consistent with the approach taken in the EIS for other catchment areas where infrastructure has been recently constructed in the floodplain, such as the Ballina Bypass and the works at Farlows Flat. Both of these areas have been assessed with the so-called 'existing case' representative of flooding before construction of these projects.

To undertake the cumulative assessment, the flood model which was created in 2012 to assess the impacts of the safety works was updated to include the Woolgoolga to Ballina project. Changes to peak flood levels in the 100 year ARI event due to both the Blackadder Creek Safety Works and the Woolgoolga to Ballina project are presented in Appendix C.

The results of the flood model were assessed against the flood management objectives for this catchment, as set out in the EIS. The relevant flood management objectives for the Corindi River catchment are:

- Less than 50 millimetres increase in flood heights at houses for any assessed flood event less than and equal to 100 year ARI event.
- On grazing, forested and other rural areas, generally less than 250 millimetres increase with localised increases of up to 400 millimetres for short duration/ local catchment flooding acceptable over small areas (nominally less than five hectares) up to the 100 year ARI event.

For impacts downstream of the project, the cumulative assessment found that the overall cumulative impact around Corindi Park Drive from both projects would be a reduction of peak flood levels from the base-case (ie pre-2011) flood levels. For the majority of properties this decrease would be between five and 50 millimetres, with some small areas still experiencing a decrease in flood impacts of greater than 50 millimetres. This is with the exception of two northern properties on Corindi Park Drive, which would cumulatively experience an increase in flood levels of up to 25 millimetres. However, all increases in peak flood levels for residences on Corindi Park Drive are within the flood management objective of 50 millimetres increase.

As the impacts of the Blackadder Creek Safety Works propagate upstream to the location of the project, the consideration of cumulative impacts upstream of the project in the project design is warranted, and should be addressed at the detailed design phase.

In a small area (around 1.2 hectares) upstream of the project along the floodplain between the Corindi River and Cassons Creek, flood levels increase by more than 400 millimetres. Impacts are up to around 600 millimetres in the 100 year ARI event and reduce to less than 250 millimetres within 170 metres of the project. The area of land upstream of the project boundary with impacts exceeding 250 millimetres is about 9 hectares in total. These impacts do not meet the flood management objectives for this catchment as impacts exceed 400 millimetres. These cumulative impacts would need to be further considered for project design at the detailed design phase.

Further consultation

Roads and Maritime has formed a focus group for the Corindi, Blackadder and Arrawarra communities as part of the Woolgoolga to Ballina upgrade. The purpose of the group is to provide input and discussion on various project issues. These issues will include flooding, noise, property access arrangements, lighting and fauna and flora connectivity.

The first meeting was held on Wednesday 5 June 2013 to listen to concerns and to identify the results of the preliminary Corindi River cumulative assessment (as discussed above). A second meeting (27 June 2013) outlined an approach to further work to be undertaken regarding the calibration of flood models and assessing impacts. This included further consultation with the community and property owners to expand on the input of local knowledge and lived experience.

The additional flood assessment includes:

- Addressing the flood issues at Corindi (associated with the detailed design and the Blackadder Creek safety works) in accordance with Roads and Maritime and community expectations.
- Improving the flood modelling by getting community input into flood levels and calibrating the flood model to the January 2012 and February 2013 flood events (using radar rainfall data).
- Assessing the design rainfall estimate used in the design against actual rainfall events to provide evidence of the accuracy of the rainfall estimates used.
- Re-modelling a range of three different scenarios to assess 100 year ARI flood events of the project detailed design and the Blackadder Creek safety works.
- Re-assess the impacts as a result of the cumulative assessment and identify any changes (if required) to the detail design for structures across the Corindi River floodplain.
- Re-assessing identified evacuation issues of residents upstream of the project.
- Get an independent review of the process via WMAWater.

Roads and Maritime has included the services of the independent reviewer for the project (WMAWater), who would review the assessment outputs.

This process is expected to be undertaken as a separate process to the Submissions/ Preferred Infrastructure Report. Two additional meetings are planned with the community to identify and discuss the results of the calibration of the flood model to the recent flood events and the other to identify the results of the additional modelling and impact assessment.

3.3.3 Assessment of debris blockage in January 2013 flood event

Following flooding in January 2013 that affected many parts of Queensland and northern New South Wales, an assessment was carried out to verify the blockage potential for bridges along the Pacific Highway. This included collecting visual evidence of blockage at bridges and viaducts along rivers and took into account bridges on the Clarence River and Tweed River (not within the project extent). The bridges at Richmond River were also inspected, even though the Richmond River wasn't experiencing flooding at the time. Photos taken are shown in Appendix C.

For the areas within the project extent:

- Bridge across Tuckombil Canal in the Richmond River catchment (refer to Plate C-9). The photos show that there is substantial debris blockage by the bridge. It is known to be susceptible to debris blockage, mainly due to the short bridge spans (around 10 metres) but also due to the unusual location of the bridge and the function of Tuckombil Canal, which connects the Richmond River and Rocky Mouth Creek to Evans River.
- There is also some evidence of debris blockage around the bridge piers of the Richmond River bridge at Woodburn and the Clarence River bridge at Harwood.

The design of bridge structures on the project have bridge spans of around 15 metres across waterways and have greater clearances than existing bridges. In the Working paper - Hydrology and flooding (SKM, 2012d), a blockage sensitivity analysis was undertaken for bridge structures across waterways. This analysis assumed a doubling of bridge piers from blockage.

The evidence of debris blockage shows the importance of good bridge design in minimising debris blockage. During detailed design, further consideration should be given to minimising bridge spans in individual waterways, where debris blockage is known to be a problem (refer to management measure HF18 in Chapter 5 of this report).

3.3.4 Clarence River flood model verification of January 2013 flood event

In response to the flood event that occurred in January 2013, flood modelling was undertaken to determine the performance of the Clarence River flood model for large flood events.

This modelling was undertaken for the following purposes:

- To further validate the model by comparing peak modelled flood levels to gauged and surveyed peak flood levels.
- To understand the theoretical impact of the project during this event, including changes to the period of road closure.

The January 2013 flood event resulted in the highest flood levels ever recorded at Grafton (since 1839). However, due to the construction of levee works and railway embankments over the past 100 years, flood levels at Grafton do not provide a consistent indication of peak flood flows. Based on assessments carried out for the Lower Clarence River Flood Study Review (2004), the January 2013 flood was the equal fourth largest flow since 1839. There were at least three larger floods (in terms of flow) in the latter part of the 19th century.

Based on flood gauge records and flood levels supplied by landholders, the January 2013 flood event was much lower than the 20 year ARI flood event in the Shark Creek Basin and other parts of the lower Clarence River floodplain. This is mainly due to the fast rate of rise and fall of this flood, which affects how much water can back-flood into the Shark Creek Basin. Furthermore, due to the very dry conditions before this flood, there was very little Shark Creek inflow and very low water levels in the basin at the start of the flood.

The January 2013 flood event in the Chatsworth and Harwood islands was estimated to be just lower than the 20 year ARI flood event (by about 0.1 metres). Again, this was due to the low volume of the flood and the large flood storage areas available on the Clarence River floodplain.

Figure 3-5 shows the performance of the flood model in comparison to the recorded flood levels at the Ulmarra, Brushgrove and Maclean flood gauges. These plots indicate that the flood model is adequately representing the rise and fall of the flood as well as the peak levels.

A peak flood level of 2.8 metres Australian Height Datum (AHD) was obtained from discussions with landholders in the Shark Creek basin. The flood model resulted in a peak flood level of 2.75 metres AHD in the Shark Creek basin which represent a very close match between the recorded data and the flood model simulation.

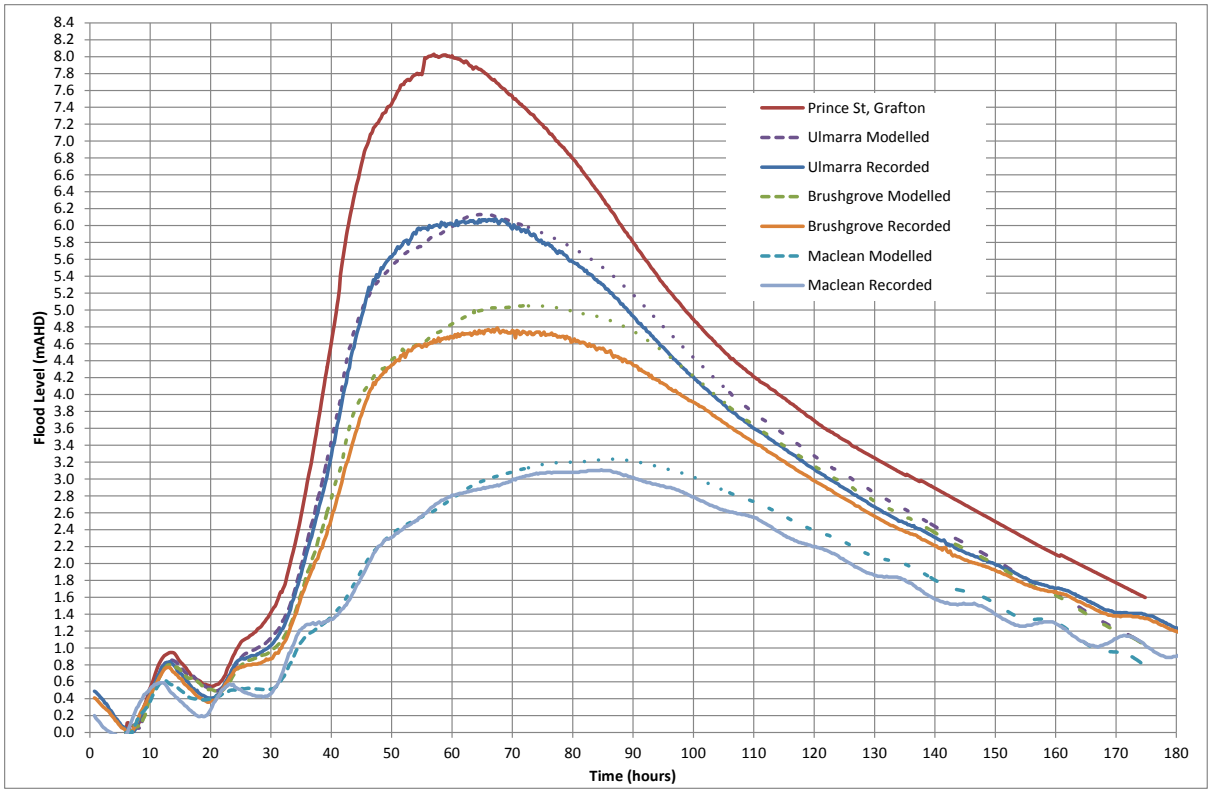

Figure 3-5: January 2013 Flood gauge comparisons to flood model results (20 year ARI flood event modelled)

Based on the assessments of the January 2013 flood compared to the upgrade design levels, the upgraded Pacific Highway would not have been cut in any location for any period of time for this flood. There would not have been any floodwaters on the lanes or the road shoulders and traffic would not have been impeded in any location. This is in comparison to the existing Pacific Highway where, between Grafton and Iluka Road, it was cut for a total of 91 hours.

If the Pacific Highway Upgrade was completed to the Class A level at the time of the January 2013 Clarence River flood event, contra flow measures would need to be used to allow the highway to remain open. A contra flow would be needed along a five kilometre section from Chatsworth Island to Harwood Island. This contra flow would need to be in place at 7.00 am, January 29 through to 9.00 am, February 1, 2013.

This assessment verified the modelling used in the EIS and showed that the Clarence River flood model provided adequate representation of large flood events and highway closure times.

3.3.5 Shark Creek cane drain network

The Shark Creek basin is characterised by sugar cane farming and consists of a network of cane drains and floodgates to drain the area. An appropriate drainage system is required to ensure that the time of inundation is not increased by the project and floodwater velocities are managed to prevent erosion on land and crops.

While a drainage design was developed for the EIS, additional information was received from landowners through submissions and in person at the EIS displays. Further assessment and modelling was then undertaken to design a possible drainage system to further meet the project flood management objectives.

The assessment included particular attention to detail around Lees Drain (Tyndale cane drain 2) and tributaries and Cracker's Drain (Tyndale cane drain 1). Based on an improved understanding of the flooding behaviour and landholder farming operations, a proposed bridge, culvert and drainage system (different from the EIS design) was developed. This option also identified that increasing the floodgates at Lees Drain would reduce the time of inundation resulting in a significant improvement in drainage.

The assessment has also considered changes to the Shark Creek bridge to provide better passage of floodwaters through the Shark Creek basin and to better maintain the existing flooding patterns. There are a number of opportunities including the reduction of the bridge length (from that identified in the EIS) and provision of culverts further south or increasing the length of the bridge.

Appendix C shows the possible arrangement of bridges, culverts and a revised drainage system for the Tyndale to Shark Creek bridge area that would meet the flood management objectives for the project. However, this proposed drainage system (and the increase in the floodgates) does not form part of the project and would be the basis for further discussions with landowners and the cane industry during the detailed design phase (refer to management measure HF27 in Chapter 5 of this report).

Any changes to Lees Drain (Tyndale cane drain 2) and the bridge across Shark Creek would also need to be considered in accordance with the Connectivity Strategy to maintain fauna crossing functionality (refer to management measure HF28 in Chapter 5 of this report).

3.3.6 James Creek drainage network

Landowner feedback has indicated that due to increases in riparian vegetation and debris, James Creek floodplain is experiencing slower rates of flood recession. As such, an assessment was undertaken to identify opportunities to improve drainage in the James Creek area.

In 2012, Roads and Maritime raised the Pacific Highway at Farlows Flat. This changed the flood behaviour in the vicinity such that there would be less floodwaters draining from the James Creek floodplain north-west cross the highway to the cane lands and then to the Clarence River. As a result, it is now likely that more floodwaters are now required to drain out the James Creek floodplain system.

The project would further raise the highway at Farlows Flat to above the 20 year ARI flood levels. This would further separate floodwaters on either side of the highway during and after flood events.

There is an opportunity to include additional flood flow capacity for the James Creek floodplain as part of the project (refer to Appendix C of this report). This additional capacity would assist in improving the rate of flood recession of this floodplain.

This opportunity does not form part of the project, but would be used as the basis for further discussions with landowners.

3.3.7 Modelling of Peak Maximum Flood (PMF) event

It is recognised that large / rare flood events (ie rarer than the 100 year ARI flood event) have not been simulated for the project in the EIS. The focus of the flood impact assessments for the EIS has been for the 2 year ARI event to the 200 year ARI flood event. The EIS has demonstrated that there are minor changes to rates of rise in flood events up to the 100 year ARI flood event. However, the changes to rates of floodwater rise in rarer flood events is expected to be proportionally less in larger floods due to the flow rate over the upgrade (at the 20 year ARI flood level). Hence, it is expected there would be minimal changes to flood behaviour for floodprone habitable areas upstream of the project for rarer events. As a result, it was considered unnecessary to model extreme events (2000 year ARI and PMF) for this project at this stage.

Rarer flood events can result in higher flood hazards due to the ‘creation’ of flood islands as floods rise. In these locations, residents can be trapped in non-inundated areas but surrounded by floodwaters. As the flood magnitude increases, these flood islands can become inundated and result in high flood hazards.

As an example, one location on the Clarence River floodplain is Chatsworth Village which is located on a low ridge on the river bank. As floods rise and exceed the 100 year ARI flood levels, the entire village area is inundated well after the closing of evacuation routes.

However, the key issue for the EIS is whether the project increases the flood risks of this area through changed flood behaviour. The assessment of the rise and fall of flood levels is contained in Appendix G of the Working Paper - Hydrology and flooding. The plots for locations 91.2 (W) and 92.6 (W) (on pages 513 and 514 respectively) show that the rate of floodwater rise for the 100 year ARI event is almost unchanged from the existing situation with the project constructed. The time to the peak of the flood is reduced by around 2 hours (over a 70 hour rising limb) in the 100 year ARI flood event. Hence, it is reasonable to conclude that the increase to the flood hazard of this area is minor due to this increased rate of rise. It also needs to be noted that the reductions in flood rise only occur once flood levels reach 2.8mAHD. At this level, flood evacuation routes from the village would already be cut. Hence, the reduced time to flood peak does not result in a reduced flood evacuation time.

In rarer flood events, there would be less of a change to flood behaviour. This is due to the level of the project being lower than the 100 year ARI flood events across the major floodplains. When flood levels exceed the 100 year ARI flood levels in rare flood events, there would be very long lengths of highway overtopped and the majority of floodwaters would pass over the highway. The expected effect on flood behaviour as flood levels rise typically diminishes as the fraction of floodwater 'weiring' over the highway increases.

In regard to the likely location of flood islands with habitation occurring in rare flood events along the project, the following is provided.

The Richmond River and Clarence River floodplains are the only floodplains where floodprone settlements / urban areas exist upstream of the project (for those upstream areas affected by the project). The exception to this is a house on Firth Heinz Road near Chaffin Creek. This house is not inundated in the 100 year ARI event but likely to be inundated in rarer flood events. Due to the clearance under the bridge further downstream across Chaffin Creek being well above the 100 year ARI flood levels, the impacts of the project are expected to be somewhat linear (in regard to increasing flood afflux for rarer flood events). The occupants of this house have access to Firth Heinz Road as an evacuation route (as the road is higher than the house) and there are no 'flood islands' created in rarer flood events.

3.3.8 Justification for nominated afflux levels

The flood management objective of 50 millimetres at houses and cane land was derived in consideration of the following issues:

- Increases to house flood damages.
- Feedback from residents through route selection, concept design and EIS process.
- Feedback from cane farmers through route selection, concept design and EIS process.
- Consistency with other Pacific Highway projects.
- Comparison with other floodplain development impacts.
- Adoption of the same afflux standard for houses and cane land.

Increases to house flood damages

Previous assessments of the relationship between flood level increases and increases to average annual house flood damages indicated that a limit to an increase in flood levels of 50 millimetres would generally result in only minor increases to total average annual damages of affected communities (of less than five per cent), noting that :

- The increase in flood damages for any individual dwelling would vary not only on the level of increase, but also the absolute height of flooding above the ground or floor level and the type of dwelling; thus an absolute afflux limit cannot be directly drawn from an increase in property damages.
- Only a small number of dwellings would experience an increase in flood levels close to the afflux limit.

Hence, the low level of flood damage increase was one of the bases for adoption of the 50mm afflux limit at houses,

This approach was verified from the assessments undertaken in the EIS. The assessments showed an increase to house flood damages was limited to between 0.6 and three per cent for communities on the Clarence River floodplain and between 0.6 and 1.1 per cent for communities on the Richmond River floodplain.

Feedback from residents through route selection, concept design and EIS process

Consultation with the community on this project on this matter dates back to the route selection phases in 2004 to 2008. During these earlier phases, afflux limits for houses were set at 50 millimetres and concept designs were presented to the community based on these afflux limits.

During the EIS phase of the project, there were a total of eight Flood Focus Group meetings held (four each on the Clarence and Richmond River floodplains). At each of these meetings, the afflux limit of 50 millimetres at houses was made clear to all attendees.

Prior to the last of the Flood Focus Group meetings, individual flood property reports were created for all expected attendees. These reports were a two page document that identified the specific flood impacts of the project for each house. At the meetings, these reports were offered to all 22 attendees. Across both meetings, less than 10 of these property reports were requested and provided.

Feedback from cane farmers through route selection, concept design and EIS process

Similarly, for the cane farming areas on the project, there were numerous meetings with cane farmers throughout the route selection, concept design and EIS process. In all of these meetings, it was made clear that the 50 millimetre afflux on the cane farms was generally acceptable. While farmers expressed the opinion that they would prefer it to be zero, they generally accepted that this was not possible. The main focus of the discussions in all meetings with the cane industry was related to minimising the increased time of inundation on cane lands.

Consistency with other Pacific Highway projects

The project has adopted flood management objectives that have been used on other approved Pacific Highway objectives. The reasons why these were adopted included:

- The weight given to flood management objectives that have been through an EIS process which involved public exhibition and consultation with these impacts.
- The consistency that local communities can expect between neighbouring areas. For example, it would be inconsistent to adopt a different afflux for houses on the Ballina floodplain recognising that the Ballina Bypass used 50 millimetres.

Comparison with other floodplain development impacts

It was noted that the vast majority of floodplain development proposals which would result in a flood level impact of 50 millimetres would be rejected as inappropriate by NSW local councils.

While it is acknowledged that this does reflect current development in the floodplain management in NSW, it should be noted that the mention of the social benefits of the project is a reflection of the merits-based approach adopted in this EIS.

Adoption of the same afflux standard for houses and cane land

In the Floodplain Development Manual, the Government has a merit approach to identifying flood objectives. Ideally, this would see that there would be a higher afflux limit for cane land than houses. This would reflect the varying impacts for these two assets on the floodplain.

However, in the project area, there are many houses located on the floodplain within the cane fields. As such, a different afflux limit would not materially change the outcome of the design or impact assessment, as it would still require assessment against the afflux limit for houses.

3.3.9 Cumulative hydrological impacts of the Woolgoolga to Ballina Pacific Highway section

The existing Pacific Highway and decades of maintenance works could have exacerbated drainage of land from the 'predeveloped' state (ie prior to the paving of the Pacific Highway). These works typically involved highway 'overlays' which add about 200mm to the road level for pavement rehabilitation. Based on consultation carried out with landholders throughout the EIS process, the following locations were raised as areas of concern in this regard:

- Blackadder Creek (safety works constructed in early 2011).
- Shark Creek overlays (constructed over recent decades).
- Farlows Flat highway raising (constructed in 2012).
- Bruxner Highway overlays near Duck Creek, Ballina (constructed over recent decades).

These works typically have had impacts on frequent flood events (eg up to 10 year ARI flood event) due to the low level of the current highway. Larger flood events completely overtop the highway and the influence of these works on flood levels is diminished.

These works mentioned above have most impact of the rates of floodwater recession on cane land. The minor raising of the highway can result in longer times of floodwater recession as it creates a shorter period in which floodwaters can recede to the river over the highway.

The cumulative impacts of these changes to the current highway and the project have not been considered in detail in the EIS and Submissions/ Preferred Infrastructure Report. However, it needs to be noted that the project would mainly affect larger floods (eg 20 year ARI and larger). The overlays and changes to the existing Pacific Highway mainly affect the more common smaller floods. Hence, the potential for cumulative impacts is low.

However, improving floodwater recession would result in benefits to cane farmers that could offset some of the impacts of the project. To that end, discussions with the cane industry in 2013 resulted in the development of a Cane Farm Strategy for the project.

One of the actions listed in the Cane Farm Strategy is listed below:

"Where opportunities exist to improve the cane drainage network, these should be explored with cane farmers and CVC / RRCC to assess costs and performance improvements. This could include Roads and Maritime funding of improvements to flood gates well outside the project boundary at Lees drain"

The Cracker Drain/ Lees Drain (south of Shark Creek) area is one of the key areas identified by Roads and Maritime where drainage performance could be improved (as discussed in Appendix C).

3.4 Review of groundwater data

3.4.1 Background

The EIS provided an assessment on the potential impacts of the construction and operation of the project on groundwater resources and the identification of management measures to minimise or mitigate such impacts (Working paper – Groundwater (SKM 2012b)). The assessment aimed to establish the significance of the impacts and provide management measures to protect environmental receivers and groundwater users.

More detailed geotechnical investigations have occurred during the preparation of the EIS and during the public exhibition period. The geotechnical data was reviewed to clarify the risk to groundwater along the project length, particularly at rock cutting locations. This section provides a revised assessment of groundwater as supplementary information to what was provided in the EIS.

3.4.2 Methodology

Field geotechnical investigations for the entire project were carried out in 2012-2013 (SKM, 2013). A selection of boreholes was completed as standpipe piezometers for groundwater chemistry sampling and for groundwater level monitoring. Electronic data loggers were installed in standpipes where rock cuttings would be located, to allow for on-going groundwater level monitoring. In total, 568 additional locations provided new groundwater data. This data provides accurate and specific groundwater information to allow further assessment of the potential for the project to impact on groundwater.

The scope of the revised assessment followed the EIS groundwater assessment, based on reviewing groundwater bore information and previous modelling studies. Each project section was assessed for potential impact to groundwater based on existing conditions, potential impact during construction of the project, and potential impact during operation.

This revised assessment is intended to be read together and in conjunction with Working paper – Groundwater (SKM 2012b). Only those impacts and results that have been revised from the EIS assessment as a result of the updated site information are presented here.

The Working paper – Groundwater (SKM, 2012b) assessed all of the 157 cuttings across the project. The revised assessment separated one long cutting into two parts, resulting in a total of 158 cuttings across the project alignment. Cuttings were categorised into three classes:

- Type A (potential high impact): Where the design profile after the cutting is predicted to be below the level of the groundwater table. This could lead to localised draw down of the groundwater table around the cutting site. Disruption to groundwater flow to local creeks, streams, springs and local water resource within around 100 metres from the cutting could result. Potential impacts could also occur to groundwater dependent ecosystems (GDE's). Engineered measures would need to be carried out and in operation to divert groundwater away from the cutting site.
- Type B (potential low to moderate impact): Where the design profile is above the groundwater table and where the groundwater table is between:
    - Two to three metres below the ground surface (resulting in a moderate impact). These cuttings may require ongoing monitoring, but are unlikely to require an engineering intervention.
    - Three to five metres below the ground surface (resulting in a low impact) but still require monitoring during construction.
- Type C (no impact): Where the groundwater table is greater than five metres below the ground surface and no impact is predicted.

Where there was insufficient groundwater data for the EIS assessment, a precautionary approach was taken and cuttings in those areas were identified as a Type A.

3.4.3 Revised assessment

Based on the assessment of additional bore information provided in geotechnical investigation reports, a new depth-to-watertable surface in metres below ground level (mbgl) and a new depth-of-watertable surface in mAHD were created. The depth-to-watertable surface along the proposed alignment was then analysed for changes in risk from the EIS assessment, and a total of 31 cuts were re-classified. Detail of the cutting types and the potential impact is shown in Table 3-21.

The revised classifications include:

- Twenty eight cut locations re-classified to a higher risk:
  - Thirteen from cut type B to cut type A.
  - Ten from cut type C to cut type A.
  - Five from cut type C to cut type B.
- Three cut locations were re-classified to a reduced risk.
  - One from cut type A to cut type B.
  - Two from cut type B to cut type C.

There were no changes to the risk classifications of cutting locations in project sections 9 to 11.

All other cuttings remain as the cut type classified in the EIS. Overall, 120 cuttings would be Type A with potentially high impacts, 23 cuttings would be Type B and have moderate to low impacts, and the remaining 15 cuttings would be Type C and would not have any impacts.

3.4.4 Management measures

No additional management measures are required from those identified in the EIS. Similarly, there are no management measures that require to be amended. Appropriate management measures for the revised cutting type would apply during construction of the project. Full listings of the mitigation and management measures for the project are provided in Chapter 5 of this report.

Table 3-21: Revised potential risk at rock cutting locations

Station		Cut type		Potential impact before mitigation
Start	Finish	EIS	Revised	
Section 1				
3.0	3.1	B	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
11.3	11.7	B	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
Section 2				
24.9	25.4	B	C	No measurable impact on local or regional groundwater systems or resources anticipated. No groundwater-reliant rainforest clusters or wetlands are present in the vicinity of the cut.
26.5	27.3	B	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
27.5	28.7	B	A	
Section 3				
34.5	34.9	C	B	No significant impacts to groundwater or water course related GDE's anticipated, but monitoring required to confirm long-term status. No groundwater-reliant wetlands are present in the area of potential impact.
35.4	35.6	C	B	
68.7	68.9	A	B	
Section 4				
81.3	81.7	B	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
81.7	81.8	C	A	
81.9	81.9	C	A	

Station		Cut type		Potential impact before mitigation
Start	Finish	EIS	Revised	
Section 5				
82.1	82.2	C	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
82.5	82.9	C	B	No significant impacts to groundwater or water course related GDE's anticipated, but monitoring required to confirm long-term status. No groundwater-reliant wetlands are present in the area of potential impact.
95.1	95.1	B	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact. Low probability of acid sulfate soils occurring throughout the cutting
95.3	95.3	B	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
95.3	95.4	B	A	
95.4	95.5	B	A	
95.5	95.5	B	A	
Section 6				
103.4	103.4	B	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
Section 7				
117.6	117.7	C	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
118.1	118.3	C	A	
119.9	120.0	C	B	No significant impacts to groundwater or water course related GDE's anticipated, but monitoring required to confirm long-term status. No groundwater-reliant wetlands are present in the area of potential impact.
120.2	120.5	C	B	

Station		Cut type		Potential impact before mitigation
Start	Finish	EIS	Revised	
125.3	125.3	B	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
125.4	125.4	B	A	
126.0	126.0	B	A	
Section 8				
127.0	127.0	C	A	Reduction of groundwater to local creeks, streams, springs and local water resource in the vicinity of the cut - within about 100m of cutting. No groundwater-reliant wetlands are present in the area of potential impact.
127.1	127.1	C	A	
127.1	127.2	C	A	
127.2	127.2	C	A	
127.7	127.9	C	A	

3.5 Cane farm strategy

Consultation with landowners and the cane industry during the preparation of the EIS and as part of the property acquisition discussions indicated a need to develop a broad strategy relating to cane farm impacts. This would provide confidence to the detail design phase and acquisition process and enable a consistent approach to the management of project impacts with individual landowners.

3.5.1 Strategy aims

The aim of the strategy is to promote appropriate management and consideration of affected cane lands and associated infrastructure during the further development of the project.

3.5.2 Scope

The cane farm strategy applies to land areas within the Clarence and Richmond Valley floodplains in the local government areas of Clarence Valley Council, Richmond Valley Council and in Ballina Shire Council. Project sections 3- 6 and 8- 11 affect and interface with cane farms and industry infrastructure, either directly or indirectly. About 300 hectares of land classified as sugar cane farm use would be directly impacted by the project (refer to Section 16.3.11 of the EIS).

3.5.3 Issues to be considered

Potential impacts on the cane industry as a result of the project need to be considered when addressing cane land and identifying to what extent its operation or function is affected. Issues include the degree of potential impact on the land, the importance of infrastructure, access and the viability of operations. The key issues for consideration for cane farms that are directly or indirectly affected by the project have been listed under the headings below.

Potential impacts on cane land

Key considerations include:

- Acquisition of cane land – requiring full or partial acquisition.
- Severance of cane land, resulting in residual portions of land.
- Residual portions that cannot be accessed, these may go fallow or lead to a change to the land use.
- Residual portions become unviable due to shape or size (ie requires an understanding on what is the critical threshold for cane farm viability).
- Should the project result in a loss of 25 per cent or more viable cane land this may render the cane farm no longer viable).
- If access cannot be provided to cane land, the landowner may need to sell the property due to lost viability.
- Flood impact on cane land including understanding the area of cane land that is free from flooding impacts. Houses and sheds are typically located in flood free areas. Flood refuge areas are a valuable asset in the floodplain.
- Levelling of cane land may have been undertaken and this may affect the value of these portions.
- Re-levelling of cane land may be required if crop orientation is changed as a result of a reduced property lot area.
- Landowners may be leasing areas of the road corridor land for use as cane land, changing this arrangement may impact area of available cane land.

Access

Key considerations include:

- Access to cane pads and overflow pads from residual portions of cane land.
- Shed access for machinery and equipment such as harvesters, tractors, cane bins and buggies across the highway upgrade.
- Access between different properties may be needed due to shared harvesting or right of way agreements.
- Access to cane lands (particularly for machinery) separated by bridges is critical, may be complex and need specific solutions eg at crossings over Clarence River North Arm (Mororo) and the Serpentine Channel.
- Relocation of farm access tracks may also require ripping up of old tracks which can be an added cost liability.

Infrastructure and utilities

Interactions between cane farms and the infrastructure servicing them can be complex. Key considerations for impacts to farm infrastructure include:

- Cane pads and overflow pads that are removed as a result of the project, need to be replaced or relocated.
- Some pads not requiring removal may need to be relocated due to access or farming operation changes.
- Strip acquisition typically can impact key property features such as cane drains or access tracks along boundaries.
- The loss of a dwelling and/or sheds may critically impact the function of cane land and the productivity of a cane farm.
- The interface with cane infrastructure and utilities (power pylons or underground cabling) is important and needs to be considered, when considering impact to land.

Hydrology and hydraulics

Key considerations of flooding and drainage on cane land include:

- Maintaining function of a farm is dependent on effective drainage (including natural or manmade drainage) and associated features (ie floodgates).
- Increasing the velocity of flood water could result in cane inundation.
- Flood gate heights should be considered as some gates may have dropped and would no longer be high enough to be effective.
- Design of culverts and bridge structures to minimise velocities and potential for scour and impact to any established levees.
- In areas where a freshwater and brackish system is in operation cane land may be stressed near the river.

Viability of operation

Key considerations for the viability of a cane farm operation include:

- Landowners may be affected by recent previous upgrades of the highway and therefore the loss of cane production may cumulatively impact on their business in future years.
- Effective operation of cane farms is reliant on efficient travel. Every extra hour of travel affects farm profitability.

- Local service roads are likely to remain the primary access routes and such, the functioning of these routes should not be altered as a result of the upgrade.
- An efficient route to the sugar mill and plant or associated infrastructure is also important.
- The level of cane yield may be different across the locality (ie yield may be high, low or 'district average'), this may have a bearing on land value and compensation.

3.5.4 Cane strategy principles

The strategy would be developed in consultation with the cane industry and in accordance with the following principles where reasonable and feasible.

Hydraulics and hydrology

- The upgrade transverse drainage needs to work in conjunction with the local cane drainage network while still achieving acceptable outcomes for the project objectives for increase flood levels, inundation period and acceptable velocities.
- New drains for cane land drainage need to be located on private land outside the road boundary. However, where there are opportunities to reduce the road boundary to enable locating these re-constructed drains on private property, these opportunities need to be considered.
- Improvements of the cane drainage network should be explored with cane farmers and Clarence Valley Council/ Richmond Valley Council to assess costs and performance improvements. Roads and Maritime would only fund improvements to flood gates outside the project boundary at Lees drain, within the Shark Creek basin area given its importance for that floodplain and the direct impact of the project alignment on that drain.
- Where there are opportunities to co-locate drains in other easements (eg power line easements, access roads), these would be considered.
- The integrity of cane levees systems would be maintained where the project disturbs an existing levee. This could be achieved by linking the severed levee into the proposed highway embankment (on either side).
- The detail design of the drainage network would also need to consider areas of potential acid sulphate soils (PASS) to prevent their disturbance and potential water quality impacts from blackwater.
- Drainage structures would be developed to minimise flood velocities and minimise scour.
- Where practical on floodplains, road drainage would include longitudinal water quality treatment (swales etc) rather than lumped basins, as required.
- Roads and Maritime is currently and would continue to consult with the cane industry and the individual property owners when further application of the above principles has been developed in detail during the detailed design phase. This will be particularly important during the land acquisition process.

Access

- Access roads would be developed as outlined in the proposed EIS and preferred infrastructure report. Further design refinements may be required during the detail design phase to address access widths, vertical clearances, turning opportunities, and final road surface. Roads and Maritime would not provide additional internal access where it is considered the local road network achieves the same level of service.
- Where there are vertical restrictions, a minimum clearance of 5.3 metres would be required to allow cane harvesters either on float or under their own control to access cane farms.

- In assessment of the existing Pacific Highway as a local service road, stakeholders would need to consider the importance of that road to the cane industry and its ultimate performance in respect to change in road users, speed zoning, signage and safety for turning and overtaking vehicles.
- The function of the local service road (existing highway) would need to be retained similar to the current function. Changes made by the relevant road authority for the local service road should be made only in consultation with the industry.
- Access on the proposed highway upgrade to the local road network and properties would be reviewed during the detail design phase to provide the most practical and safe access opportunities. This may require the current concept design (for both the Class M and the Class A scenarios) to be further refined during the detail design phase. For example this would include consideration to the southbound access to the upgrade from Harwood Sugar Mill and Jacky Bulbin Road.

Cane pads

- Where cane pads, that work in tandem as overflow, would be isolated by the upgrade, these pads would be increased to maximum size to operate as stand-a-lone (ie 18 bin pad). An increase in design would be undertaken in accordance with industry best practice and in consultation with property owners. In some areas severance of existing operations may result in the provision of new cane pads to achieve the desirable function.
- Roads and Maritime in consultation with the cane industry would consider the benefits of ancillary work areas and platforms established during and for the construction phase to be partly retained as future cane pad areas. This assessment would identify early the opportunity, site construction specifications, cane pad location, ownership, access and road safety requirements.

Fencing highway corridor adjacent to cane properties

- Where possible and where there are no other project requirements and in discussions with property owners fencing would not be provided.
- Where required for management of fauna, fencing would be located to allow effective operation of the cane farm while not compromising the operation and maintenance of the motorway corridor.
- On flood plains where required for other purposes such as fauna, fencing would be installed at the most practical location within the road corridor to minimise the risk of collecting debris and impacting on floodplain mitigation. Solutions would be developed during detail design investigating fence heights, types potential damage and maintenance.

Cane land acquisition

- Minimise the area of impact by disposal of excess cane land initially acquired for road
- Apply the remnant land strategy to maintain primary function of cane land pre and post construction and in disposal of cane land.
- Roads and Maritime and contractor to manage volunteered (unattended cane) by removal of cane to avoid spread of disease.

3.5.5 Strategy implementation

Stakeholder / Agency / Authority involvement

Roads and Maritime would continue to work with the cane industry through the development phase (including the acquisition process), detailed design phase and the construction phase to ensure all issues are appropriately considered and addressed.

The key areas for the successful implementation of the strategy include cooperation from relevant cane harvester cooperatives, and clear and consistent information provided to affected landowners. The relevant stakeholders involved in the implementation of the strategy include:

- Cane Harvesters Co-operative.
- Directly and indirectly affected individual cane farmers.
- Clarence Valley Council, Richmond Valley Council and Ballina Shire Council.

Roads and Maritime is currently in the process of consulting with the relevant stakeholders to:

- Outline the principles and obtain feedback on the cane farm strategy.
- Establish an informed working group to manage cane farm stakeholder engagement and transparent and productive discussion on the issues to progress negotiations.
- Implement an integrated approach across the floodplains and with other land use issues.
- Identify mitigation / management measures proposed.

3.6 Fencing strategy

Consultation with landowners adjoining the project corridor as part of the property acquisition discussions and with Government agencies (eg OEH and Forest Corporation of NSW) during the preparation of the EIS, indicated a need to develop an broad strategy on fencing given the issues that adjoining land use may present for project design.

3.6.1 Strategy aims

The fencing strategy aims to provide a framework for the type and placement of fencing along the upgraded highway corridor, including fauna exclusion fencing and property boundary fencing.

3.6.2 Scope

The fencing strategy is applicable to the entire project area of the Woolgoolga to Ballina EIS (Roads and Maritime, 2012) and applies to both public and private land. The strategy includes consideration of differing fencing requirements along the length of the project to ensure that the most appropriate type of fencing is considered during the detail design phase and in discussions with property owners.

3.6.3 Issues to be considered

Due to the substantial length of the proposal and the varying land uses bordering the proposed road corridor, there are a number of localised issues that may arise with regards to fencing. These issues have been outlined below.

- Maintenance of the fencing: Fencing should be accessible by vehicle and easy to maintain on an ongoing basis.
- Use of fauna exclusion fencing in lieu of property boundary fencing: This would be considered for rural properties. However, fencing may require modification to ensure its appropriateness for farming stock. In these situations agreement with the property owner during property acquisition and adjustment process would be required. Additionally, permanent markers would be required to indicate the road boundary. Fauna exclusion fencing (rather than property boundary fencing) could be used across areas fronting a state forest, national park and nature reserve.

- Placement of fencing with regards to timbered country: Placement of fencing needs to consider either the property boundary or fauna exclusion fencing requirements. In these situations, fencing could be located on the edge of the earthworks clearing, to minimise the requirement to clear additional vegetation outside of the project boundary for maintenance and access (ie through state forests, national parks and nature reserves).
- Placement of fencing with regards to Aboriginal heritage sites: Placement of all types of fencing needs to consider and where possible, avoid, the locations of Aboriginal heritage sites and PADs that are unaffected by the project.
- Existing flood behaviours and velocities: This is particularly relevant from station 46.0 (Pillar Valley Creek) to the bridge structure at station 78.0. Flooding may present issues such as the capture of debris within the fencing, and the ability to withstand water velocities which may result in the fence being pushed over during these events. Collapsible solutions would be considered in these areas. Fauna exclusion fencing, particularly through Section 4, may also be affected by floodwaters. Opportunities to provide fencing closer to the road pavement and higher on embankments, and placement of fencing so as not to obstruct culverts, to reduce the risk of impact by floodwaters would be considered.
- Combined fence types: The use of combined fauna fence types to cater for a variety of native fauna (including emus) and domestic stock known to occur in the area may need to be considered at some locations. This would include the use of hybrid fencing to enable emus to pass while restricting cattle.
- The use of natural barriers such as dense plantings of Paper Bark or Swamp Oak or rocks on batters would also be considered for some locations.
- Fauna exclusion fencing would need to be placed above culvert head walls.

3.6.4 Fencing strategy principles

The fencing strategy for the project would be formulated based on certain principles aimed at ensuring the most appropriate solution is identified to cater for the various conditions along the project length. These principles would be implemented where reasonable and feasible and include:

- Discuss individual fencing needs with affected and adjoining landowners. Fencing requirements for sugar cane farms would be considered as part of the cane farm strategy (refer to Section 3.3).
- Develop a design that would combine fauna and boundary fencing (including appropriate stock proof fencing) in consultation with Government agencies.
- Identify opportunities to erect fences within the construction footprint, to avoid the need for additional vegetation clearing.
- Confirm the legal requirements and preferred approach in consultation with Roads and Maritime property and legal branch associated with combining fauna fence and property fence within the construction footprint and not necessarily on the road boundary.
- Develop a hybrid fence design to enable emus to pass and restrict cattle.
- Opportunities for fencing design to tie into culvert structures rather than cross the culvert face would be investigated.
- Where a combined fence design is required for fauna, boundary and stock such as cattle grazing, a fence may need to be erected on the boundary to restrict cattle from passing through culverts. The fence design across the culvert face would need to consider surface water impacts such as flooding/water velocities.
- Identify opportunities to place fauna exclusion fencing on the top of batter in floodplain areas.

3.6.5 Strategy implementation

Roads and Maritime would continue to work with Government agencies and individual landowners through the detailed design phase, property acquisition and adjustment stages of the project.

The relevant stakeholders involved with the implementation of the strategy include:

- Government agencies (as adjoining landowners).
- Government agencies (discussions on stock/boundary/fauna exclusion fencing).
- Directly affected landowners (to understand their specific property fencing requirements).

3.7 Water quality monitoring strategy

The Woolgoolga to Ballina EIS (Roads and Maritime, 2012) identified that Roads and Maritime would produce a water quality monitoring strategy to ensure compliance with regulatory requirements (refer to management measures SSW62 and SSW63 in Chapter 5 of this report).

Roads and Maritime has developed three interim surface water and groundwater monitoring protocols one for each of the following sections of the project:

- Woolgoolga to Glenugie.
- Glenugie to Devils Pulpit.
- Devils Pulpit to Ballina.

These protocols establish baseline water quality data and groundwater levels for pre-construction and form the basis for the ongoing strategy to manage water quality during and after construction of the project. The outcomes of the pre-construction monitoring would assist in refining the surface water and groundwater monitoring protocol for the construction and operational stages of the project. These interim protocols would be consolidated into one overall Water Quality Monitoring Program before construction, as detailed in the Working paper – Water quality (SKM, 2012e).

The protocols identify the aims, scope, surface and groundwater parameters, sampling regimes and strategy implementation. The information presented below has been summarised from the draft interim monitoring protocols (dated 13 March 2013, 16 January 2013 and 21 December 2012 respectively) into the following sections.

3.7.1 Strategy aims

The primary aim of the water quality monitory strategy is to collect surface water and groundwater quality data before and during construction to assess the potential impact of the project on:

- Water quality, and its beneficial uses: to protect aquatic ecosystems, agricultural uses including stock watering, recreational uses and drinking water supplies
- on groundwater levels and groundwater quality from cuttings.
- Groundwater in order to protect licenced bores, waterways and watercourses, and groundwater depended ecosystems.
- Consult with relevant Government agencies including the Department of Planning & Infrastructure, Environment Protection Authority, Department of Primary Industries (Fisheries) and the Commonwealth Department of Environment.

3.7.2 Scope

- The scope of the interim monitoring protocols includes:
- To undertake pre-construction and during construction water quality monitoring of surface waters near the project.
- To record standing water levels, collect data from dataloggers and measure pH (in fill areas) in piezometers installed in the study area before and during construction.

- To obtain water quality samples from groundwater monitoring bores located in the vicinity of a Rous Water extraction borefield.
- Sampling surface water and assessing the health of Groundwater Dependent Ecosystems (GDEs) near the project.

3.7.3 Surface and groundwater parameters

Woolgoolga to Glenugie

The sampling parameters for the pre-construction phase has been largely based on the water quality monitoring framework outlined in the Working paper – Water Quality (SKM, 2012e), groundwater quality monitoring framework outlined in the Working paper – Groundwater (SKM, 2012b), *Roads and Maritime Guideline for Construction Water Quality Monitoring* (RTA, 2003) and *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC & ARMCANZ, 2000a). The sampling parameters for surface water and groundwater are identified respectively in Table 3-25 and Table 3-26 below.

Roads and Maritime has specified surface water and groundwater sampling parameters based on two classifications (Type A and Type B Parameters). These are detailed in Table 3-22 and Table 3-23.

Table 3-22: Surface water sampling parameters

Parameter	Type A	Type B
pH	✓	✓
Temperature	✓	✓
Electrical Conductivity (EC)	✓	✓
Dissolved Oxygen (DO)	✓	✓
Turbidity	✓	✓
Total Suspended Solids (TSS)	✓	✓
Total Oils and Grease (TPH to be included as Type A parameter if oil/grease is visible	✓	✓
Total Phosphorus (TP), Total Nitrogen (TN)	✓	✓
Phosphate, Ammonia, Nitrate, Nitrite		✓
Total Petroleum Hydrocarbons (TPH) (TPH to be included as Type A parameter if oil / grease is visible)	*	✓
Heavy Metals: Aluminium, Arsenic, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Selenium, Silver, Zinc		✓

Table 3-23: Groundwater sampling parameters

Parameter	Analytes	Field analysis	Laboratory analysis
Physical and chemical properties	pH	✓	
	Temperature	✓	
	Electrical Conductivity (EC)	✓	
	Dissolved Oxygen (DO)	✓	
	Turbidity	✓	
	Total Dissolved Solids (TDS)		✓
Hyrdocarbons	Total Petroleum Hydrocarbons (TPH)		✓
Nutrients	Total Phosphorus, Total Nitrogen		✓
Major Cations	Sodium (Na+), Potassium (K+), Calcium (Ca+) and Magnesium (Mg2+)		✓
Major Anions	Chloride (Cl-), Sulfate ($SO_4$2-), Bicarbonate (HCO3-)		✓
Heavy Metals	Aluminium, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Nickel, Zinc		✓

Glenugie to Devils Pulpit

The Australian Drinking Water Guidelines (NHMRC & NRMMC, 2011), and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000b) were consulted to establish the list of sampling parameters. A summary of the relevant surface water and groundwater parameters are identified in Table 3-24 below.

Table 3-24: Guidelines for surface water and groundwater sampling parameters

Analyte	Australian drinking water guidelines 2011 (mg/L)	ANZECC 2000 95% trigger values (µg/L)	ANZECC 2000 guidelines for recreational water quality (µg/L)	ANZECC 2000 irrigation water (long term trigger values) (mg/L)	ANZECC 2000 livestock drinking water (mg/L)
Metals / metalloids					
Aluminium	-	55	200	5	5
Arsenic (total)	0.01	24	50	0.1	0,5
Cadmium	0.002	0.2	5	0.01	0.01
Chromium (VI)	0.05	1.0	50	0.1	1
Copper	2	1.4	1000	0.2	0.4
Iron	-	-	300	0.2	-
Lead	0.01	3.4	50	2	0.1

Analyte	Australian drinking water guidelines 2011 (mg/L)	ANZECC 2000 95% trigger values (µg/L)	ANZECC 2000 guidelines for recreational water quality (µg/L)	ANZECC 2000 irrigation water (long term trigger values) (mg/L)	ANZECC 2000 livestock drinking water (mg/L)
Manganese	0.5	1900	100	0.2	-
Mercury (inorganic)	0.001	0.6	1	0.002	0.002
Nickel	0.02	11	100	11	1
Selenium	0.01	11	10	0.02	0.02
Silver	0.1	0.05	50	-	-
Zinc	-	8	5000	2	20
Other chemicals					
Total Dissolved Solids (TDS)	-	-	1,000,000	-	<2000
Oil and Grease	-	-	-	-	-
Phosphorous	-	-	-	0.5	-
Nitrogen	-	-	-	5	-
Ammonia	-	900	10	-	-
Calcium	-	-	-	-	-
Magnesium	-	-	-	-	-
Major Anions - Chloride - Sulfate - Bicarbonate - Carbonate	 5 500 - -	 - - - -	 400,000 400,000 - -	 - - - -	 - - - -
- Calcium - Magnesium - Sodium - Potassium	- - - -	- - - -	- - 300,000 -	- - - -	- - - -

Devils Pulpit to Ballina

The Australian Drinking Water Guidelines (NHMRC & NRMMC, 2011), and the National Water Quality Management Strategy, (NHMRC & NRMMC 2004) were consulted to establish the list of sampling parameters. The sampling parameters for surface water and groundwater are identified respectively in Table 3-25 and Table 3-26 below.

Roads and Maritime has specified surface water parameters based on four classifications (Type A through Type D):

- **Type A:** standard monitoring parameters
- **Type B:** locations that are considered potential habitats for threatened fish species. Testing includes standard parameters as well as tests for heavy metals

- **Type C:** are required in the catchment for Rous Water (Section 8). Testing includes standard parameters as well as ammonia, cadmium, copper and lead.
- **Type D:** are Groundwater Dependent Ecosystems. Testing includes standard parameters as well as major cations and anions.

Table 3-25: Surface water sampling parameters

Parameter	Unit	Field or laboratory	Type A	Type B	Type C	Type D
Visual Observation of Flow		Field	✓	✓	✓	✓
Dissolved Oxygen (DO)	mg/l	Field	✓	✓	✓	✓
Electrical Conductivity (EC)	µS/cm	Field	✓	✓	✓	✓
Redox Potential	mv	Field	✓	✓	✓	✓
pH		Field	✓	✓	✓	✓
Temperature	°C	Field	✓	✓	✓	✓
Turbidity	NTU	Field	✓	✓	✓	✓
Total Suspended Solids (TSS)	mg/l	Laboratory	✓	✓	✓	✓
Oils and Grease	mg/L	Laboratory	✓	✓	✓	✓
Total Petroleum Hydrocarbons (TPH)	µg/l					
Total Phosphorus (TP)	mg/l	Laboratory	✓	✓	✓	✓
Total Nitrogen (TN)	mg/l	Laboratory	✓	✓	✓	✓
Ammonia	mg/l	Laboratory		✓	✓	
Cadmium	mg/l	Laboratory		✓	✓	
Copper	mg/l	Laboratory		✓	✓	
Lead	mg/l	Laboratory		✓	✓	
Aluminium	mg/l	Laboratory		✓	✓	
Silver	mg/l	Laboratory		✓		
Arsenic	mg/l	Laboratory		✓		
Chromium	mg/l	Laboratory		✓		
Iron	mg/l	Laboratory		✓		
Manganese	mg/l	Laboratory		✓		
Nickel	mg/l	Laboratory		✓		
Selenium	mg/l	Laboratory		✓		

Parameter	Unit	Field or laboratory	Type A	Type B	Type C	Type D
Zinc	mg/l	Laboratory		✓		
Mercury	mg/l	Laboratory		✓		
Magnesium	mg/l	Laboratory		✓		
Calcium	mg/l	Laboratory		✓		
Major cations	mg/l	Laboratory				✓
Major anions	mg/l	Laboratory				✓

Table 3-26: Groundwater sampling parameters

Parameter	Drinking Water – health	Drinking water - aesthetic	Parameter	Drinking Water – health	Drinking water - aesthetic
Thermotolerant coliforms	Y	N	Lithium	N	N
Aluminium	*	Y	Magnesium	N	N
Antimony	Y	N	Manganese	Y	Y
Arsenic	Y	N	Mercury	Y	N
Barium	Y	N	Molybdenum	Y	N
Beryllium	*	*	Nickel	Y	N
Boron	Y	N	Selenium	Y	N
Calcium	N	N	Silver	Y	N
Cadmium	Y	N	Sodium	N	Y
Chloride	N	Y	Uranium	Y	N
Chromium (as VI)	Y	N	Vanadium	N	N
Cobalt	N	N	Zinc	N	Y
Copper	Y	Y	Ammonia (as N)	N	Y
Fluoride	Y	N	Nitrite (as N)	Y	N
Iodide	Y	N	Sulphate	Y	Y
Iron	N	Y	TDS	N	Y
Lead	Y	N	-	-	-

* - No available data

3.7.4 Sampling regime

Woolgoolga to Glenugie

Surface water monitoring

Sampling for the 12 months before construction would comprise one sampling round per month (12 events) at each of the monitoring sites. Type A parameters would be assessed for 11 of the sampling rounds and Type B parameters would be assessed during one round of sampling that is a 'dry weather' event.

Four 'wet weather' sampling rounds would be conducted at a rate of one per season. Three of these rounds would assess Type A parameters and one round would assess Type B parameters.

To be classified as a wet weather sample, rainfall must be recorded as exceeding 15 millimetres of rain within 24 hours and the sample must be taken within 24 hours of the rainfall event concluding. To be classified as a dry weather sample, there must have not been rain in the preceding 24 hour period.

Groundwater monitoring

Groundwater level monitoring would be undertaken at each of the groundwater monitoring sites using automatic water level recorders. It is recommended that the automatic water level recorders are set to take readings at a maximum of one hour intervals with a maximum three monthly period between downloads and calibration.

Quarterly downloads would include physical measurement of total depth of the bore and depth to standing water level at each monitoring bore for correlation with the automatic recordings. The total depth of the bore and depth to standing water level is to be measured before any purging and sampling.

At the completion of the monitoring event the data would be recorded.

A calibrated water quality probe would be used in the field to measure the following parameters:

- pH.
- Temperature.
- Electrical Conductivity (EC).
- Dissolved Oxygen (DO).
- Turbidity (NTU).

These measurements would be made after the purging of the wells and before the collection of samples for laboratory analysis. The collection of groundwater samples for laboratory analysis would be undertaken after purging and field measurements.

Glenugie to Devils Pulpit

Surface water monitoring

Surface water sampling before construction would involve monthly (12 events) and four wet weather pre-construction water quality monitoring of surface waters from 25 major watercourses and groundwater dependent ecosystems identified within the study area.

Surface water physico-chemical water quality, including pH, dissolved oxygen, electrical conductivity, temperature and turbidity will be measured in the field during each monitoring event.

A wet weather sample would be required when greater than 15 millimetres of rain fall is recorded in the preceding 24 hour period. Due to the number of monitoring sites and their locations across the study area, wet weather events would be split into north and south areas depending on the amount of local rainfall recorded in the area.

Groundwater monitoring

A total of 78 groundwater well locations will be monitored on a quarterly basis to record standing water levels, collect data from dataloggers and measure pH (in fill areas) within the study area.

Ground water physico-chemical water quality, and temperature, will be measured in the field during each monitoring event using calibrated hand held water quality meter.

A representative sample of groundwater will be collected from each well for an in-situ water quality measurement.

After 12 months of monitoring, interpretative data reports would be prepared for the pre-construction surface and groundwater monitoring program.

Devils Pulpit to Ballina

Surface water monitoring

Surface water sampling before construction would occur at 15 locations identified within the Devils Pulpit to Ballina study area. Four of these sampling locations are classified as Type A and B, four are classified as Type C and B, and seven are classified as Type A.

Groundwater Dependent Ecosystems (GDEs) monitoring would occur at 9 locations along major waterways identified within the Devils Pulpit to Ballina study area. Sampling would occur at 6 GDE locations as these overlap with the above surface water sampling locations.

A minimum of 12 monthly samples would be taken from the sampling locations and four wet weather samples, which represent each season (ie samples taken in summer, autumn, winter and spring), would also be taken at each location. Additionally, 8 of the identified surface water locations would be tested once during a dry weather event for heavy metals, under the Type B classification.

To be classified as a wet weather sample, rainfall must be recorded as exceeding 15 millimetres of rain within 24 hours and the sample must be taken within 24 hours of the rainfall event concluding. To be classified as a dry weather sample, there must have not been rain in the preceding 24 hour period.

Groundwater monitoring

Groundwater sampling before construction would involve undertaking quarterly groundwater monitoring to record standing water levels, collecting data from data loggers, and measuring pH. After 12 months of monitoring, interpretative data reports would be prepared for the pre-construction surface and groundwater monitoring program.

Three groundwater wells have been identified for monthly sampling for a minimum of 12 months. In addition, four wet weather samples, which represent each season (ie samples taken in summer, autumn, winter, and spring), would be taken at each location.

Data loggers across 63 groundwater monitoring locations would be programmed to record groundwater levels at 10 minute intervals. Data readings will be downloaded quarterly. The pH would be obtained from areas of proposed fill embankments during each data logger downloading event.

3.7.5 Strategy implementation

As detailed above, the Woolgoolga to Ballina EIS (Roads and Maritime, 2012) identified that Roads and Maritime would produce a water quality monitoring strategy to ensure compliance with regulatory requirements (refer to management measures SSW62 and SSW63 in Chapter 5 of this report). Three interim surface water and groundwater monitoring protocols were developed for each of the following sections of the project:

- Woolgoolga to Glenugie.
- Glenugie to Devils Pulpit.
- Devils Pulpit to Ballina.

Surface and groundwater monitoring is currently being undertaken in accordance with these protocols in order to establish baseline water quality data and groundwater levels that will be used to set project-specific or site-specific targets for water quality and hydrology management during construction and post-construction phases.

The project Water Quality Monitoring Plan would be further developed to cater for conditions of approval for the project. This monitoring plan would be developed with input from relevant agencies including, but not limited to, the Environmental Protection Authority, Rous Water, the NSW Office of Water, Department of Primary Industries and the Commonwealth Department of Environment.

3.8 Proposed extension to construction hours

3.8.1 Proposed work hours

As identified in the EIS, Roads and Maritime is seeking approval for extended working hours for construction for the project. The standard working hours for construction projects noted in the NSW Interim Construction Noise Guideline (DECC, 2009) NSW are:

- Monday to Friday between 7am to 6pm.
- Saturday between 8am to 1pm.

Roads and Maritime would be extending these working hours by two hours on weekdays and by four hours on Saturdays from the standard working hours. The proposed 'extended' working hours for the project are:

- Monday to Friday between 6am to 7pm.
- Saturday between 8am to 5pm.
- Sunday and public holidays, no work.

Justification for extended working hours

The Interim Construction Noise Guidelines (DECC, 2009) detail five categories of work that might be undertaken outside the recommended standard hours. These categories include:

- Public infrastructure works that shorten the length of the project and are supported by the affected community
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

In addition, the guidelines state that, in general, only work undertaken on public infrastructure can be undertaken outside the recommended standard hours. This need is typically based on a requirement to sustain the operational integrity of public infrastructure, as work to restore operation of the infrastructure provides a benefit to the greater community (that is, more than just local residents).

As such, constructing the project under extended working hours would shorten the length of the project, reducing the length of time of amenity impacts of affected residences and traffic disruption for highway users. In addition, it would hasten the completion of the overall Pacific Highway Upgrade program which began in 1996, enabling the earlier realisation of substantial economic and community benefits as a result of the upgrade of the highway (for further details on the justification for the project, refer to Chapter 3 of the EIS). Early completion of the construction would provide considerable benefits to the road users and community.

In particular extended working hours would:

- Reduce the volume of traffic on the roads during peak hours due to construction staff and some construction vehicles travelling to and from the work site outside peak traffic periods.
- Potentially bring forward the opening date for the project by increasing the allowable construction hours.
- Cause less disruption to the community, local business, motorists, pedestrians and cyclists as work would be completed earlier than currently planned.
- Provide a safer road and shared user network earlier than currently planned.
- Enable greater flexibility in project scheduling; this would enable the contractor to make allowances for adverse weather or reduce impacts at the weekend should there be a need (such as a special community event).
- Result in a direct increase in productivity across the project, making maximum and most efficient use of existing equipment and resources.

The proposed extended daytime working hours would be unlikely to result in significant impacts on the amenity of affected sensitive receivers. This is because of the location of the project within a predominantly rural and agricultural area that is sparsely populated. The implementation of management measures identified in the EIS would ensure impacts were limited.

3.8.2 Preliminary consultation feedback

As part of seeking approval for extended work hours, Roads and Maritime has consulted with members of the community on the subject. Stakeholders were informed of the proposal to extend construction hours through a community update newsletter, issued in October 2012 to all people on the project communications database (around 5,500 people), and also via a feedback form provided on the Roads and Maritime website.

Roads and Maritime also provided the information on the proposal and the opportunity to provide feedback at the EIS community information sessions held in January and February 2013. More than 100 feedback forms were received from the community, a number of calls on the issue were also received on the project free-call line, and a number of submissions mentioned the proposed ‘extended’ working hours.

An outline of the survey form feedback is provided in Table 3-27.

Table 3-27: Survey form feedback on the proposed extension to construction hours

Residential suburb of respondent	Support	Oppose
Arrawarra NSW 2456	1	0
Ashby NSW 2463	0	2
Ballina NSW 2478	3	0
Broadwater	0	1
Brushgrove NSW 2460	1	0
Chatsworth Island NSW 2465	3	0
Coffs Harbour NSW 2450	1	0
Coolgardie NSW 2478	0	1
Corindi Beach NSW 2456	5	1

Residential suburb of respondent	Support	Oppose
Corindi	1	0
Corowa NSW 2646	1	0
Deer Vale NSW 2453	1	0
Dirty Creek NSW 2456	0	1
Dudley NSW 2290	1	0
East Lismore	1	0
Evans Head NSW 2473	1	0
Glenugie NSW 2460	3	0
Grafton NSW 2460	4	1
Gulmarrad NSW 2463	7	0
Halfway Creek NSW 2460	1	0
Harwood NSW 2465	2	0
Harwood Island NSW 2465	2	0
Hornsby Heights NSW 2077	1	0
Iluka	1	0
Karangi NSW 2450	1	0
Maclean NSW 2463	18	1
New Italy NSW 2472	6	0
Pimlico NSW 2478	1	0
Rileys Hill NSW 2472	1	0
Sherwood QLD 4075	1	0
South Arm NSW 2460	2	0
South Grafton	1	0
Taree NSW 2430	1	0
Teneriffe QLD 4005	1	0
Terranora NSW 2486	1	0
Townsend NSW 2463	5	0
Tucabia NSW 2462	3	2
Tyndale NSW 2460	12	1
Ulmarra NSW 2462	1	0
Wardell NSW 2477	2	0

Residential suburb of respondent	Support	Oppose
Wells Crossing NSW 2460	1	0
Woodburn NSW 2472	9	1
Wooli NSW 2462	1	0
Woombah NSW 2469	0	1
Wooloweyah NSW 2464	1	0
Suburb not provided	2	0
TOTAL	**112**	**13**

Residents in support of extended construction hours noted quick project completion and no extended disruption as the main advantage. Some feedback suggested Roads and Maritime should seek to extend construction hours further. Residents who were opposed to extended construction hours stated that they work nights and/or did shift work and felt that noise generated from construction, particularly on weekends, would affect them.

Around 125 residents and community members responded with feedback forms, calls made to the project free-call line or submissions to the EIS. This represents only two per cent of people contacted on the issue.

However, the following observations could be made from the feedback received:

- Of the respondents, most of those in favour of extended construction hours reside in Corindi Beach, Maclean, Gulmarrad, New Italy, Tyndale and Woodburn.
- Overall, 90 per cent of respondents were in favour of extended construction hours.

3.8.3 Management measures

The project includes a range of management measures to manage noise generated during the construction of the project. These general measures are identified in Chapter 5 of this Submissions / Preferred Infrastructure Report. These measures consist of general work practices and equipment choices and would be apply across the project.

In certain locations however, specific measures may be required to further manage construction noise, particularly where ‘extended’ construction hours are concerned. Further consultation with affected residents and noise assessment undertaken during detailed design would confirm areas where site specific measures may be required. Property owners affected by construction noise would be made aware of the complaints management procedure during the work.

Site specific measures could include:

- Reduced working hours (either consideration of use of standard construction hours only, extended hours for either morning or evening only).
- Use of sensitive site design (for ancillary facilities).
- Temporary hoarding/barriers.
- Temporary relocation of affected residents.

In addition, management measure CNV2 would require that construction would be timetabled to minimise noise impacts where feasible and reasonable. This may include time and duration restrictions and respite periods. These measures would be considered after consultation with affected receivers. As part of this measure, noisy activities such as piling may be restricted to standard construction hours to minimise noise impacts where in proximity to sensitive receivers. The noise assessment undertaken for the EIS (Working paper – Noise and vibration) identified a number of sensitive receivers that are 'highly noise affected' in accordance with the Interim Construction Noise Guidelines. Site specific measures (including those mentioned above) at 'highly noise affected' locations were identified (refer to Appendix I of the working paper). These locations and the potential for other receivers to be affected would be further considered in detailed design.

Roads and Maritime would consider the use of standard construction hours in situations where impacts from extended construction hours will not be acceptable, such as close proximity to sensitive receivers and high impact noise activities (noise management level above 5dB(A)).

Roads and Maritime will continue to consult with communities and Government agencies regarding the application of extended working hours during construction.

3.9 Management of surplus material

3.9.1 Background

It is estimated that the project would generate around 1,410,000 cubic metres of surplus material during construction that would require permanent stockpiling or use. This amount may increase depending on the specific ground conditions encountered at sites that may require more material to be excavated (eg wet ground conditions) than has been estimated. The earthworks balance would be revised during detailed design to reduce the potential for surplus material where possible.

Unsuitable material would be generated from cuttings or embankments in areas of soils that are not able to be used for engineering fill for road embankments or pavement support. Areas along the project where large amounts of unsuitable material would be generated may include the floodplain areas. Surplus material excavated from the project may consist of:

- Virgin excavated natural material (natural rock, soil, sand and clay).
- Excavated natural material (at least 98 per cent natural material that doesn't meet the VENM definition).
- Excavated public road materials (typically asphalt or concrete pavement materials).

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

However, during construction, some of this material may need to be stockpiled temporarily to suit the sequence of construction activities within each project section prior to being stockpiled permanently.

Offsite disposal of unsuitable material would only be used a last resort. Offsite disposal of surplus material is permitted to other public or private land with the permission of the landholder. Before any disposal, spoil or surplus material would be classified in accordance with the Waste Classification Guidelines Part 1: Classifying Waste (DECCW, 2009) (refer to management measure WM5) and the *Protection of the Environment Operations Act 1997*. The amount of material that may require disposal off-site as waste would be available at detailed design.

The following section addresses the use of surplus material from the project.

3.9.2 Material management

Design options

Where possible, construction methodology and programming would aim to make beneficial re-use of surplus material generated during construction within the project boundary. This process would start at the detailed design phase, where surplus material management would be further considered.

Re-use of surplus could be achieved by:

- Flattening out of fill batters (eg from a 2:1 ratio to a 4:1 ratio).
- Backfilling of cuttings and borrow sites.
- Use in landscape design including visual or acoustic mounding, should they be warranted.

Environmental criteria

Consideration of material management and design of surplus material placement sites would include an assessment against environmental criteria. Key environmental criteria to be considered in the detailed design of these placement sites would include the need to:

a. Not require vegetation clearing beyond that already required by construction.
b. Not decrease the function of a fauna connectivity structure.
c. Be located more than 100 metres from a waterway.
d. Be located in areas of low heritage significance.
e. Not impact Matters of National Environmental Significance (MNES) beyond that already required by construction.

The detailed design may also consider where there is the potential for visual and acoustic benefit for residents and other sensitive receivers, as a result of re-use of surplus material in the landscape design.

Roads and Maritime would continue to review potential surplus material sites and have a balanced assessment to consider environmental, social and functional issues.

3.9.3 Key surplus material sites

A number of key sites have been identified within the project boundary for the permanent placement of material. These are shown in Figure 3-6 to Figure 3-10. An assessment of these sites, located within the project boundary, against the surplus material environmental criteria is provided in Table 3-28.

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Table 3-28: Environmental criteria assessment of surplus material sites

Station	Primary purpose	Selection criteria				
		No further vegetation clearing	Maintains fauna connectivity	More than 100 m from waterway	Low heritage significance	No further impacts to MNES
Section 1- Woolgoolga to Halfway Creek						
2.2 to 2.5	Landscaping	✓	✓	✓	✓	✓
2.8 to 3.3	Landscaping	✓	✓	✓	✓	✓
7.4 to 7.5	Landscaping	✓	✓	✓	✓	✓
9.3 to 9.6	Landscaping	✓	✓	✓	✓	✗ (habitat critical to the survival of koalas)
9.4 to 9.8	Landscaping	✓	✓	✓	✓	✗ (habitat critical to the survival of koalas)
13.2 to 14.0	Landscaping	✓	✗	✗	✓	✓
Section 2- Halfway Creek to Glenugie upgrade						
17.4 to 18.0	Landscaping	✓	✓	✓	✓	✓
18.5 to 18.8	In-fill of cutting at Halfway Creek	✓	✓	✓	✓	✗ (habitat critical to the survival of koalas)
25.0 to 25.2	Landscaping	✓	✓	✓	✓	✗ (habitat critical to the survival of koalas)
25.7 to 25.9	Landscaping	✓	✓	✓	✓	✓
28.0 to 28.2	Landscaping	✓	✓	✓	✓	✓

Station	Primary purpose	Selection criteria				
		No further vegetation clearing	Maintains fauna connectivity	More than 100 m from waterway	Low heritage significance	No further impacts to MNES
Section 3- Glenugie upgrade to Tyndale						
67.2 to 67.4	Landscaping north of Sheeys Lane	✓	✓	✓	✓	✓
67.5 to 68.2	Landscaping north of Tyndale interchange	✓	✓	✓	✓	✓
Section 4- Tyndale to Maclean						
76.0 to 76.5	In-fill of cutting at Green Hill	✓	✓	✓	✓	✓
77.4 to 78.1	Landscaping near Gulmarrad	✓	✓	✓	✓	✓
Section 6- Iluka Road to Devils Pulpit						
97.7-98.4	In-fill of cutting at Mororo Road	✓	✓	✓	✗ (see management measure AH46)	✓
Section 7- Devils Pulpit upgrade to Trustums Hill						
124.7 to 124.8	Landscaping south of Nortons Road	✓	✓	✓	✓	✓
126.5 to 127.0	Batter flattening between highway and service road	✓	✓	✓	✓	✓
Section 8- Trustums Hill to Broadwater National Park						
134.8 to 134.9	Lang Hill borrow site rehabilitation	✓	✓	✗[1]	✓	✓
Section 9- Broadwater National Park to Richmond River						
142.2 to 142.7	Landscaping south of Evans Head Road	✓	✓	✓	✓	✓
Section 10- Richmond River to Coolgardie Road						
147.7 to 148.2	Borrow site rehabilitation	✓	✓	✓	✗	✓

Station	Primary purpose	Selection criteria				
		No further vegetation clearing	Maintains fauna connectivity	More than 100 m from waterway	Low heritage significance	No further impacts to MNES
148.4 to 148.7	Borrow site rehabilitation	✓	✓	✓	✓	✓
152.1 to 152.2	West of Wardell borrow site rehabilitation	✓	✓	✓	✓	✓
152.5 to 152.9	Landscape mound between project and Hillside Lane (south of Wardell Road)	✓	✓	✓	✓	✓
153.0 to 154.3	Landscaping between project and Lumleys Lane	✓	✓	✓	✓	✓

[1] Refer to Lang Hill design refinement (Section 4.4.12) for detailed OPP management and mitigation measures

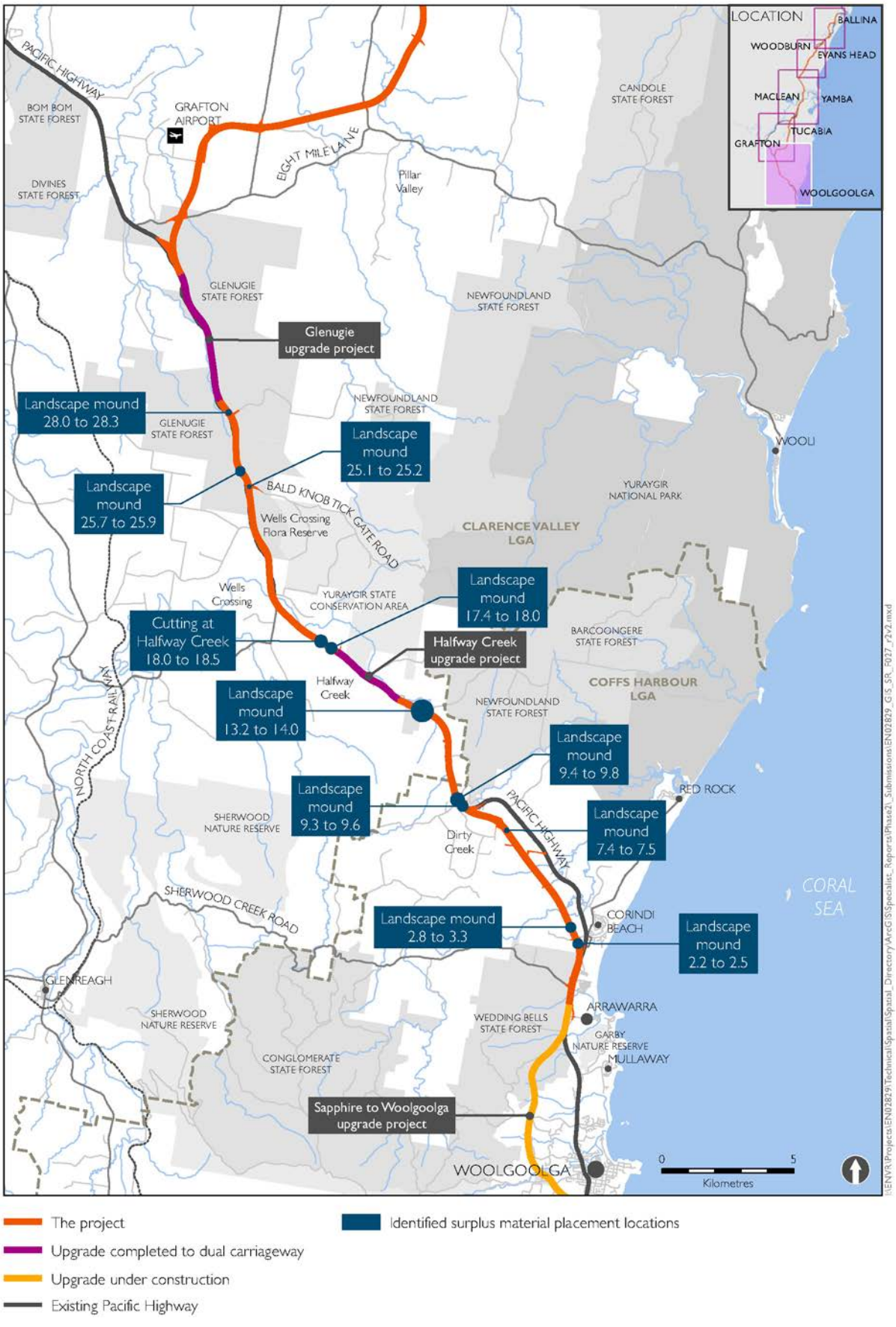

Figure 3-6: Surplus material placement locations (project sections 1-3)

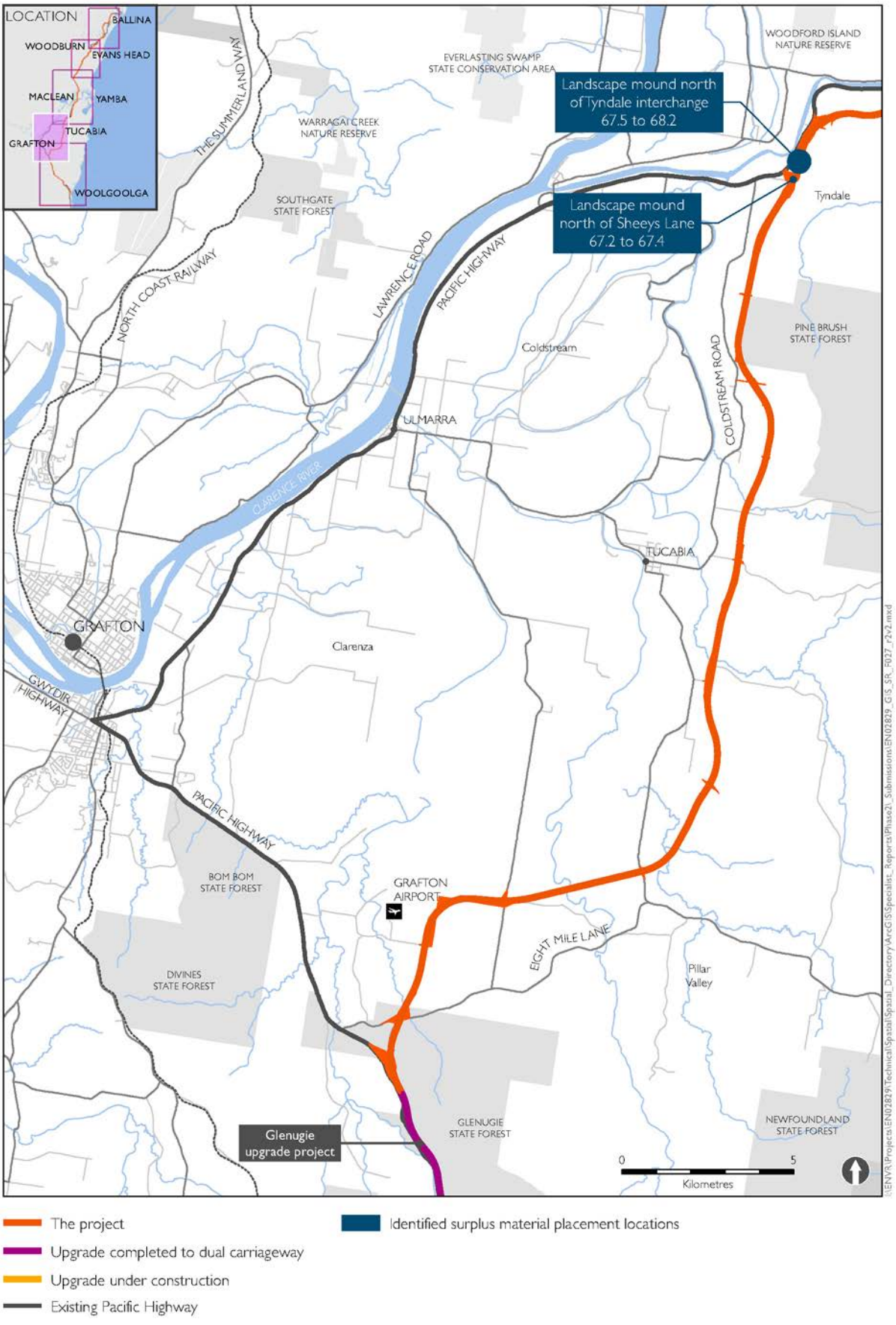

Figure 3-7: Surplus material placement locations (project section 3)

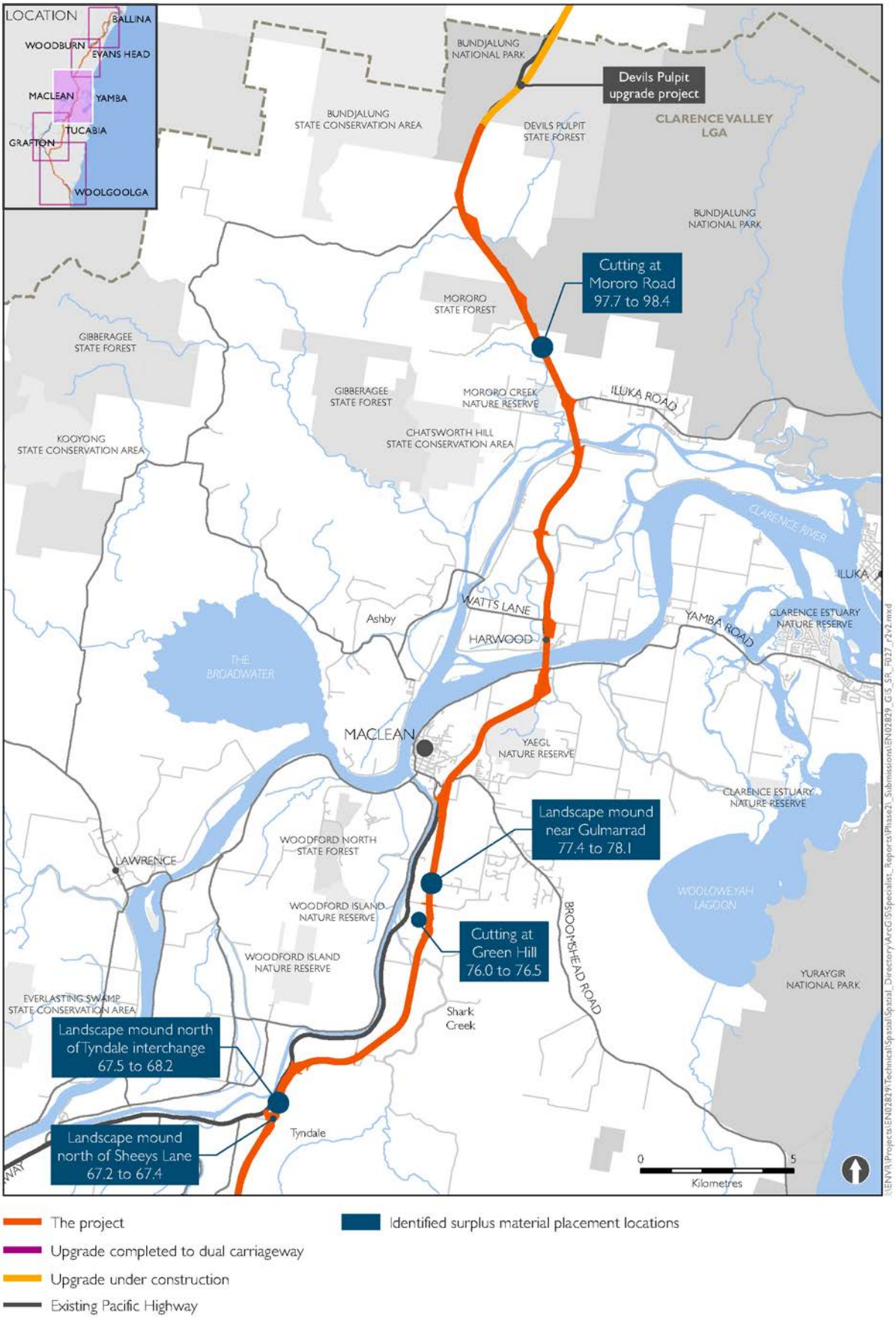

Figure 3-8: Surplus material placement locations (project sections 3-6)

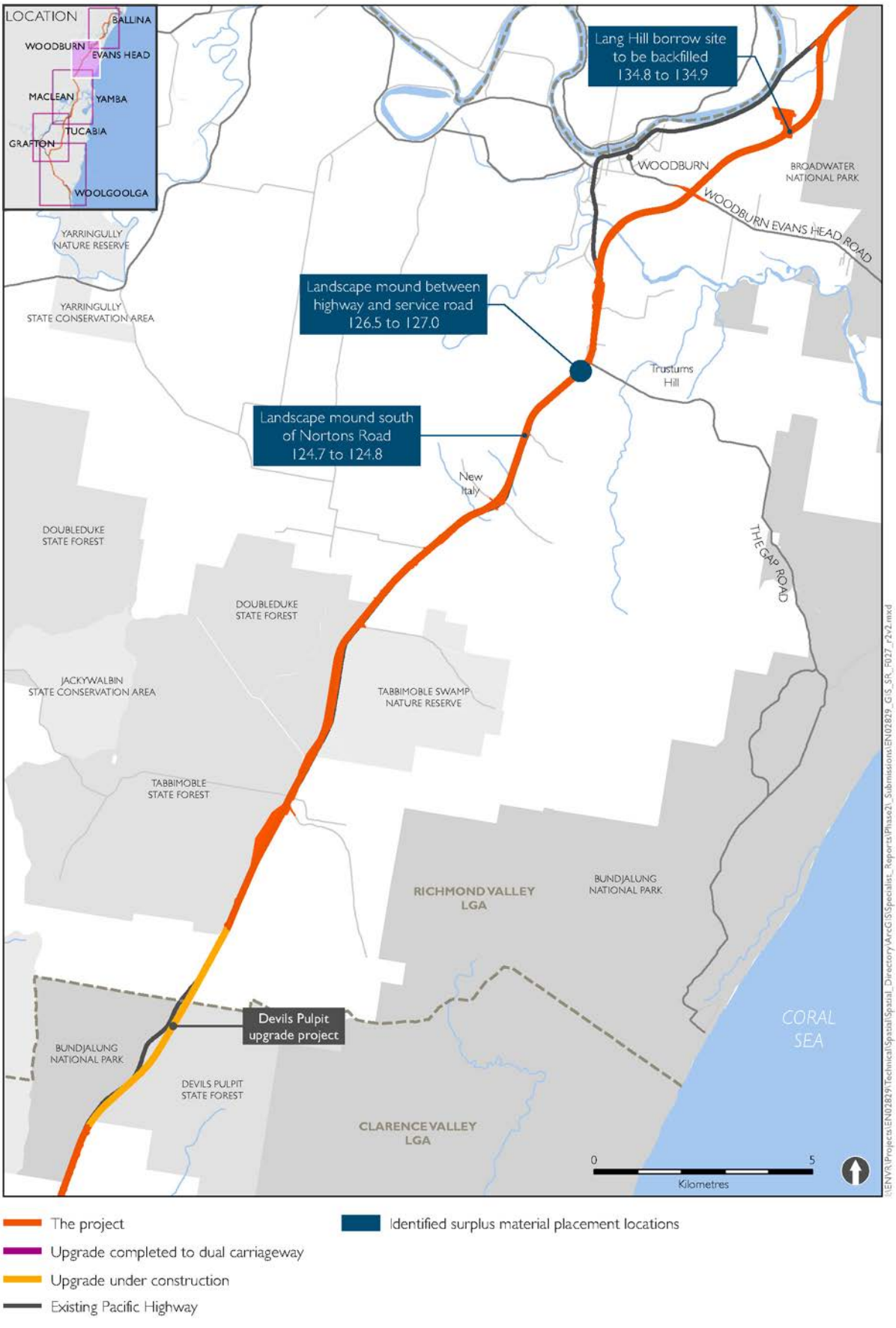

Figure 3-9: Surplus material placement locations (project sections 7-8)

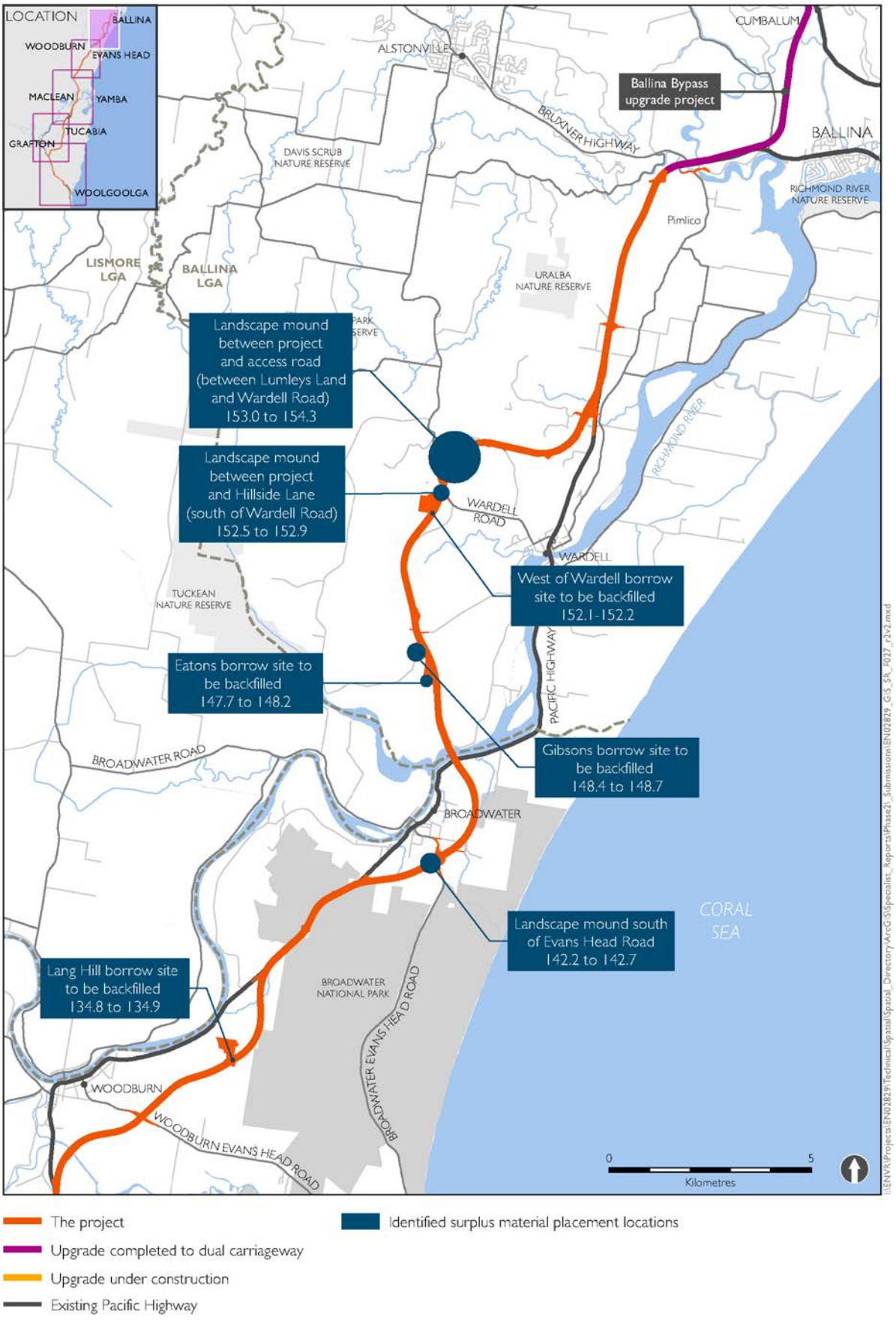

Figure 3-10: Surplus material placement locations (project sections 8-11)

An assessment of surplus material that could be permanently re-used within the project road corridor for in each project section has been undertaken (detailed in Table 3-28). The majority of surplus material generated by the project can be re-used for landscaping within the project corridor. However, as detailed in Table 3-28, there is a capacity shortage in some sections. However, it should be noted that this is only a preliminary assessment of available opportunities. This would be further investigated during detailed design, as would surplus material quantities.

Table 3-29: Estimate of surplus material re-use in project

Project section	Estimate of surplus	Key design options	Estimate of re-use
1	210,000 m3	-batter flattening at St 2.8-3.4, 3.6-4.0, 4.3-4.4. -landscape mound St 2.2-2.5. -landscape mound St 2.8-3.3. -landscape mound St 7.4-7.5. -landscape mound St 9.3-9.6. -landscape mound St 9.4-9.8. -landscape mound St 13.2-14.0.	25,000 m3 11,000 m3 30,000 m3 10,000 m3 63,000 m3 77,000 m3 28,000 m3
2	70,000 m3	-batter flattening St 21.7-22.3 -landscape mound St 17.4-18.0. -landscape mound St 25.1-25.2. -landscape mound St 25.7-25.9. -landscape mound St 28.0-28.3. -cutting at Halfway Creek.	5,000 m3 21,000 m3 13,000 m3 15,000 m3 20,000 m3 11,000 m3
3	304,000 m3	-batter flattening St 41.9-44.5, 45.7-48.0. -landscape mound St 67.2-67.4. -landscape mound St 67.5-68.2.	49,000 m3 15,000 m3 36,000 m3
4	101,000 m3	-batter flattening St 70.0-75.0, 78.0-81.0. -cutting at Green Hill. -landscape mound St 77.4-78.1.	80,000 m3 27,000 m3 24,000 m3
5	132,000 m3	-batter flattening St 83.0-86.0, 87.0-94.0.	100,000 m3
6	78,000 m3	-batter flattening St 100.0-105.5. -cutting at Mororo Road.	55,000 m3 48,000 m3
7	133,000 m3	-landscape mound St 124.7-124.8. -landscape mound St 126.5-127.0.	3,000 m3 6,000 m3
8	131,000 m3	-batter flattening St 129-134.5. -Lang Hill rehabilitation.	55,000 m3 300,000 m3
9	72,000 m3	-batter flattening St 144.7-145.0. -landscape mound St 142.2-142.7.	3,000 m3 63,000 m3
10	151,000 m3	-batter flattening St 146-147.4. -quarry rehabilitation St 147.7-148.2. -quarry rehabilitation St 148.4-148.7. -west of Wardell Road rehabilitation. -landscape mound St 152.5-152.9. -landscape mound St 153.0-154.3.	14,000 m3 412,000 m3 145,000 m3 300,000 m3 27,000 m3 60,000 m3
11	28,000 m3		
TOTAL	**1,410,000 m3**		**2,151,000 m3**

A review of opportunities available from flattening road batters from 2:1 to 4:1 has found that about 10,000m^3 could be used per kilometre. This analysis assumed a conservative height of three metres for low-set embankments (ie embankments through floodplains).

Across the whole project this would use an estimated 386,000m^3 of surplus material. However, this analysis does not take into consideration whether the corridor space is constrained within the project boundary. Batter design, including flattening opportunities will be considered further in detailed design.

Overall, this conservative assessment has identified that around a total of 2,151,000 m^3 surplus material could be re-used within the project corridor.

The Lang Hill, west of Wardell, Eatons and GIbsons borrow sites would be backfilled with available surplus material generated by the project. Each borrow site would be landscaped Rehabilitation of the sites will be undertaken in accordance of the landscape strategy (UD3), design principles (UD5) and the intended future land use of the sites.

3.9.4 Management measures

The management of surplus material would consider the aforementioned environmental criteria. The following management objectives apply to the detail design and construction phase of the project, as relevant:

- Reduction of surplus volume through detailed design refinement.
- Reduction of surplus haulage during construction.
- Beneficial re-use or recycling of surplus material within the project boundary, where practicable.
- Beneficial landscaping through the use of usable surplus material.
- Management of permanent stockpiles would be in accordance with Roads and Maritime' Stockpile Management Guidelines (Roads and Maritime, 2011).
- Disposal of contaminated spoil off-site in accordance with the Waste Classification Guidelines (DECC 2008b).

A materials stockpile strategy would be developed to consider all temporary and permanent stockpiling of material and any re-use of surplus material within the landscaping design.

As a minimum, the materials stockpile strategy would include:

- Surplus material management measures as identified within Chapter 5.
- Processes for spoil and surplus material handling, transportation and movement, stockpiling, re-use and disposal.
- Surplus material management monitoring, auditing and reporting requirements.

The management measures identified in Chapter 11 (Urban design, landscape character and visual impact) and Chapter 18 (Other issues) of the EIS (and updated in Chapter 5 of this report) are applicable to the management of surplus materials, where appropriate.

The additional mitigation measures in Table 3-30 are applicable to surplus material management.

Table 3-30: Surplus materials – additional mitigation

Issue	Mitigation ID no.	Mitigation measure	Timing	Relevant section
Waste management	WM22	A materials stockpile strategy would be developed to consider all temporary and permanent stockpiling of material and any re-use of surplus material within the landscaping design.	Pre-Construction and Construction	All

3.10 Rest area strategy review

Roads and Maritime, in partnership with the heavy vehicle industry, is working on various strategies to manage heavy vehicle safety and driver fatigue. Rest areas form part of this strategy, addressing the need for drivers to take rest breaks, use amenities and check loads and vehicles. Heavy vehicle drivers must conform to fatigue management legislation that specifies strict resting requirements. In order to fulfil these requirements they require suitable rest area facilities that are regularly spaced along key freight routes.

Relevant to the upgrade of the Pacific Highway, Roads and Maritime is implementing the *Strategy for Major Heavy Vehicle Rest Areas on Key Rural Freight Routes in Rural NSW* (Roads and Maritime 2010). The Pacific Highway Upgrade Program aims at establishing major rest areas at around 50 kilometre intervals along the upgraded highway.

With the role of the Pacific Highway as an interstate freight route there has been consistent growth in the use of the Pacific Highway by heavy vehicles and the need for and use of rest areas is expected to continue to grow.

Where space permits, heavy vehicle rest areas also accommodate light vehicles, providing similar rest and amenity opportunities for light vehicle drivers and passengers. These rest stops help to improve the driving experience on NSW roads.

Five rest areas would be provided along the Woolgoolga to Ballina Pacific Highway Upgrade, two for northbound traffic and three for southbound, as follows:

- Pine Brush rest area (north and southbound).
- Mororo Road rest area (southbound only).
- Richmond River rest area (north and southbound).

The southbound existing rest area at Halfway Creek would be retained, however, the northbound rest area at this location would be removed. The location of rest areas that are relevant to the project, including those within the project extent, are listed in Table 3-31. Rest areas that are proposed as part of the project are in bold in the table.

Table 3-31: Vehicle rest areas relevant to the project

Project section	Station	Northbound rest area	Station	Southbound rest area	Comment
Not in project extent	-0.7 to -0.5	Arrawarra Beach Road	-0.7 to -0.5	Arrawarra Beach Road	Part of Sapphire to Woolgoolga Upgrade
2	-	- (existing rest area to be removed)	17.1-17.4	Halfway Creek	Existing near Lemon Tree Road
3	**56.0 to 56.4**	**Proposed rest area at Pine Brush**	**55.6 to 56.0**	**Proposed rest area at Pine Brush**	**Relocated south from EIS design**
Not in project extent	108.1 to 108.5	Pine Road		**-**	Part of Devils Pulpit Upgrade
6	-	-	**100.2 to 100.7**	**Proposed rest area near Mororo Road**	**Same location as EIS design**
10	**147.7 to 148.6**	**Proposed rest area north of Richmond River**	**148.8 to 149.9**	**Proposed rest area north of Richmond River**	**Relocated north from EIS design**
Not in project extent	166.3	Teven interchange	166.3	Teven interchange	Part of the Ballina Bypass

In locating the rest areas within the project extent, the concept design process considered certain functional, road design and safety requirements. These key design requirements are:

- Located at or around 50 kilometres apart from either existing or proposed rest areas.
- Located on or near a natural topographical crest, avoiding safe deceleration and efficient acceleration in the rest area access lanes.
- Located outside of traffic acceleration zones within the main formation, to reduce traffic conflicts.

Other issues considered include whether areas had a current record of driver fatigue or a fatigue related crash history, and also whether the existing area of the highway is characterised by a number of stopping opportunities that would no longer be available to traffic travelling on the upgrade.

In placing rest areas, consideration is also given to minimising environmental and social impacts. These include:

- Minimising biodiversity impacts (including Matters of National Environmental Significance).
- Minimising heritage impacts.
- Minimising amenity impacts, avoiding areas in close proximity to sensitive receivers.
- Minimising land impacts and total additional area to be acquired.

In some instances the provision of rest areas in an upgrade may be deferred, until such time that traffic demand warrants it and an alternative stopping opportunity (such as a highway service centre) is available for highway users. In addition, the capacity of rest areas may be staged according to demand. This would result in a limited capacity being provided initially, with increases in parking areas and amenities provided later to accommodate future growth, in accordance with the approved design.

Rest area at Pine Brush

Applying the distance criterion of 50 kilometres between rest areas, the first rest area required on the project would be located halfway between Glenugie and Tyndale within section 3. A rest area in this section would be critical to meet the strategy given the length of this section and that the proposed project alignment bypasses a number of stopping opportunities.

A rest area was originally proposed near the Pine Brush State Forest (station 63.3 to 64.3) in the EIS. To further minimise the environmental impacts, in particular impacts to Commonwealth listed Sandstone Rough-barked Apple (*Angophora robur*) and koala habitat, the rest area was relocated south to station 56.0 to 56.4.

A review of potential locations adjacent to the proposed alignment was undertaken in section 3. The review identified up to 16 potential locations. Broadly, the review found that for the majority of section 3, any rest area would require clearing of native vegetation, including threatened species and/or communities. Areas that are currently cleared towards the southern end have a number of residences in proximity of the alignment (and therefore any rest area). In addition, a rest area located in the southern end of section 3 would be outside the range of the required 50 kilometre spacing.

As detailed in section 4.4, the relocated rest area would be located about 56 kilometres from the rest area at Arrawarra and 52 kilometres from the Pine Road rest area (constructed as part of the Devils Pulpit project). This places the rest area within the approximate distance required for rest areas. Additionally, the rest area has also been located near a crest, providing safe and efficient access for traffic.

The relocated site is mostly situated in an area that would need to be cleared for the construction of the main alignment. This aims to minimise any additional vegetation clearing required. While still requiring removal of vegetation (including habitat critical to the survival of the koala), the revised rest area location at Tucabia would result in a less native vegetation cleared that the EIS design, including reduced impact on the *Angophora robur*, threatened ecological communities and koala habitat.

The rest area has also been sited to avoid amenity impacts, with only one sensitive receiver located within 600 metres of the rest area.

Further detail on the revised rest area at Tucabia and the resulting differences in environmental impact between the EIS design and the design refinement is provided in section 4.4.

Rest area north of Mororo Road

Approximately 50 kilometres from Tucabia, a rest area is required somewhere north of Iluka Road, Woombah in section 6. A northbound rest area north of Pine Road is being constructed as part of the Devils Pulpit Upgrade. To be consistent with the strategy, a proximity to the northbound rest area and the preference to locate the rest area near on a crest (and in particular outside of the flat and flood prone areas south of Iluka Road), supported a southbound rest area to be located near Mororo Road. Between Woombah and Woodburn (section 6 to section 7), the upgrade would duplicate the existing highway, with state forest and national park situated adjacent to the project boundary for around 50 per cent of its length. Other areas are either heavily vegetated on private land or agricultural land. There are only scattered receivers through the section, however there is a concentration to the south of the section.

The EIS design located the rest area within the section of existing road corridor made redundant by the diversion of both carriageways of the existing Pacific Highway at station 100.2 to 100.7. This location is situated 44 kilometres from the rest area near Tucabia and 48 kilometres south of the rest area north of the Richmond River.

The southbound rest area is located wholly within the existing road boundary to avoid impacts to the Bundjalung National Park. The rest area would impact on vegetation located between the previous highway pavement and the current dual carriageway pavement. This includes an area of Subtropical Coastal Floodplain Forest TEC (TSC Act) which is also identified as habitat critical to the survival of the koala. There are no sensitive receivers within 600 metres of the rest area.

Rest area north of Richmond River

Applying the distance criterion of 50 kilometres between rest areas, the next rest area required on the project would be located after Broadwater (at station 145.0) and on a crest point north of Richmond River.

The EIS proposed a rest area within section 10 north of the Richmond River at station 147.3 to 148.3. From crossing the Richmond River the alignment follows a disturbed landscape between Wardell Heath and the Blackwall Range, generally following cleared pasture and cane paddocks in between.

The biodiversity assessment undertaken for the EIS identified that the vegetated areas north of Richmond River that adjoin the Wardell Heath and continue west to the Blackwall Range represented an important landscape corridor for threatened mammal species. The position of the rest area in the EIS design meant the road corridor (and therefore area of clearing) would be around 240 metres in width. As a result, fauna connectivity in this location would be very restricted.

To minimise vegetation clearing and provide opportunities for improved fauna connectivity, the southbound rest area was relocated north of Old Bagotville Road (station 149.1 to 149.6), while the northbound rest area was relocated to station 148.1 to 148.3. The heavy vehicle checking station has also been removed from the rest area design to reduce the overall footprint of the rest area (a commitment given in the EIS).

The relocated rest area is situated within a cane paddock and would not impact on native vegetation. There are no sensitive receivers within 600 metres of the rest area.

This rest area is situated 47 kilometres from the rest area north of Mororo Road, however, only 17 kilometres south of the rest area at Teven Interchange, at Ballina. Although, the close proximity between the rest areas north of Richmond River and the rest areas proposed at Teven interchange is acknowledged, if the rest areas were not provided at this location the distance between the rest area north of Mororo Road and the rest areas at Teven interchange would be over 65 kilometres.

3.11 Potential future service centre

The Mid and Far North Coast regional strategies (NSW DoP, 2009 and 2006) identify locations of service centres along the Pacific Highway. The regional strategies require that service centres are suitably placed and provide commercial opportunities. Service centres also provide a means of coordinating vehicle stopping opportunities with local facilities on the Pacific Highway. The locations identified north between Coffs Harbour and Ballina include Woolgoolga, Maclean and Ballina. There is a service centre proposed at the Teven interchange within the Ballina bypass section of the Pacific Highway. The rest area at Arrawarra Beach Road (north of Woolgoolga) being constructed as part of the Sapphire to Woolgoolga project has been designed to facilitate and make provision for a potential future service centre. The other location within the project extent for a potential service centre would be at Maclean.

While the proposed service centre location falls within the project extent, Roads and Maritime is not seeking approval for service centres as part of this project. Any service centre proposal would be developed by a third party and be subject to a separate development consent through the relevant approval authority. Should a service centre be developed near the interchange at Maclean, it is anticipated that this would be located near to the south of the proposed Maclean interchange. A review of environmental constraints (including Matters of National Environmental Significance protected under the *Environmental Protection and Biodiversity Conservation Act 1999*) for the area south of the interchange is provided below.

Hydrology and flooding

South of the interchange at Maclean, the land is situated in the Chaselings Basin (north of Shark Creek) and is subject to flooding. The site would need to be partially above the 20 year ARI flood event (either through placement on higher land or through building up the site) for structures on the site (ie shops, service station). Appropriate assessment of the site and any flood mitigation proposed would need to be undertaken to identify any impacts for the area.

Soils, sediments and water

A cane drain crosses through the Pacific Highway upgrade at station 80.2, around 340 metres south of the interchange at Maclean, and exits into the South Arm (Clarence River).

There is a high probability of acid sulfate soils occurring in this area. Service centre construction activities could disturb and expose acid sulfate soils. The area south of the interchange is a known area of soft soils. Appropriate construction techniques for the service centre would be required to avoid settlement of soft soils and to treat acid sulfate soils.

Biodiversity

Land to the south of the interchange is largely cleared for agriculture. Two patches of Swamp Oak Floodplain Forest on Coastal Floodplains (Endangered, TSC Act) are located to the south east of the interchange at Maclean. The closest patch is between station 80.1 and 80.2, around 50 metres south of the interchange. The South Arm (Clarence River) runs adjacent to the Pacific Highway upgrade and is key fish habitat, although not identified as suitable habit for Black Cod (Vulnerable FM Act, Vulnerable EPBC Act), Green Sawfish (Presumed extinct FM Act, Vulnerable EPBC Act). A Grey-headed Flying-fox (Vulnerable TSC Act, Vulnerable EPBC Act) colony is located around 200 metres north of the interchange in Maclean. There are trees located to the east of the interchange that are likely to provide foraging resources for the Flying-fox.

The closest fauna connectivity structure (bridge) is located around 2.5 kilometres north of the interchange at Maclean, the next closest fauna connectivity structure (culvert) is located around 6 kilometres to the south.

There are no Ramsar wetlands listed in the area, however the Clarence River Estuary (including the Clarence River) is located 130 metres to the northwest of the interchange at Maclean and covers a total of 1700 hectares. The estuary is comprised of a range of aquatic habitats that support a diverse fish and crustacean fauna.

There are no other incidences of flora and fauna habitat south of the interchange and any development of a service centre would not impact on biodiversity issues or Matters of National Environmental Significance.

Urban design, landscape character and visual

The area south of the Maclean interchange is surrounded by agricultural activities. While the development of a service centre would alter the existing environment, visually it would fit into the surrounding environment as would be within close proximity to the Maclean interchange and northeast of the BP service station situated on the existing pacific highway.

Aboriginal heritage

The area south of the interchange at Maclean to McIntyres Lane has moderate sensitivity for Aboriginal heritage. This area has a high degree of ground disturbance from previous vegetation clearance and agricultural use. The closest heritage site is three kilometres south of the interchange, with four identified Aboriginal archaeological deposits, Hirst 1 (AHIMS ID 09-1-0206), Hirst 2 (AHIMS ID 13-1-0185), Hirst 3 (AHIMS ID 13-1-0192) and Shark Creek Site 2 (AHIMS ID 13-4-0170) within the project boundary.

Historical (non-Aboriginal) heritage

Two historical (non-Aboriginal) heritage items were identified within three kilometres south of the interchange at Maclean to McIntyres Lane. Item 12 Maclean Punt and former Ashby ferry is located 160 metres south west of the interchange, and Item 22 Former house site is located 90 metres south east of the interchange at Maclean.

Traffic and transport

The development of a service centre would not impact the highway's predicted capacity when open to traffic (assumed to be 2016), or the Maclean interchange's predicted level of service.

Access to the service centre would be from the interchange or local service road (existing highway).

Noise and vibration

There are two sensitive receivers within 850 metres south of the interchange at Maclean, to the west of the project. These receivers are currently adjacent to the existing Pacific Highway and will be within 150 metres of the proposed road boundary.

Land use

The surrounding land use at this location consists of agricultural uses, primarily sugar cane cropping. As such, the development of a service centre would impact on high yielding cane land.

Social and economic

Maclean is currently bypassed by the existing highway, and has a population large enough to support the local economy. The EIS indicated traffic-dependent businesses comprise around three per cent of total businesses in Maclean. Of these, the BP service station located south of Maclean is expected to experience a reduction in passing traffic.

The potential future service centre would be located in an agricultural area with few nearby receivers, while still being close to Maclean. It is unlikely that accessibility, visibility and the quality of amenity in the Maclean town centre would be affected by a potential future service centre.

3.12 Ancillary facilities assessment

3.12.1 Consultation

During the EIS process, landowners of potential ancillary facilities were consulted to discuss Roads Maritime's interest in leasing their property for the construction of the project. Whilst a number of owners were interested in the opportunity, some indicated that they were not interested and they were subsequently eliminated from further contact on the matter.

In addition, during property acquisition discussions and the ongoing community consultation process, a further four sites were identified for potential use for an ancillary facility. These additional sites are located in Section 1 and Section 5 of the project and have been incorporated into the following assessment.

Roads and Maritime is taking a proactive approach to facilitate commencement of the construction phase as early as possible. At information sessions held during the display of the EIS, Roads and Maritime presented details on both ancillary sites and the extension of standard working hours to the local communities.

Roads and Maritime will continue to meet landowners and consult with the community (including residents surrounding potential ancillary facilities) in regard to the use of areas for the purposes of construction. This consultation would continue through to the construction period as part of the project consultation strategy (refer to management measures SE1 and SE3). Once details of the layout, usage, access routes, operating hours, impacts and management measures are known Roads and Maritime would inform neighbouring residents.

3.12.2 Assessment against standard conditions of approval

The Department of Planning and Infrastructure published draft conditions for state significant linear infrastructure approvals in March 2012. These outlined expected criteria that would be applied to the project for locating ancillary facilities. The criteria are as follows:

a. Be located more than 50 metres from a waterway.
b. Be located within or adjacent to land where the state significant infrastructure is being carried out.
c. Have ready access to the road network.
d. Be located to minimise the need for heavy vehicles to travel through residential areas.
e. Be sited on relatively level land.
f. Be separated from nearest residences by at least 200 metres (or at least 300 metres for a temporary batching plant).
g. Not require vegetation clearing beyond that already required by the state significant infrastructure.
h. Not impact on heritage items (including areas of archaeological sensitivity) beyond those already impacted by the state significant infrastructure.
i. Not unreasonably affect the land use of adjacent properties.
j. Be above the 20 ARI flood level unless a contingency plan to manage flooding is prepared and implemented.
k. Provide sufficient area for the storage of raw materials to minimise, to the greatest extent practical, the number of deliveries required outside standard construction hours.

These standard conditions of approval supersede the criteria that was identified in the EIS. Where feasible and unless otherwise approved by the Director General, Roads and Maritime will adopt these criteria and apply to the proposed sites and any additional sites identified hereafter. Table 3-32 provides a comparative assessment of those sites detailed in Table 3-42 to determine whether any current ancillary facility meets the above criteria. The assessment of the criteria is based on the assessments undertaken for the EIS (Chapter 6 for location and access details and Working papers Hydrology and Flooding and Noise and Vibration) and the Submissions / Preferred Infrastructure Report (refer to the following sections for assessments on heritage and biodiversity).

Table 3-32: Comparative assessment of ancillary facilities on standard condition criteria

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
Section 1												
2.5 to 3.4	1a	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to five artefact scatters)	✓	✓	✓
3.3 to 3.4	1b	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to one artefact scatter)	✓	✓	✓
5.2 to 5.4	2	✓	✓	✓	✓	✓	✗ (around 180m away)	✓	✗ (Historical heritage indirect impact to Item 39)	✓	✓	✓
7.4 to 7.6	3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9.5 to 9.5	4a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9.4 to 9.6	4b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4.6 to 5.0	5	✗ (less than 50m away)	✓	✓	✓	✓	✓	✗ (Biodiversity impacts to TEC near Cassons Creek)	✓	✓	✓	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
Section 2												
16.7 to 17.0	1a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17.1 to 17.4	1b	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to a modified tree)	✓	✓	✓
17.5 to 18.1	1c	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
19.3 to 19.6	2	✗ (Halfway Creek less than 10m away)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20.3 to 20.5	3	✓	✓	✓	✓	✓	✗ (around 150m away)	✓	✗ (Aboriginal heritage impact to PAD)	✓	✓	✓
21.7 to 22.2	4	✓	✓	✓	✓	✓	✗ (around 50m away)	✓	✗ (Aboriginal heritage impact to a artefact scatter)	✓	✓	✓
23.5 to 23.8	5a	✓	✓	✓	✓	✓	✗ (around 50m away)	✓	✓	✓	✓	✓
23.6 to 24.0	5b (3 areas)	✓	✓	✓	✓	✓	✗ (around 50m away)	✓	✗ (Aboriginal heritage impact to a artefact scatter)	✓	✓	✓
25.7 to 25.9	6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
Section 3												
34.2 to 34.4	1	✓	✓	✓	✓	✓	✗ (around 100m away)	✓	✓	✓	✓	✓
39.5 to 40.2	2	✗ (unnamed creek in ancillary facility and dam 10m away)	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
41.1 to 41.4	3a	✓	✓	✓	✓	✓	✗ (around 140m away)	✓	✓	✓	✓	✓
41.1 to 41.4	3b	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
45.5 to 45.9	4	✓	✓	✓	✓	✓	✗ (around 100m away on Wooli Road)	✓	✓	✓	✓	✓
49.4 to 49.6	5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
51.4 to 51.5	6a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
52	6b	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to	✓	✓	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
									a modified tree)			
55.5 to 55.9	7a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
56.1 to 56.3	7b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
61.1 to 61.4	8	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
62.0 to 62.3	9	✓	✓	✓	✓	✓	✗ (around 100m away)	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
67.2 to 7.4	10	✓	✓	✓	✓	✓	✗ (around 100m away)	✓	✓	✓	✓	✓
Section 4												
69.3 to 69.6	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
73.4 to 74.0	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
75.5 to 75.7	3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
76.8 to 77.1	4a	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
77.0 to 77.1	4b	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
77.0 to 77.2	4c	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
78.1 to 78.3	5	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
79.4 to 79.9	6	✗ (South Arm 40m away)	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
80.5 to 81.1	7a	✓	✓	✓	✓	✓	✗ (around 130m away)	✓	✓	✓	✗ (within 20 yr flood level)	✓
80.5 to 80.8	7b	✓	✓	✓	✓	✓	✗ (around 130m away)	✓	✓	✓	✗ (within 20 yr flood level)	✓
Section 5												
83.3 to 83.5	1	✓	✓	✓	✓	✓	✗ (around 90m away)	✓	✓	✓	✗ (within 20 yr flood level)	✓
85.8 to 86.0	2a	✓	✓	✓	✓	✓	✗ (around 60m away)	✓	✓	✓	✗ (within 20 yr flood level)	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
85.8 to 86.1	2b	✓	✓	✓	✓	✓	✗ (around 60m away)	✓	✓	✓	✗ (within 20 yr flood level)	✓
85.8 to 85.9	2c	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
85.9 to 86.2	2d	✓	✓	✓	✓	✓	✗ (around 180m away)	✓	✓	✓	✗ (within 20 yr flood level)	✓
86.9 to 87.2	3a	✓	✓	✓	✓	✓	✗ (around 100m away)	✓	✓	✓	✗ (within 20 yr flood level)	✓
87.2 to 87.7	3b	✓	✓	✓	✓	✓	✗ (around 180m away)	✓	✓	✓	✗ (within 20 yr flood level)	✓
90.8 to 90.9	4a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
90.5 to 90.8	4b (5 areas)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
93.3 to 93.4	5a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
93.6 to 93.7	5b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
93.3 to 93.4	5c (2 areas)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
95.5 to 96.0	6	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
95.0 to 95.4	Additional site 7	✓	✓	✓	✓	✓	✗ (5 receivers in 200 metres)	✗ (Potential threatened fauna habitat)	✓	✓	✓	✓
95.5 to 95.8	Additional site 8	✓	✓	✓	✓	✓	✗ (3 receivers in 100 metres)	✗ (Potential threatened fauna habitat)	✓	✓	✓	✓
94.9 to 95.5	Additional site 9	✗ (Mororo Creek on site)	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to two artefact scatters)	✓	✓	✓
Section 6												
98.1 to 98.3	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
100.1 to 100.5	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
103.0 to 103.7	3a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
102.9 to 103.7	3b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
105.6 to 106.0	4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
108.5 to 108.8	5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Section 7												
109.9 to 110.2	1	✗ (Tabbimoble Floodway No.3 10m away)	✓	✓	✓	✓	✗ (around 120m away)	✓	✓	✓	✓	✓
114.0 to 114.3	2a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
114.2 to 114.4	2b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
121.2 to 121.7	3	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
125.1 to 125.5	4	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
Section 8												
129.7 to 130.1	1	✓	✓	✓	✓	✓	✗ (around 120m away on Trustums Hill Road)	✓	✓	✓	✗ (within 20 yr flood level)	✓
131.2 to 132.5	2a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
131.8 to 132.1	2b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
132.1 to 132.2	2c	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
134.8 to 135.1	3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
Section 9												
136.7 to 137.1	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
137.3 to 142.7	2	✗ (McDonalds Creek 10m away)	✓	✓	✓	✓	✗ (around 60m away)	✓	✓	✓	✓	✓
142.2 to 142.7	3	✓	✓	✓	✓	✓	✗ (around 50m away)	✓	✓	✓	✓	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
Section 10												
145.3 to 145.6	1a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
146.2 to 146.4	1b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓
147.8 to 148.1	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
152.1 to 152.5	3a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
152.5 to 152.7	3b	✓	✓	✓	✓	✓	✗ (around 50m away)	✓	✓	✓	✓	✓
156.0 to 156.5	4	✓	✓	✓	✓	✓	✓	✓	✗ (Historic heritage impact to Item 43)	✓	✓	✓
157.3 to 157.4	5	✓	✓	✓	✓	✓	✗ (around 150m away)	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓
158.2 to 158.5	6	✓	✓	✓	✓	✓	✓	✓	✗ (Aboriginal heritage impact to an artefact scatter)	✓	✓	✓

Station	Site No.	(a)	(b)	(c)	(d)	(e)	(f)	(g)[1]	(h)[2]	(i)	(j)[3]	(k)
Section 11												
159.3 to 159.8	1a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
159.6 to 159.9	1b (3 areas)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
163.6 to 164.4	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ (within 20 yr flood level)	✓

[1] Vegetation clearing for construction has been assessed in the EIS and this Submission / Preferred Infrastructure Report. Refer to Chapter 5 for management measures.

[2] Aboriginal and historical heritage impact for construction has been assessed in the EIS and Submission / Preferred Infrastructure Report. Refer to Chapter 5 for management measures.

[3] Areas below the 20 ARI flood level have been assessed in the EIS. It is acknowledged that these ancillary facilities would need to be built above the 20 year ARI flood level. For those sites where a significant impact on flooding behaviour occurs, appropriate management measures have been identified (refer to Chapter 5).

As required by the draft conditions for linear infrastructure, where the criteria cannot be met, an assessment demonstrating that there would be no significant adverse impact from the ancillary facility's construction or operation is to be provided. The assessments for ancillary facilities are outlined in Sections 3.12.2 to 3.12.5.

3.12.3 Approach to assessment

Eighty one ancillary facilities for project construction were identified in the EIS. The footprint of 25 ancillary facilities were assessed as part of the construction impacts of the project as they are located in areas fully impacted by the carriageway or service/access road construction. These sites were not further assessed in the supplementary biodiversity or heritage assessments. However, where sites would be needed on adjacent lands, a desktop assessment was undertaken in the EIS for historical (non-Aboriginal) heritage, biodiversity, hydrology, contamination, construction noise modelling and Aboriginal heritage to determine any additional impacts from the use of that site.

Based on the EIS assessment, recommendations for more detailed assessment, including field investigations for Aboriginal heritage, historical (non-Aboriginal) heritage, and biodiversity on particular sites were made. Sites requiring detailed assessment were identified in the respective Chapters of the EIS and are addressed in the following sections.

Following EIS exhibition, an additional four ancillary facilities were identified and have also been considered in the assessment below.

A supplementary biodiversity assessment was prepared outlining the assessment for ancillary facilities, potential design refinement impacts and supplementary investigations (refer to Appendix J). Aboriginal heritage and historical (non-Aboriginal) heritage assessments of newly identified historical sites for ancillary facilities and design refinements are also provided in Appendices D and E.

3.12.4 Aboriginal heritage

The desktop Aboriginal heritage assessment identified 23 PADs, associated with ancillary facilities and design refinements and recommended further investigations (management measure AH15 in the EIS). Field surveys were undertaken on these sites by qualified and experienced heritage consultants in accordance with the relevant guidelines. This assessment fulfils management measure AH15 of the EIS (this has been removed from the revised list of management measures in Chapter 5 of this report).

Scope

The scope of work for assessing Aboriginal heritage constraints for the additional four ancillary facilities and ancillary facilities located outside the EIS boundary included:

- Identifying gaps in previous Aboriginal heritage assessment and address these through further desktop assessment.
- Undertaking comprehensive consultation with registered Aboriginal parties (both through meetings reviews and the provision of cultural knowledge).
- Undertaking field investigations (survey and where required sub-surface test excavation) with nominated site officers to investigate known sites, and to identify and sub-surface test PADs to better define the Aboriginal cultural heritage values identified near and within ancillary areas
- Undertaking a significance assessment of the sites and places identified. This includes both scientific (archaeological) and cultural (determined by registered Aboriginal parties).
- Providing an assessment of the potential impact/harm to Aboriginal cultural heritage sites and places.
- Developing management recommendations in consultation with registered Aboriginal parties so that before, during and after construction Aboriginal cultural heritage sites and places are effectively managed. The level of management required would be based on the identified impacts and the significance of the site or place.

Field investigations were undertaken between 17 September 2012 and 20 December 2012 and employed the field survey methodology that was used as part of the EIS (refer to Chapter 12 of the EIS). The surveys were undertaken on foot in teams who walked across the entire ancillary facility, plus a 25 metre buffer. Subsequently, sub-surface testing was undertaken at 19 PAD locations within the ancillary facilities locations, (this included stand-alone PADs and those associated with a site, eight previously recorded and 15 recorded sites during survey). Sub-surface testing was undertaken by manually excavating 0.5 metre x 0.5 metre test pits. The testing included the excavation of 418 shovel test pits and discovery of 264 stone artefacts in 11 of the test pits.

It should be noted that a number of ancillary facilities were not able to be assessed due to property access restrictions at this time. These include:

- Section 1, Additional site 5.
- Section 2, Site 3.
- Section 3, Site 8.
- Section 4, Site 1.
- Section 4, Site 3.
- Section 7, Site 1.
- Section 10, Site 1a.

At these sites, an assessment of the likelihood of the ancillary facility location containing archaeological material was made. This assessment was based on the Aboriginal heritage predictive model (prepared for the EIS assessment), review of aerial photography and previous field investigation findings.

Field survey results

In total, around 292.8 hectares was subject to survey (within 25 metres of ancillary facilities), totalling over 86 per cent of the ancillary facilities area. Seven potential ancillary facilities were not assessed as access was unavailable. Eight sites and 10 PADs were newly identified resulting from the ancillary facility survey.

Sub-surface testing was undertaken at 19 PAD locations (including stand-alone PADs and those associated with a site). Seven of these were previously recorded and 12 newly recorded during the ancillary facility field survey, with the following results:

- Eight new sites (Taylors Run 1, Taylors Run 2, Taylors Run 3, Lemon Tree Road 1, Wells Crossing Artefacts 1, WX2I 8, Old Tucabia Dump, and Hirst 3) were recorded during survey – three of these sites (Taylors Run1, WX2I 8 and Hirst 3) also had PAD components and were subject to sub-surface testing (the remaining five sites had no PAD components and were therefore not subject to sub-surface testing)
- Four new sites were recorded as a result of sub-surface test excavating (Upper Coldstream 1, Mororo Creek 2, New Italy 1 (Dubaijeen Site), and The Gap 1).
- No artefacts were discovered at five PADs (Post Office Lane 1, Old Six Mile Lane 1, Old Six Mile Lane 2, The Gap 2 and Rileys Hill 1), which as a result, were confirmed to not be sites or PADs.
- At seven sites (Taylors Run 1, WWC37, WWC39, Shark Creek Site 2, Mororo Creek 1, Hirst 3, and Site 12) sub-surface testing finds added to existing recordings for these sites.
- Two PADS (Kungala Rd 1 and the PAD component of WX2I Site 4) were untested as the property was unable to be accessed.

A total of twelve new sites were identified at the completion of the ancillary facility fieldwork, including eight artefact scatters, two scarred trees and two isolated artefact sites.

A summary of field survey results is provided in Table 3-33. The newly recorded sites during the recent investigations are highlighted in bold.

Table 3-33: Results of field survey and sub-surface investigations

Site name (AHIMS site ID)	Ancillary facility	Site type(s) after survey	Description	Investigation and sub-surface results	Updated site type(s) after completion of fieldwork
Taylors Run 2	**Section 1, Site 1a**	**Site – Artefact scatter**	**Two surface artefacts located on upper slope of a spur.**	**Survey**	**Site – Artefact scatter**
Taylors Run 3	**Section 1, Site 1a**	**Site – Isolated artefact**	**Located on mid-lower slope adjacent swampy gully.**	**Survey**	**Site – Isolated artefact**
Taylors Run 1	**Section 1, Site 1a**	**Site – Artefact scatter and PAD**	**Located on rolling hills at the crest and upper slope landform.** **18 surface artefacts were located during ancillary survey.**	**Survey and sub-surface testing** **17 shovel test pits yielding 3 artefacts**	**Site – Artefact scatter**
WWC37 (22-1-0344)	Section 1, Site 1a	Site – Artefact scatter and PAD	Small artefact scatter (n=5) identified in the working paper, with mostly surface material, south of Corindi Creek on slopes of spur above floodplain. One artefact identified during ancillary survey, eroding from edge of vehicle track.	Survey and sub-surface testing 65 shovel test pits yielding 2 artefacts	Site – Artefact scatter
WWC39 (22-1-0343)	Section 1, Site 1a and 1b	Site – Artefact scatter and PAD	Medium-large sized surface and sub-surface artefact scatter (n=234) identified in the working paper. On prominent very gentle spur crest south of Corindi creek and adjacent gentle simple slope leading north to creek and creek flats. Several less common artefact types. 491artefacts identified during ancillary survey in recently ploughed blueberry rows – totalling 725 artefacts now found.	Survey and sub-surface testing 31 shovel test pits yielding 5 artefacts	Site – Artefact scatter
Post Office Lane 1	**Section 1, Site 2**	**PAD**	**Terrace landform adjacent swampy area.**	**Survey and sub-surface testing** **21 shovel test pits yielding no artefacts**	**No material found from sub-surface testing – no longer considered to be a PAD or site**
Lemon Tree Road 1 (13-4-0180)	**Section 2, Site 1b**	**Site – Modified tree**	**Scarred tree situated on the mid slope of an undulating plain.**	**Survey**	**Site – Modified tree**

Site name (AHIMS site ID)	Ancillary facility	Site type(s) after survey	Description	Investigation and sub-surface results	Updated site type(s) after completion of fieldwork
Kungala Rd 1 (13-4-0181)	**Section 2, Site 3**	**PAD**	**Located on an undulating plain, consisting of upper slope and crest.**	**Survey from boundary No access onto site**	**PAD**
Wells Crossing 1 (13-4-0183)	**Section 2, Site 4**	**Site - Artefact scatter**	**Located on a flat plain, located in disturbed context on previous road. 3 surface artefacts (fine grained siliceous flakes) were identified.**	**Survey**	**Site – Artefact scatter**
Old Six Mile Lane 1	**Section 3, Site 2**	**PAD**	**Slope adjacent swampy stream**	**Survey and sub-surface testing 7 shovel test pits yielding no artefacts**	**No material found from sub-surface testing – no longer considered to be a PAD or site.**
Old Six Mile Lane 2	**Section 3, Site 2**	**PAD**	**Rise adjacent swampy stream**	**Survey and sub-surface testing 6 shovel test pits yielding no artefacts**	**No material found from sub-surface testing – no longer considered to be a PAD or site.**
WX2I Site 8 (09-4-0108)	Section 3, Site 3b	PAD	Stone artefacts were identified during survey from the wall of a dam within the PAD. One was a silcrete flake, the other a small jasper core. Sub-surface testing took place across the crest of a small rise. No artefacts were located.	Survey and sub-surface testing 29 shovel test pits yielding no artefacts	Site – Artefact scatter
Old Tucabia Dump (13-4-0184)	**Section 3, Site 6b**	**Site – Modified tree**	**Long scar probably of cultural origin on tree located on the lower slope of an undulating plain adjacent to a swamp.**	**Survey**	**Site – Modified tree**
Upper Coldstream 1 (13-4-0182)	**Section 3, Site 9**	**PAD**	**Undulating plain landform consisting of swamp component, mid slope and upper slope.**	**Survey and sub-surface testing 10 shovel test pits yielding 1 artefacts**	**Site – Isolated artefact**

Site name (AHIMS site ID)	Ancillary facility	Site type(s) after survey	Description	Investigation and sub-surface results	Updated site type(s) after completion of fieldwork
Shark Creek 2 (13-4-0170)	Section 4, Site 4c	Site – Artefact scatter and PAD	Located on the lower slopes of a spur, above a floodplain. Three additional surface artefacts were located within the PAD. One basalt ground edge axe, one medium grained siliceous and one chert flaked artefact. Site now totals eight artefacts.	Survey and sub-surface testing 14 shovel test pits yielding no artefacts	Site – Artefact scatter
Hirst 3 (13-1-0185)	**Section 4, Site 5**	**Site – Artefact scatter and PAD**	**Consisting of terrace, mid and upper slope landform units. One flaked axe blank artefact was discovered on the surface during the survey.**	**Survey and sub-surface testing** **17 shovel test pits yielding 2 artefacts**	**Site – Artefact scatter**
Mororo Creek 1 (13-1-0191)	**Section 5, Site 6 and 6a**	**Site – Artefact scatter and PAD**	**Located atop a low and flat raised sandy area adjacent to a creek, which is surrounded by swampy ground.** **12 surface artefacts were found, including chert(1), quartz (2), silcrete (3), and fine grained siliceous artefacts (6).**	**Survey and sub-surface testing** **12 shovel test pits yielding 8 artefacts**	**Site – Artefact scatter**
Mororo Creek 2 (13-1-0193)	**Section 5, Site 6a**	**PAD**	**Located atop a low and flat raised sandy area adjacent to a creek, which is surrounded by swampy ground.**	**Survey and sub-surface testing** **4 shovel test pits yielding 5 artefacts**	**Site – Artefact scatter**
New Italy 1 (Dubaijeen Site)	**Section 7, Site 3**	**PAD**	**Located on an undulating plain, consisting of lower, mid and crest landform units.**	**Survey and sub-surface testing** **97 shovel test pits yielding 194 artefacts**	**Site – Artefact scatter**
The Gap 1 (13-1-0194)	**Section 7, Site 4**	**PAD**	**Low flat rise adjacent to swamp, and slopes of rise adjacent.**	**Survey and sub-surface testing** **32 shovel test pits yielding 14 artefacts**	**Site – Artefact scatter**

Site name (AHIMS site ID)	Ancillary facility	Site type(s) after survey	Description	Investigation and sub-surface results	Updated site type(s) after completion of fieldwork
The Gap 2	**Section 7, Site 4**	**PAD**	**Low flat rise adjacent to swamp, and slopes of rise adjacent.**	**Survey and sub-surface testing** **5 shovel test pits yielding no artefacts**	**No material found from sub-surface testing – no longer considered to be a PAD or site**
Gittoes Jali (09-1-0204, 09-1-0205, 09-1-0203)	Section 8, Site 3	Site – Artefact scatter, paint wells, grinding stone	The site is situated on the crest and slope of a ridgeline. The area is cleared with clumps of trees and is currently used for grazing. Adjacent paddocks are used for farming. 411 stone artefacts (chert, fine grained siliceous, cobble, basalt, chalcedony, sandstone, crystal quartz) were discovered.	Survey and sub-surface testing 5 shovel test pits yielding no artefacts	No additional material found
Rileys Hill 1 (13-1-0195)	**Section 9, Site 2**	**PAD**	**Low flat rise above surrounding plain.**	**Survey and sub-surface testing** **9 shovel test pits yielding no artefacts**	**No material found from sub-surface testing – no longer considered to be a PAD or site**
Site 1 (04-4-0179)	Section 10, Site 4	Site – Artefact scatter and PAD	Located on a low, flat, raised sandy area at the end of the foot slopes of the Blackwall Range and the edge of low-lying swampy area.	Survey and sub-surface testing 10 shovel test pits yielding no artefacts	Site – Artefact scatter
Site 12 (04-4-0176)	Section 10, Site 6	Site – Artefact scatter and PAD	Located on a low deflated dune.	Survey and sub-surface testing 4shovel test pits yielding 20 artefacts	Site – Artefact scatter

Significance assessment

A significance assessment of all identified sites and cultural places was undertaken as part of the assessment. The significance assessments are made up of several criteria that attempt to define why a site is important. The assessment of Aboriginal cultural heritage in this assessment is based upon the four values of the Australia ICOMOS Burra Charter (Australian ICOMOS, 1999).

- Social values.
- Historical values.
- Scientific values.
- Aesthetic values.

Each of these values was assessed and an overall significance was then given based on an average across the values. Results for the overall significance (based on scientific, social, aesthetics and historical significance) were considered.

Impact assessment

For the purpose of this impact assessment, it was assumed that all places and sites occurring within the boundaries of ancillary areas would be directly impacted. Where a place or site occurred inside or within 25 metres of an ancillary facility, the potential for indirect impact was also considered. Where they occur within, but only near the edge of areas, avoidance measures are suggested. Adjustments to the construction footprint within the ancillary facilities would be considerd in detailed design to avoid impacts to some of these sites. Adjustment to construction footprints to avoid impacts would be considered before mitigation is considered.

Based on the current construction footprint for the ancillary facilities assessed, there would be direct impacts to 18 sites and one PAD (Kungala Road 1). One ancillary facility could also have indirect impacts to a site (site 6b, within Section 3). Six Aboriginal cultural places may also be impacted across the project by ancillary facilities. As these places are broad landscape areas, avoidance of those areas would not be possible. The potential impacts to Aboriginal heritage sites are detailed in Table 3-34. Only where ancillary facilities have direct or indirect impacts to Aboriginal sites or places are they included in the table.

Management measures

The management hierarchy for Aboriginal heritage is to firstly avoid impacts to the site. Where complete avoidance of sites by the project is not possible, management measures have been identified.

The management measures identified in the EIS are also applicable where relevant. However, specific management measures have been identified to manage the potential impacts from ancillary facilities. The Aboriginal heritage management measures from the EIS have been updated in Chapter 5 of this report to include the additional management measures outlined in Table 3-35.

Table 3-34: Potential impacts to archaeological sites and Aboriginal cultural places near or within an ancillary facility

Ancillary facilities	AHIMS ID	Name	Overall significance	Site type	Impact	Impact statement
Section 1						
1a		Taylors Run 2	Low	Artefact scatter	Direct	The ancillary facility would impact on the entire recorded extent of the site and impact its heritage values.
1a		Taylors Run 1	Low-moderate	Artefact scatter	Direct	The ancillary facility would impact on 70% of the recorded extent of the site and impact its heritage values. The higher density area of the site is outside but immediately adjacent to the ancillary facility.
1a	22-1-0344	WWC37	Low	Artefact scatter	Direct	The ancillary facility would impact on 50% of the recorded extent of the site and impact its heritage values. This site would be impacted by the project and the ancillary facility, both impacts resulting in impact to 100% of the site and its heritage values.
1a, 1b	22-1-0343	WWC39	Moderate	Artefact scatter	Direct	This site is within the footprint area of two ancillary facilities. Site 1a would impact on 25% of the recorded extent of the site and impact to its heritage values. Site 1b would impact on another 30% of the recorded extent of the site and impact its heritage values.
Section 2						
1b		Lemon Tree Rd 1	Moderate	Modified tree	Direct	This site is entirely within the ancillary facility. There would be impacts on the entire recorded extent of the site and its heritage values.
3		Kungala Rd 1	Moderate	PAD	Direct	Around 40% of the estimated extent of the PAD would be impacted by the ancillary facility.
4	N/A	Corindi Beach corridors of movement	Moderate	Aboriginal cultural place	Direct	This place is unavoidable as it traverses the region, and would be partially impacted by the ancillary facility. The cultural heritage values and significance of this place would also be partially diminished by the ancillary facility, though the corridor of movement would not be severed.
4		Wells Crossing Artefacts 1	Low	Artefact scatter	Direct	The ancillary facility would impact on the entire recorded extent of the site and impact its heritage values.

Ancillary facilities	AHIMS ID	Name	Overall significance	Site type	Impact	Impact statement
5b	13-4-0157	WWC139	Low	Artefact scatter	Direct	The ancillary facility would impact on the entire recorded extent of the site and impact its heritage values.
Section 3						
3b	09-4-0108	WX2I Site 8	Low	Artefact scatter	Direct	The ancillary facility would impact on the entire recorded extent of the site and impact its heritage values.
6b	13-4-0184	Old Tucabia Dump	Moderate	Modified tree	Indirect	No direct impacts to this place are likely from the ancillary facility, as the tree and its canopy are located adjacent to the ancillary area boundary. However, the buffer area around the tree extends partially into the ancillary facility (about 20%), therefore there is the potential for indirect impact through interruption to the tree's root system.
8	09-4-0104	WX2I Site 4	Low	Artefact scatter	Direct	The ancillary facility would impact on 50% of the recorded extent of the site and impact its heritage values.
9	13-4-0182	Upper Coldstream	Low	Isolated artefact	Direct	The ancillary facility would impact on 25% of the recorded extent of the site and impact its heritage values.
9	N/A	Tyndale corridors of movement	Moderate-high	Aboriginal cultural place	Direct	This place would be partially impacted by the ancillary facility. The cultural heritage values and significance of this place would be diminished by the impact. However, the route of this corridor of movement is not known, as this information appears to have been lost.
Section 4						
4a, 4b, 4c	13-4-0170	Shark Creek 2	Low-moderate	Artefact scatter	Direct	Site 4b would impact on 20% of the recorded extent of the site and impact its heritage values. Site 4c would impact on 20% of the recorded extent of the site and impact its heritage values. This is additional to the impacts from the project, which would impact on about 60% of the site. Together, 100% of the site would be impacted.
5	13-1-0185	Hirst 3	Low	Artefact scatter	Direct	The ancillary facility would impact on 50% of the recorded extent of the site and impact its heritage values.
Section 5						

Ancillary facilities	AHIMS ID	Name	Overall significance	Site type	Impact	Impact statement
6a	13-1-0191	Mororo Creek 1	Low-moderate	Artefact scatter	Direct	The ancillary facility would impact on 80% of the recorded extent of the site and impact its heritage values.
6, 6a	13-1-0193	Mororo Creek 2	Low-moderate	Artefact scatter	Direct	Section 5, Site 6a would impact on 90% of the recorded extent of the site and impact its heritage values. Section 5, Site 6 would impact on less than 5% of the recorded extent of the site, with minimal impact to its heritage values.
Section 7						
3		New Italy 1 (Dubaijeen Site)	Moderate	Artefact scatter	Direct	The ancillary facility would impact on 90% of the recorded extent of the site and impact to its heritage values.
4	13-1-0194	The Gap Rd 1	Low-moderate	Artefact scatter	Direct	The ancillary facility would impact on the entire recorded extent of the site and impact to its heritage values.
Section 10						
All areas within sections 10 and 11	N/A	Cooks Hill to Teven Junction	Moderate	Aboriginal cultural place	Direct	Unavoidable partial impact to this landscape as it encompasses the whole region. The ancillary facilities would result in minimal impact to the cultural heritage values in addition to that already assessed in the EIS for the project.
5	04-4-0167	Rudgley Site 1	Low	Artefact scatter	Direct	The ancillary facility would impact about 90% of the site and have a moderate impact to its heritage values.
6	04-4-0176	Site 12	Moderate	Artefact scatter	Direct	The ancillary facility would impact about 30% of the site and have a moderate impact to its heritage values.

Table 3-35: Additional Aboriginal heritage mitigation measures

Issue	ID number	Mitigation measure	Timing	Relevant section
Ancillary facilities	AH14a	Ancillary facility - Section 1, Site 1a (at Taylors Run 2): • All previously recorded artefacts must be recovered and removed off-site, and passed to registered Aboriginal stakeholders for reburial or storage at a chosen location, subject to a care agreement being established. • If the Aboriginal archaeological site is not to be impacted, an exclusion zone will be established as per management measure AH2. Ancillary facility - Section 1, Site 1a (at Taylors Run 3): • Exclusion zones will be established as per management measure AH2. Ancillary facility - Section 1, Site 1a (at Taylors Run 1): • The surface scatter portion of this Aboriginal archaeological site outside the proposed ancillary facility, will be avoided. An exclusion zone with a buffer of 15 metres of the surface artefact point will be established as per management measure AH2. • Any ground disturbance impacts to the archaeological site in the ancillary facility, will require the top soil down to the sterile clay layer to be graded, stockpiled separately (within a portion of the ancillary facility area), and reinstated at the same area following completion of the activity. • Any portions of the Aboriginal archaeological site not to be impacted will be protected by exclusion zones as per management measure AH2. Ancillary facility - Section 1, Site 1a (at WWC37 (22-1-0344)): • Within the Aboriginal archaeological site in the boundary of the project, after salvage activities, but before any other ground disturbance, the top soil down to the sterile clay layer will be graded from the area, stockpiled separately and used in batters (not fill) of the road/bridge. This will be undertaken in consultation with the relevant registered Aboriginal stakeholders and will be engaged to direct this activity. In addition: • The salvage to be excavated by machine is 30 % of the Aboriginal archaeological site. • The older house nearest to the river within the Aboriginal archaeological site will be removed, with minimal ground disturbance, before salvage excavations being undertaken, so that this area may be targeted for a portion of the salvage. • Their nominated site officers are present during removal of the plastic covering the blueberry bush rows, to identify artefacts on the surface under the plastic – an archaeologist will also be	Pre-construction and construction	1

Issue	ID number	Mitigation measure	Timing	Relevant section
		present to document finds. • All cultural material recovered will be subject to detailed analysis, which will be included in a technical report, including detailed discussion and interpretation. • Any portions of the Aboriginal archaeological site that are not to be impacted will be protected by exclusion zones as per management measure AH2.		
	AH14b	Ancillary facility - Section 1, Site 1a, 1b (at WWC39 (22-1-0343)): • If impact to WWC39 is necessary, salvage excavation of the portion of the Aboriginal archaeological site to be impacted will be undertaken as detailed in the Ancillary facility and design change CHAR (Appendix D of the Submissions/ Preferred Infrastructure Report) and in consultation with RAPs. • If impacts to the Aboriginal archaeological site are necessary, following archaeological salvage the top soil down to the sterile clay layer will be graded from the area, stockpiled separately and placed in batters. • Where ground disturbance is not necessary, geotextile fabric and crushed rock or similar will be used to protect the ground from compaction. • The area of the Aboriginal archaeological site not to be impacted will be protected by an exclusion zone as per management measure AH2.	Pre-construction	1
	AH14c	Ancillary facility - Section 1, Additional site 5: • Sub-surface test excavation will be undertaken prior to the use of the ancillary facility. This will be conducted in accordance with the methodology used in the working paper, and will occur several months before any ground disturbance in this location. Further recommendations for the Aboriginal archaeological site will then be made in consultation with the registered Aboriginal stakeholders.	Pre-construction	1
	AH14d	Ancillary facility - Section 2, Site 1b (at Lemon Tree Road 1 (13-4-0180): • An exclusion zone will be established around this Aboriginal site as per management measure AH2.	Construction	2
	AH14e	Ancillary facility - Section 2, Site 3 (at Kungala Road 1 (13-4-0181)): • Sub-surface test excavation will be undertaken prior to construction, conducted in accordance with the methodology used in the working paper, and occur several months before any ground disturbance at this location. Further recommendations for the Aboriginal archaeological site will then be made in consultation with the registered Aboriginal stakeholders, including potentially establishing a care agreement will be necessary to enable this. • Any portions of the Aboriginal archaeological site that are not to be impacted will be protected by exclusion zones as per management measure AH2.	Pre-construction and construction	2

Issue	ID number	Mitigation measure	Timing	Relevant section
	AH14f	Ancillary facility - Section 2, Site 4 (at Wells Crossing Artefacts 1 (13-4-0183): • If this Aboriginal archaeological site is to be impacted, salvage excavation of the portion of the Aboriginal archaeological site to be impacted will be undertaken as detailed in the Ancillary facility and design change CHAR (Appendix D of the Submissions/ Preferred Infrastructure Report) and in consultation with RAPs.	Pre-construction	2
	AH14g	Ancillary facility - Section 2, Site 5b (at WWC139 (13-4-0157)): • The Aboriginal archaeological site that is not to be impacted will be protected by exclusion zones as per management measure AH2.	Construction	3
	AH14h	Ancillary facility - Section 3, Site 3b (at WX2I Site 8 (09-4-0108)): • All previously recorded artefacts will be recovered and removed off-site before construction, subject to a care agreement being established. • All cultural material recovered will be subject to detailed analysis, which will be included in a technical report, including detailed discussion and interpretation.	Pre-construction	3
	AH14i	Ancillary facility - Section 3, Site 6b (at Old Tucabia Dump 1 (13-4-0184)): • An exclusion zone will be established at the boundary of the Aboriginal archaeological site (including a buffer based on the drip zone of the tree) as per management measure AH2.	Construction	3
	AH14j	Ancillary facility - Section 3, Site 9 (at Upper Coldstream 1 (13-4-0182): • All previously recorded artefacts will be recovered and removed off-site, subject to a care agreement being established. • Any portions of the Aboriginal archaeological site not to be impacted will be protected by exclusion zones as per management measure AH2.	Pre-construction and construction	3
	AH14k	Ancillary facility - Section 4, Site 1: • Sub-surface test excavations will be undertaken in accordance with the methodology used in the working paper, and will occur before any ground disturbance at this location. Further recommendations for the Aboriginal archaeological site will then be made in consultation with the registered Aboriginal stakeholders.	Pre-construction	4
	AH14l	Ancillary facility - Section 4, Site 3: • This property could not be accessed for field investigations. Sub-surface test excavation are to be undertaken. This will be conducted in accordance with the methodology used in the working paper, and will occur before ground disturbing work for the project or ancillary activities being undertaken at this location. Further recommendations for the Aboriginal archaeological site will	Pre-construction	4

Issue	ID number	Mitigation measure	Timing	Relevant section
		then be made in consultation with the RAPs.		
	AH14m	Ancillary facility - Section 4, Site 5 (at Hirst 3 (13-1-0192): • This Aboriginal archaeological site is to be avoided if possible unless agreement can be reached with the RAPs. An exclusion zone will be established as per management measure AH2. • If agreement to use the site is reached with RAPs, salvage excavation of the portion of the Aboriginal archaeological site to be impacted will be undertaken as detailed in the Ancillary facility and design change CHAR (Appendix D of the Submissions/ Preferred Infrastructure Report) and in consultation with RAPs.	Pre-construction	4
	AH14n	Ancillary facility - Section 5, Site 7 (at Mororo Creek 1 (13-1-0191)): • This Aboriginal archaeological site within the ancillary facility location will be avoided. An exclusion zone at least five metres outside the boundary of the Aboriginal archaeological site will be established as per management measure AH2.	Construction	5
	AH14o	Ancillary facility - Section 5, Site 5 and Site 7 (at Mororo Creek 2 (13-1-0193): • This Aboriginal archaeological site within the ancillary facility location will be avoided. An exclusion zone at least five metres outside the boundary of the Aboriginal archaeological site will be established as per management measure AH2.	Construction	5
	AH14p	Ancillary facility - Section 7, Site 1: • A site walk over survey will be undertaken to confirm whether sub-surface test excavations are required. This will be conducted in accordance with the methodology used in the working paper, and will occur several months before any ground disturbance at this location. Further recommendations and use of the Aboriginal archaeological site will be developed in agreement with the registered Aboriginal stakeholders.	Pre-construction	7
	AH14q	Ancillary facility - Section 7, Site 3 (Dubaijeen Site (New Italy 1): • Salvage excavation of the portion of the Aboriginal archaeological site to be used will be undertaken as detailed in the Ancillary facility and design change CHAR (Appendix D of the Submissions/ Preferred Infrastructure Report) and in consultation with RAPs. The excavations apply to the portion of the site that be impacted by the project as well as the ancillary facility. • Any portions of the Aboriginal archaeological site that are not to be impacted will be protected by exclusion zones as per management measure AH2.	Pre-construction and construction	7
	AH14r	Ancillary facility - Section 7, Site 4 (The Gap Rd 1(13-1-0194)): • If impact to The Gap Rd 1 is necessary, salvage excavation of the portion of the Aboriginal archaeological site to be impacted will be undertaken as detailed in the Ancillary facility and	Pre-construction and construction	7

Issue	ID number	Mitigation measure	Timing	Relevant section
		design change CHAR (Appendix D of the Submissions/ Preferred Infrastructure Report) and in consultation with RAPs. • Any portions of the Aboriginal archaeological site that are not to be impacted will be protected by exclusion zones will be established as per management measure AH2.		
	AH14s	Ancillary facility - Section 10, Site 1a: • A site walk over survey will be undertaken to confirm whether sub-surface test excavation is required. This will be conducted in accordance with the methodology used in the working paper, and will occur several months before any ground disturbance at this location. Further recommendations for the Aboriginal archaeological site will then be made in consultation with the registered Aboriginal stakeholders.	Pre-construction	10
	AH14t	Ancillary facility - Section 10, ancillary facility 5At Rudgley Site 1 (04-4-0167): • This Aboriginal archaeological site will be avoided, where practical, using an exclusion zone as per management measure AH2. • If avoidance is not possible, salvage excavation of the portion of the Aboriginal archaeological site to be impacted will be undertaken as detailed in the Ancillary facility and design change CHAR (Appendix D of the Submissions/ Preferred Infrastructure Report) and in consultation with RAPs. • Any portions of the Aboriginal archaeological site that are not to be impacted will be protected by exclusion zones as per management measure AH2.	Pre-construction and construction	10
	AH14u	Ancillary facility - Section 10, Site 6 (Site 12 (11-2-0082)): • If avoidance is not possible, salvage excavation of all portions of the Aboriginal archaeological site to be impacted will be undertaken as detailed in the Ancillary facility and design change CHAR (Appendix D of the Submissions/ Preferred Infrastructure Report) and in consultation with RAPs. • Any portions of the Aboriginal archaeological site that are not to be impacted will be protected by exclusion zones as per management measure AH2.	Pre-construction and construction	10

Issue	ID number	Mitigation measure	Timing	Relevant section
	AH14v	Ancillary facility - Section 11, Site 1a: • The ground will be inspected for any Aboriginal archaeological material by an archaeologist and registered Aboriginal stakeholders during and following clearing activities. Any archaeological material will be recorded, removed from the Aboriginal archaeological site, and a suitable location for the material determined in consultation with the stakeholders. An AHIMS record will be submitted for any finds and any locations where the material is to be stored – unless reburied on or near Aboriginal archaeological site, establishing a care agreement will also be necessary.	Pre-construction and construction	11

3.12.5 Historical (non-Aboriginal) heritage

Scope

The desktop historical (non-Aboriginal) heritage assessment undertaken for the EIS found that of the 82 ancillary facilities proposed for the project, there would be impact on three heritage items (Item 21 Harwood Convent, Item 32 Harwood Heritage Conservation Area, Item 33 High Conservation Value Old Growth Forests). The impact to these sites occurred as a result of the project construction and were assessed in the EIS and are not considered in this assessment. Nine ancillary facilities were identified as having a medium likelihood of previously unrecorded heritage sites present. None of the ancillary facilities were identified as having a high likelihood of previously unrecorded historical heritage sites. A management measure (HH4) required further assessment of the nine ancillary facilities with a medium likelihood of previously unrecorded heritage sites.

Field survey was undertaken at the nine identified[1] ancillary facilities, as recommended in the EIS by a qualified and experienced heritage consultant. Three sites were identified as being of local significance and impact assessments have been completed for these items (refer below and in Appendix E). This assessment therefore fulfils management measure HH4 of the EIS and it has been deleted from the revised list of management measures in Chapter 5 of this report. The other 76 ancillary facilities were subject to a desktop assessment.

Desktop assessment

As part of the EIS assessment, a desktop assessment was undertaken to identify the likelihood of previously unrecorded or unknown historical heritage sites for all ancillary sites. All ancillary sites were assessed, to determine the likelihood of sites, by identifying:

- Whether the ancillary site is outside the project boundary and therefore not already subject to assessment.
- Whether there is presence/absence of known historical heritage sites.
- Whether obvious historical features are visible in aerial imagery.
- What the level of disturbance, cultivation, vegetation and development of area is.
- Whether field survey was undertaken within or adjacent to area.

The predictive model was also considered in the desktop assessment of the ancillary sites. Each ancillary site was ranked with low, medium or high likelihood of historical heritage sites based on the above criteria. Requirements for further assessment including field survey were identified in the Historical (non-Aboriginal) Heritage Assessment (SKM, 2013).

Field survey methodology

Field investigations were undertaken at the same time as Aboriginal heritage field surveys between 17 September 2012 and 20 December 2012. The field survey for historical heritage occurred over 12 days, with qualified archaeologists walking the area for each of the nine ancillary facilities identified during the desktop assessment for further assessment.

The methodology for field surveys included:

- A walk-over survey in 5-10 metre wide transects across each survey area, with particular attention given to areas of higher ground-surface visibility or where the surface was exposed.
- Recording surface and sub-surface exposures for each survey area, and observations of vegetation type, previous modification/disturbance, landform and land-use.
- Recording site locations as GPS points or marked on aerial imagery and maps of property.
- Recording environmental and archaeological context of each heritage item including general location, site components, landscape features and ground disturbance.

[1] An additional heritage site was identified during field survey in proximity to an ancillary facility not identified in the desktop assessment as requiring field survey. While this site was not in or directly impacted by the ancillary facility or project, it was recorded in the assessment.

- Photographic records.
- Identification of the curtilage of each historical heritage item through assessment of field data.

Field survey results

During the field survey, five previously unknown historical heritage items were identified and recorded either within or immediately adjacent to the ancillary facility boundaries. These included:

- Halfway Creek fire station, Halfway Creek (Section 2).
- Dwelling/hut, Jacky Bulbin Flat (Section 6).
- Dairy remains, Woodburn (Section 8).
- Drainage channels, Coolgardie (Section 10).
- Dairy/farming remains, Pimlico (Section 10).

A new historical heritage item - Post Office Lane Stockyards, Corindi Beach - was identified during field survey of ancillary facilities. This item is situated immediately adjacent to the ancillary facility boundary and is not impacted by the project.

No potential sub-surface historical archaeological remains were identified at any site during the survey.

A summary of the results of the recent field surveys is presented in Table 3-36.

Table 3-36: Results of field survey of ancillary facilities

Project section	Location	Site no	Known historical heritage sites (before survey)	Results of survey
1	5.2 - 5.4 RHS[1]	2	No	Timber stockyard (Item 39) situated outside but immediately north-east of the ancillary site boundary. No historical heritage items were identified within the ancillary site boundary.
2	17.2 – 17.5 RHS	1b	No	Cleared area behind the service station contains no structures or evidence of historical heritage items and comprises a vehicular rest area. A shed associated with the former Halfway Creek fire station (Item 40) is situated immediately to the west, and outside the ancillary site boundary.
3	61.2 – 61.5 RHS	8	No	This ancillary site contains a modern shed with no heritage significance. No historical heritage items were identified during the survey.
4	77.2 – 77.3 LHS[2]	4c	No	This ancillary site contains a modern house and two recently built sheds, one galvanised corrugated iron and the other made out of Colorbond-style material. No historical heritage items were identified during the survey.
4	79.5 – 80.0 LHS	6	No. 500 m south of Item 22 (former house site) and < 500 m south of Item 12 (Ferry/ punt) - no impact.	This ancillary site contains an early 20th century house with substantial modification, and galvanised corrugated iron sheds and outbuildings. The area also contains a brick mid-20th century house with timber-fenced paddocks and a small open-sided shed. No historical heritage items were identified during the survey.
6	103.1 to 103.9 RHS	3a	No	This ancillary site contains a complex of recently built sheds and beehives. A small dwelling/hut

Project section	Location	Site no	Known historical heritage sites (before survey)	Results of survey
				was also found on the property (Item 41).
8	132.0 – 132.2 LHS	2b	No	This ancillary site contains the concrete footings of a former dairy (Item 42).
9	136.8 – 137.2 LHS	1	No	This ancillary site contains buildings and features associated with a modern nursery. No historical heritage items were identified during the survey.
10	156.2 to 156.6 RHS	4	No. < 1 km east of Item 29 (Stonehenge). No impact to site.	This ancillary site contains an extension of the drainage channels identified at Item 29 (Stonehenge). The drainage channels are part of a system constructed in the early 20th century (Item 43).
10	158.3 – 158.7 LHS	6	No	The ancillary site contains concrete and stone footings, potentially related to a dairy or other farming activity (Item 44).

NOTES: [1] Right Hand Side: to the east of the project boundary

[2] Left Hand Side to the west of the project boundary

Significance assessment

Of the six items found during the survey, four (Items 40, 41, 42, 44) were considered to have insufficient heritage significance to fulfil criteria for local or state heritage listing and are not considered further in the impact assessment. Two items were considered to have local heritage significance (Items 39 and 43). A summary of the significance of each item is presented in Table 3-37.

Table 3-37: Summary heritage significance of heritage items

Project section	Item no	Item name	Statement of significance
1	39	Post Office Lane Stockyards, Corindi Beach	The site is important for its association with a long-standing Corindi family. The intact nature of the stockyards provides a good example of the use of local materials and construction methods for farm infrastructure. The stockyards have the potential to provide information on the design and construction of stock enclosures in the north coast region of NSW. The site is of local heritage significance.
2	40	Halfway Creek fire station (former), Halfway Creek	Item does not meet the criteria thresholds for local or state listing. While the former fire station is associated with the long-standing Halfway Creek Rural Fire Brigade, the importance of the organisation to the history of the local area is not clear.
6	41	Dwelling/hut, Jacky Bulbin Flat	Item does not meet the criteria thresholds for local or state listing. While the property has been owned by the same family since the early 20th century with an ongoing focus on beekeeping, this industry is not key to the development of the local area and the site has little contribution to understanding local history.

Project section	Item no	Item name	Statement of significance
8	42	Dairy remains, Woodburn	Item does not meet the criteria thresholds for local or state listing. While the site is associated with the important local historical industry of dairying, the remains only have potential to provide very limited information about the industry.
10	43	Drainage channels, Coolgardie	The overall drainage network in the Coolgardie and Wardell district demonstrates the techniques used in the management of water in the region, including the organisation of co-operative unions, to enable the continuing productive use of such land for agricultural purposes. The requirement for the management of water in the region is a feature of the geography of the landscape as coastal lowlands. The single component of the drainage channel situated within the ancillary site can be graded as moderate as it makes some contribution to the overall local significance of the drainage network. The overall network is of local heritage significance.
10	44	Dairy/farming remains, Pimlico	Item does not meet the criteria thresholds for local or state listing. While the site is likely associated with the important local historical industry of farming/dairying, the remains have the potential to provide very limited information about the industry. The site is associated with a range of different people throughout the 20th century and has no obvious ties to any important local people.

The potential impacts of the project on the heritage significance of the two items identified as being of local heritage significance as detailed in Table 3-38 and have also been included in Chapter 5.

Impact assessment

The two additional heritage items identified as being of heritage significance (Item 39 Post Office Lane Stockyards and Item 43 Drainage channels) would potentially be impacted through use of the ancillary facilities within sections 1 and 10.

Table 3-38: Summary heritage significance of heritage items

Project section	Item no	Item name	Potential impacts
1	39	Post Office Lane Stockyards, Corindi Beach	Heritage item is not situated in the ancillary facility site. The heritage item is situated to the north east of the ancillary facility. There would be potential for damage due to accidental disturbance by materials, machinery or vehicles.
10	43	Drainage channels, Coolgardie	This heritage item is situated within the ancillary facility could be directly impacted through infilling, or through accidental collapse due to machinery, vehicles, stockpiling or other activities occurring in close proximity to, on or over the drainage channel.

No other historical heritage items would be impacted by the use of ancillary facilities.

Management measures

The management measures identified in the EIS (and included in Chapter 5) are applicable to the ancillary facilities, particularly management measures HH1 to HH4. However, additional management measures have been identified to mitigate the potential impacts to the two additional heritage items identified as being of heritage significance (Item 39 Post Office Lane Stockyards and Item 43 Drainage channels).

The additional management measures are included in Table 3-39.

Table 3-39: Additional historical heritage management measures

Issue	ID number	Mitigation measure	Timing	Relevant section
Ancillary facilities	HH5	• At project section 1, site 2: a temporary barrier fence will be erected between item 39 and the ancillary site. The fence will remain in place until the conclusion of the use of the ancillary site at which time it will be removed.	Construction	1
	HH6	• At project section 10, site 4: a temporary barrier fence will be erected to protect the drainage channel that is not directly impacted by the project (item 43). The fence will remain in place until the conclusion of the use of the ancillary site at which time it will be removed.	Construction	10

3.12.6 Biodiversity

In the EIS, the biodiversity assessment identified that of the 81 ancillary facility sites identified, 25 were located wholly within the project boundary. The loss of vegetation and habitat was included in the project impacts described in Chapter 10 of the EIS and no further assessment of these sites was required. The potential ecological impacts for the remaining 59 sites outside of the project boundary and not assessed in detail in the EIS, are addressed in this section of the report and described further in Appendix J.

Scope

Of these 55 sites identified in the EIS plus the additional four sites identified after the EIS was placed on display (59 sites in total), 46 contain remnant vegetation on a portion of the site. These sites may include small patches of dense tree cover, or scattered light tree cover including paddock trees and were assessed for threatened species presence. These 46 sites were the focus of the biodiversity assessment and field investigations undertaken for the ancillary facilities. The remaining 13 sites do not contain native vegetation or/and are located on either cropping or grazed pasture areas.

The additional assessment for biodiversity undertaken for the ancillary facilities supplements the biodiversity assessment working paper included in the EIS (refer to Appendix J).

The methodology used to assess the suitability of the sites for ancillary facilities has been outlined below.

Desktop analysis

Existing information on the presence and distribution of threatened species and populations in relation to the proposed ancillary sites was obtained from a variety of data sources including:

- An updated review of the Atlas of NSW Wildlife Database (OEH, 2012b).

- OEH Threatened Species Profile Search for any new species population and ecological communities added to the TSC Act since the review for the working paper (accessed online January 2013).
- Protected Matters Search Tool (DSEWPaC, 2009).
- Species profile and threats databases (OEH, 2012b; DSEWPaC, 2009) (accessed online January 2013).

Field surveys

Field surveys were conducted over three weeks at the proposed ancillary sites on 3-7 December 2012, 17-21 December 2012 and 14-18 January 2013. The surveys were designed to provide a consistent and systematic approach for capturing the presence of threatened species and important habitat values. The level of survey effort and type of survey techniques employed was determined by the existing knowledge of vegetation cover, the extent of habitat and its condition and threatened flora and fauna species likelihood at each site. Field surveys focused on sites that contained patches of remnant vegetation, dams and adjacent wetlands and or sites close to large water bodies and sites with obvious mature paddock trees.

Identification of vegetation communities used a combination of transects and general traverses aimed at classifying the vegetation according to the Biometric Vegetation Types database (OEH, 2012a) for comparison with the vegetation descriptions in the working paper.

A general traverse approach was used to target threatened flora species within remnant and regrowth and disturbed and cleared areas. Where a threatened species was identified, further survey was conducted to identify the size and extent of the population. Targeted threatened flora surveys were conducted wherever remnant vegetation was noted, which included all densely vegetated patches, light tree cover, scattered isolated trees and cleared land in low wet areas for species including Hairy Joint Grass (*Arthraxon hispidus*). These surveys involved random meanders across all portions of the site and identification of biometric vegetation types where possible.

Detailed and targeted fauna surveys started with a review of aerial photography and vegetation mapping to identify the extent of habitat present on each site and potential habitat features such as dams. This was used to predict whether threatened fauna species could be expected to occur, and whether vegetation on each site provided connectivity to larger habitats.

Targeted koala surveys were conducted where appropriate feed tree species occurred. The location of identified koala scats were recorded with a Global Positioning System as was the tree species. Reptile surveys were integrated into the koala scat search and conducted at all relevant sites by misplacing small logs, litter and bark around tree bases. Targeted searches for frogs and reptiles included nocturnal and diurnal hand searches for the Giant Barred Frog (*Mixophyes iteratus*) and Wallum Sedge Frog (*Litoria olongburensis*). This was conducted within the confines of the site boundaries at Cassons Creek and Halfway Creek (Section 1) and Pheasants Creek (Section 3).

Waterways intersecting or seasonally connecting to proposed ancillary facility sites were surveyed using trapping techniques and also water quality testing. Aquatic surveys were conducted using a variety of appropriate methods including fish surveys, water quality assessments, habitat assessments, and targeted surveys.

Investigations were done at three aquatic habitat sites to determine the potential presence of Oxleyan Pygmy Perch. This included habitats associated with Cassons Creek and Halfway Creek (Section 2) and Pheasants Creek (Section 3). Six locations were sampled in total using a range of techniques. The surveys were undertaken in consultation with the Department of Primary Industries (Fisheries), and in accordance with the Survey Guidelines for Australia's Threatened Fish (DSEWPaC 2011). This ensured the optimum survey period for the Oxleyan Pygmy Perch and minimised impacts to breeding life-cycle events. Fish sampling methods included electrofishing, dip nets and bait traps.

Further details on the field survey methodology and mapping of survey coverage is in the Supplementary Biodiversity Assessment (Appendix J).

Results

Most ancillary facility sites were cleared of vegetation and comprised only a scattered low density of vegetation, mainly as isolated habitat fragments or early stages of natural regeneration where low density grazing has occurred. Due to this variability, some sites have isolated threatened tree species, and/or regenerating threatened ecological communities. Some sites have some value for biodiversity and threatened species including potential refuge or habitat for life-cycle events and are therefore worthy of avoiding.

The surveys confirmed that remnant vegetation and associated high quality habitats are absent or limited on most sites. This indicates that the selection of ancillary facility sites has been appropriate and would have minimal impact on threatened species, populations and communities. Important features on the ancillary facility sites such as habitat structural integrity, hollow-bearing trees, logs, native shrubs and connectivity features for fauna are largely absent. The value of the habitat on these sites is mostly in the presence of scattered and often isolated resources such as small dams, occasional tree hollows for shelter, roosting and nesting habitat for birds and microchiropteran bats and seasonal flowering resources that may be used by wide-ranging nectarvores such as the Grey-headed Flying-fox, Swift Parrot and Little Lorikeet. The value of these habitats is limited by small patch sizes associated with previous clearing and fragmentation of habitats and a lack of connectivity.

A small number of sites contain more extensive stands of remnant vegetation, although are adjacent to cleared areas. Of particular note were the forested portions of site 5 (Section 1) and site 2 (Section 2), both of which contain a range of significant habitat features suitable for threatened flora and fauna.

Two other sites, which were found to be mostly cleared, contain scattered low numbers of koala feed trees and evidence of infrequent use by koalas via old scats (ie Section 3, site 9 and Section 5, site 6). Both sites occur adjacent to extensive areas of potential koala habitat and the observed koala use of the cleared sites may be either represented by a portion of the home range of an individual koala or previous visitation by a dispersing individual.

Isolated exotic and native remnant trees occur at most sites and represent a low to medium conservation value in a changed structural and floristic form, with large areas of vegetation removed. Wildlife may depend on these trees to cross and move between intact vegetation patches, especially if trees are primary food trees for koalas or contain hollows. Habitat for fauna is limited at most sites where land use has modified forest structure.

Some ancillary facility sites still contain remnant isolated habitat in the form of hollows and foraging space that may hold high ecological value, especially where threatened species are present. In particular Section 2, site 2 and Section 1, Additional site 5 were both found to contain important habitats for threatened fauna species and specific recommendations for these sites has been included.

Aquatic habitats present within the ancillary facility sites were generally in the form of artificial riparian areas, drainage lines, open farm dams and swamp/wetland environments. However some water sources were highly modified and varied in habitat value for amphibians and fish.

An overview of potential ancillary site impacts on TECs, threatened flora, threatened terrestrial fauna, threatened aquatic fauna and fauna connectivity is provided below and detailed in Appendix J.

Threatened ecological communities

The majority of the sites investigated contain cleared pasture or cropping land with occasional isolated remnant trees or small areas of vegetation regrowth. Some sites that have had low use in the recent past (such as light grazing) show early stages of natural regeneration of native plant species once grazing has been discontinued. This includes recent regrowth of vegetation showing elements of former threatened ecological communities, in particular low-lying Swamp Sclerophyll Forest and Floodplain Eucalypt Forest (TSC Act). This regrowth was found to be of low condition and suppressed in native species richness due to a depleted native seed bank and were subsequently dominated by hardy and early successional pioneer plant species. These small patches of TEC's are already indirectly impacted by weeds and increased exposure over long periods. The temporary use of the site would not be expected to exacerbate these indirect impacts. Lowland Rainforest community patches were found to be present at a small number of sites and these were of low condition due to past clearing and significant changes in the structure of the community and high weed abundance. There is scope to retain vegetation on ancillary facility sites and this recommendation would ensure minimal direct or indirect impacts to the several small patches of TEC's identified.

Three ancillary sites in section 10 (site 4, site 5 and Site 6) occur on cleared land however it is noted that fragments of the endangered Swamp Sclerophyll Forest (TSC Act) and Lowland Rainforest (TSC act and EPBC Act) occur in proximity to the boundaries of the site. Provided there are protective buffers around these communities as is recommended, then further edge effects are not expected.

Threatened flora

Five threatened flora species were identified from the site surveys and these were found to occur either directly on a site or within immediately adjoining areas off-site including access tracks and have potential to be indirectly impacted. These species are:

- Hairy Joint Grass (*Arthraxon hispidus*) – vulnerable species EPBC Act and TSC Act.
- Sandstone Rough-barked Apple (*Angophora robur*) – vulnerable species EPBC Act and TSC Act.
- Square-fruited Ironbark (*Eucalyptus tetrapleura*) – vulnerable species EPBC Act and TSC Act.
- Slender Screw Fern (*Lindsaea incisa*) – endangered species TSC Act.
- *Maundia triglochinoides* – vulnerable species TSC Act.

Details of the sites where threatened flora were recorded and potential direct and indirect impacts are discussed in Table 2-9 in Appendix J. This includes site specific mitigation measures, where required

Threatened terrestrial fauna

A summary of the general findings of the survey is described below, and more site specific information and mitigation measures are presented in Table 2-10 in the Supplementary Biodiversity Assessment.

Most of the sites assessed in the field were found to comprise scattered low densities of remnant trees, some mature and some young age which have been retained as paddock trees or along property boundaries. This includes occasional dead trees and hollow-bearing trees provide habitat value as potential roost or nesting resources for fauna, mainly wide-ranging and highly mobile species such as microbats and birds. Associated with this scattering of trees is a potential food resource for nectivorous fauna in the form of seasonally available blossom. Spatially separated resources are accessed by wide-ranging and highly mobile threatened species such as the Grey-headed Flying-fox, Little Lorikeet and Swift Parrot. Of particular value for these nectarvores is the presence of winter flowering tree species, however these resources were found to be scarce on the ancillary facility sites assessed. There is considerable scope to retain these important resources through careful planning and placement of infrastructure within the sites.

Isolated paddock trees are known to provide foraging, breeding and refuge habitat for some fauna, and could also support high diversity of insectivores (Gibbons & Boak 2000). Wildlife may depend on these trees to cross and move between intact vegetation patches, especially if trees are primary food trees for Koalas or contain hollows. The threatened Osprey is known to regularly construct nests in paddock trees and large dead trees where these occur close to waterbodies. While no large raptor nests were located in any of the proposed ancillary facility sites there is potential for these to occur.

Cane farms occupied many sites and these have very limited ecological value except as potential foraging habitat for the endangered Coastal Emu population and some cane drains were found to the used by the threatened Wallum Froglet (*Crinia tinnula*, vulnerable TSC Act) or may be used by common frogs and birds.

Some cleared ancillary sites bordered intact remnant vegetation on adjoining land, and it would be assumed that fauna population within these large habitats may occasionally forage, roost or occupy small areas of habitat inside the boundaries of the ancillary facility site. An example is Section 3 site 9 and Section 6 site 6, in which both were predominantly cleared but surrounded by open forest. A small number of trees on the cleared sites showed infrequent use by koalas. In both instances, the trees may constitute the edge of a home range area for a koala, or were used by dispersing individuals.

Aquatic habitats that intersect ancillary facility sites were generally in the form of narrow riparian areas, drainage lines, open farm dams and small swamp/wetland environments. Most of these were highly disturbed and varied in habitat value for amphibians and fish.

A number of threatened fauna species were previously identified as having at least a moderate likelihood of occurring on an ancillary site that contain scattered low densities of remnant trees. These species are those fauna that demonstrate tolerance to disturbed and cleared habitats. The species with a higher likelihood of occurring would include hollow-roosting bats which may use isolated remnant trees for roost sites and forage over cleared and modified habitats in conjunction with and other cave-roosting microbats. A number of species were identified as potentially occurring on the more densely forested sites. This included the Common Planigale, Spotted-tailed Quoll, Yellow-bellied Glider, Squirrel Glider and Square-tailed Kite. The avoidance of these sites as is proposed will ensure that direct loss of habitat would not occur and they have only a low chance of occurring on the cleared lands with scattered trees.

Of the remaining species which includes Coastal Emu, Brush-tailed Phascogale, Masked Owl, Grey-crowned Babbler, Koala and Wallum Froglet, these species are known to occur in remnant and regrowth habitat and some cleared and modified sites provide essential habitat elements. These features, which include remnant trees and small fragments of vegetation would be retained on site and the temporary use of these sites suggests that suitable habitat characteristics would remain post-construction and continued use of the site could be expected. No large hollows suited as nest sites for the Masked Owl were observed from the surveys and no large raptor nests, although a re-survey prior to the start of construction is recommended for Osprey nests, particularly in locations on the floodplain close to rivers and streams.

Threatened aquatic fauna

None of the proposed ancillary sites directly impacts on known or potential habitat for the Oxleyan Pygmy Perch. The results of the surveys for the three creeks that are present within the boundaries of an ancillary site (sites within section 2 and 3) confirmed that these habitats are not suitable for the Oxleyan Pygmy Perch. There will be no direct impact on habitat of the Oxleyan Pygmy Perch from the proposed ancillary site. There is however at least seven proposed ancillary facility sites, located in Sections 7, 8 and 9, which occur within proximity to known and potential habitat for Oxleyan Pygmy Perch. These are discussed in Table 2-11 in Appendix J including the potential indirect impacts of the activities proposed and appropriate site specific mitigation measures.

The potential indirect impacts associated with sites in proximity to habitat for the species would be associated with the following high-risk activities:

- The removal of vegetation on the floodplain and the associated disturbance of soil and potential sediment run-off into waterways
- Stockpiling of spoil storage or mulch in floodplain areas that is transported to a waterway during an unexpected flood event

- Sites for treating water, where option to directly discharge into waterways is not available, and the potential for spillage of chemicals.

This assessment of impacts for the Oxleyan Pygmy Perch in relation to ancillary facility sites indicates that impacts are avoidable and can be mitigated through careful planning including:

- Planning is needed to avoid stockpiling on the floodplain at these sites
- The development of specific Environmental Works Methods Statements (EWMS) to support on-ground-works
- Vegetation clearing on these sites should be avoided or where clearing is required this should limit ground disturbance (eg leaving stumps in place and groundcovers)
- Sediment fencing is required on sloping sites or where ground disturbance is likely.

Given the distance of the site from the habitat of the species and the low risk activities expected to occur, the additional cumulative impacts on Oxleyan Pygmy Perch habitat are expected to be minimal and able to be mitigated.

Connectivity for fauna

The location of connectivity mitigation measures was considered in the selection of ancillary facility sites. Hence the majority of sites are not located near or would block access to any dedicated or combined fauna crossing structures currently proposed for the project. Further, as these facilities are only intended to be temporary sites to be used during construction, there are no anticipated long-term impacts to the movements of fauna. A discussion on potential impacts to fauna connectivity from use of an ancillary facility site is provided in Appendix J.

In a few cases a cleared ancillary site occurs adjacent to a proposed connectivity structure. In some of these instances it is proposed to improve connectivity in this location by re-vegetating the site post–construction. This would occur in the road reserve or where the site is owned by Roads and Maritime. In summary these sites are:

- Section 10, site 1b on the west side and adjacent to the bridge over the Richmond River.
- Section 3, site 2 along an unmanned tributary of Glenugie Creek. Rufous Bettong has been recorded in several places near this site and has been targeted by placement of an underpass here.
- Section 2, site 1a. An arboreal crossing is proposed near this location to provide connectivity to Yuraygir State Conservation area. The proposed ancillary site currently exists as a cleared site completely surrounded by large expanses of remnant vegetation.

Summary

With the exception of the portions of six sites in which high biodiversity values were noted and recommendations made to avoid these sites (Section 1 site 1b and Additional site 5; Section 2, site 2; Section 5, Additional site 7 and Additional site 8, Section 10, site 6), the remaining ancillary sites would add minimal cumulative impacts to the project, for these reasons:

- Any patches of threatened ecological communities noted were highly modified, with a low natural floristic and structural diversity. In most cases, there is scope to avoid vegetation removal through appropriate planning for ancillary facilities on the site.
- Vegetation on these sites is generally characterised by scattered small and fragmented patches or isolated trees in low condition and are well represented in the surrounding locality.
- There are scattered low densities of trees with some potential value as shelter or nesting resources for wide-ranging and highly mobile species such as the threatened Grey-headed Flying-fox and Swift Parrot. These species are capable of exploiting resources which occur over very large

spatial areas. These resources are expected to remain on the site during construction and post construction such that the current opportunity to use these resources would remain.

- Low evidence of koala use was observed at two sites which were both positioned adjacent to extensive areas of suitable habitat for koalas suggesting the site was of limited importance and may only contribute to a small portion of a home range or be used by dispersing individuals. These habitat features have been noted and would be protected.
- Any potential impacts resulting from the use of these ancillary facility sites are considered able to be mitigated through appropriate planning and consideration for the ecological values noted in this assessment.

Further the proposed revegetation of a small number of cleared sites adjacent to proposed fauna connectivity structures would improve the connectivity around these structures for future use by fauna. This should occur as a minimum within the road reserve, and over the residual areas of the site where the property is owned by Roads and Maritime and is described further in the Supplementary Biodiversity Assessment.

Table 3-40 summarises the findings of the ancillary facility site field surveys, including the presence of threatened species, populations or communities, vegetation condition, aquatic habitats, fauna habitat resources. The summary includes an indication of the potential use of each site by flora and fauna. More detailed site descriptions are provided in Appendix J.

Table 3-40: Results of biodiversity field investigations

Section	Site name	Threatened Ecological Communities (TSC Act and EPBC Act)	Vegetation condition	Aquatic habitats	Fauna habitat resources	Threatened species confirmed (EPBC Act listed species in bold)
1	Site 1a & 1b	Subtropical Coastal Floodplain Forest (TSC Act)	Regenerating	Local ponds and creek	Remnant trees	Absent
1	Site 2a (Casson Creek)	Swamp Sclerophyll Forest (TSC Act)	Remnant and high condition	Large ponds (adjoining site) containing high quality areas of fringing vegetation	Abundant nectar resources and remnant trees. High structural and floristic diversity	Absent, potential habitat for several threatened fauna species including Green-thighed frog, **Grey-headed Flying-fox**, microbats, Powerful Owl
1	Site 3	Absent	Cleared and modified	None	Limited by lack of trees and native vegetation. Only species tolerant of modified habitats expected.	Absent, low value for threatened fauna.
1	Additional site 5	Swamp Sclerophyll Forest (TSC Act)	High condition	Large ponds (adjoining site) containing high quality areas of fringing vegetation. High quality aquatic habitats on Cassons Creek for frogs, birds, reptiles. Fish survey completed - site unsuitable for Oxleyan Pygmy Perch	Abundant seasonal food resources (nectar feeding species), remnant trees with hollows present throughout forested parts but scarce over remainder of cleared areas. High structural and floristic diversity	None confirmed from the survey, although potential habitat for several threatened fauna species including Green-thighed frog, Giant Barred Frog, Grey-headed Flying-fox, microbats, Powerful Owl. Habitat not optimum for **Oxleyan Pygmy Perch** and not recorded from targeted survey at the site.
2	Site 1a, 1b	Absent	Modified	Site 1a: Farm dam in south west corner.	Site1b: small number of hollow bearing trees and large remnant trees, disturbed and maintained understorey.	Absent
2	Site 2	Absent	Remnant and high condition	Creek line (adjoining site) contains deep pools and riparian vegetation	Numerous hollow bearing trees and fallen timber habitats, high structural and floristic diversity.	**Grey-headed Flying-fox**, potential habitat for several other threatened fauna species including Squirrel Glider, Brush-tailed Phascogale, Rufous Bettong, microbats, **Giant Barred Frog**.

Section	Site name	Threatened Ecological Communities (TSC Act and EPBC Act)	Vegetation condition	Aquatic habitats	Fauna habitat resources	Threatened species confirmed (EPBC Act listed species in bold)
2	Site 3	Absent	Planted	Absent	Absent	Absent
2	Site 4	Absent	Low	Absent	Hollow bearing trees present inside the road corridor but absent outside corridor on remainder of the site	Absent
2	Site 5a	Absent	Low	Drainage line	Nectar resources for birds and Grey-headed Flying-fox	**Square-fruited Ironbark** (*Eucalyptus tetrapleura*), potential foraging **for Grey-headed Flying-fox**.
3	Site 2	Subtropical Coastal Floodplain Forest (disturbed)	Modified and disturbed	Creek line within modified landscape, some scattered patches of riparian vegetation	Scattered remnant trees, some with hollows, grassy understory cover, common frog habitat	**Grey-headed Flying-fox (***Pteropus poliocephalus*) Rufous Bettong on road adjacent to site (*Aepyprymnus rufescens*)
3	Site 4	Subtropical Coastal Floodplain Forest	Modified and moderate	Absent	Koala habitat trees Glossy Black Cockatoo habitat to the south of the site. Scattered, mature hollow-bearing trees	**Sandstone Rough-barked Apple** (*Angophora robur*) Grey-crowned Babbler (*Pomatostomus temporalis temporalis*). Potential for emu, glossy black-cockatoo and microbats
3	Site 5	Absent	Low	Small moist depressions and creek lines in open paddock	Two dead stags, very limited fauna habitat resources	Absent
3	Site 6a & 6b	Absent	Low	Small farm dam	Limited to seasonal nectar resources	**Sandstone Rough-barked Apple** (*Angophora robur*)
3	Site 7b	Absent	Low	Absent	One large hollow tree	Slender Screw Fern (*Lindsaea incisa*) (on access trail from Bostock Road)
3	Site 8	Swamp Sclerophyll Forest (Regeneration in the north east site boundary)	Low	Absent	Scattered low number of hollow bearing trees	Absent, potential Slender Screw Fern (*Lindsaea incisa*) habitat (outside the north eastern site boundary)

Section	Site name	Threatened Ecological Communities (TSC Act and EPBC Act)	Vegetation condition	Aquatic habitats	Fauna habitat resources	Threatened species confirmed (EPBC Act listed species in bold)
3	Site 9	Swamp Sclerophyll Forest (in adjacent areas)	Modified and low, history of grazing	Farm dam and adjoining drainage line	Scattered low number of koala habitat trees, abundant in adjoining properties	**koala** scats located under one tree at northwest corner. **Sandstone Rough-barked Apple** (*Angophora robur*) *Maundia triglochinoides* (in adjacent areas)
4	Site 4a, 4b & 4c	Absent	Low	Absent	Two dead stags and timber logs.	Absent
4	Site 5	Absent	Native vegetation absent	Absent	Absent	Absent
4	Site 7a	Absent	Low	Artificial drainage channels	Absent	Absent
5	Site 1	Swamp Sclerophyll Forest (low condition)	Low	Absent	Scattered low number of trees, no hollows	Absent
5	Site 6 and 6a	Swamp Sclerophyll Forest (regenerating and adjoining to the west)	Low, grazed paddock, regenerating swamp forest community	Artificial and remnant drainage channel. Disturbed riparian vegetation on 6a	Very low number of koala habitat trees. Large dead stag and hollow bearing tree on edge of site Threatened fauna habitat: potential koala and owls.	**koala** (scats)
5	Site 6b, 6c	Absent	Low	Absent	Potential koala habitat based on the presence of Grey Gum (*E.propinqua*) and Tallowwood (*E.microcorys*)	Absent, potential for **koala**, **Grey-headed Flying-fox**, microbats

Section	Site name	Threatened Ecological Communities (TSC Act and EPBC Act)	Vegetation condition	Aquatic habitats	Fauna habitat resources	Threatened species confirmed (EPBC Act listed species in bold)
5	Additional site 7	Absent	Dense tree cover (moderate to high)	Absent	Low numbers of Koala feed tree species. Potential koala habitat based on the presence of Grey Gum. No evidence of koalas. Mature trees and dense canopy presence, some hollow-bearing trees, food and shelter resources	None, potential **koala**, Squirrel Glider
5	Additional site 8	Absent	Partial dense cover and partial cleared (moderate)	Absent	Foraging, shelter resources, moderate structural complexity.	None, potential **koala**, Squirrel Glider
5	Additional site 9	Swamp Sclerophyll Forest along Mororo Creek	Partially cleared with vegetated creek line at southern end (Moderate in riparian areas, low in cleared areas)	Mororo Creek, habitat assessment conducted - not suitable for Oxleyan Pygmy Perch	Aquatic habitat, deep pools suited to common fish and frogs, reptiles. Riparian corridor may be used by range of fauna. Lack of large or hollow bearing trees.	None, potential **koala**, Squirrel Glider
6	Site 3a & 3b	Subtropical Floodplain Forest (intact and regenerating)	Low	Ephemeral depression	Multiple hollow bearing trees and dead stags Threatened fauna habitat: potential koala, Masked Owl, Powerful Owl, Spotted Quoll, Brush-tailed Phascogale, gliders and microbats	Absent
7	Site 3	Absent	Low	Wetland (adjoining site in the north east)	Threatened and migratory bird habitat (north east) koala primary food trees	Absent, potential Wallum Froglet, **koala**
7	Site 4	Swamp Sclerophyll Forest (regenerating and intact on edges)	Low	Ephemeral swamp in adjoin land	Limited to seasonal nectar resources on the site	Absent

Section	Site name	Threatened Ecological Communities (TSC Act and EPBC Act)	Vegetation condition	Aquatic habitats	Fauna habitat resources	Threatened species confirmed (EPBC Act listed species in bold)
8	Site 2a,2b & 2c	Adjoins Swamp Sclerophyll Forest	Low	Site 2a: Drainage channel. Site 2b: drainage line	Absent	Absent
8	Site 3	Absent	Native vegetation absent	Absent	Large log habitats	Absent
9	Site 1	Subtropical Coastal Floodplain Forest (Intact at north east)	Low to moderate	Man-made ponds and drainage channels	Ground logs and artificial material. Small dead stags. koala primary food trees in northeast corner	Absent, potential **koala**
9	Site 2	Subtropical Coastal Floodplain Forest (regenerating)	Low	Wet ephemeral depressions	Wet ephemeral depressions suited to some from and bird species	Absent, potential Wallum Froglet
9	Site 3	Absent	Low	Farm dam (offsite)	Limited to seasonal nectar resources	Absent
10	Site 1b	Absent	Native vegetation absent	Brackish drainage channel	Fallen log	Absent
10	Site 3a, & 3b	Absent	Low	Small farm dam	Scattered low number of koala habitat trees	Absent, some potential for **koala** to occur
10	Site 4	Absent	Native vegetation absent	Narrow creek lines	Limited to disturbed creek, potential for common frogs	**Hairy Joint Grass** (*Arthraxon hispidus*) confirmed
10	Site 5	Absent	Low	Absent	Rocky habitats, scattered low number of trees, seasonal nectar resources	Absent
10	Site 6	Two patches of Lowland Rainforest present and continues off-site to the west.	Some scattered trees (Low)	Absent	Limited to scattered low number of trees, potential food resources	**Hairy Joint Grass** (Arthraxon hispidus) confirmed

Recommendations and mitigation measures

The results of the field investigations have identified a number of recommendations:

- There are a number of sites that contain remnant vegetation over the entire site and are suitable for threatened species, or are constrained by the presence of both TECs and threatened species and are therefore are unsuitable for use as an ancillary facility. These are:
    - Section 1, site 1b and Additional site 5.
    - Section 2, site 2.
    - Section 5, Additional site 7 and Additional site 8.
    - Section 10, site 6.

The mitigation measures identified in the EIS (and included in Chapter 5) are applicable to the ancillary facilities, particularly management measures B48 to B51. However, additional management measures have been identified to mitigate the potential impacts to these sites associated with the ancillary facilities.

The additional mitigation measures are included in Table 3-41.

Table 3-41: Additional biodiversity management measures

Issue	ID number	Mitigation measure	Timing	Relevant section
Stockpile and ancillary facility management	B52a	Ancillary facility - Section 2 site 1a: • Flag and avoid hollow bearing trees • Revegetation of the section of the site in the road reserve or the entire site (if practicable).	Construction	2
	B52b	Ancillary facility - Section 2 site 5a: • Avoid isolated trees and flag and avoid hollow bearing trees where possible. Site to remain cleared to benefit emus.	Construction	2
	B52c	Ancillary facility - Section 2 site 6a and 6b: • Site to remain clear (not vegetated) to benefit emus.	Construction	2
	B52d	Ancillary facility - Section 3 Site 1: • This compound site that was used for the Glenugie Upgrade and has been revegetated post-construction. A site inspection and survey is required prior to construction to determine its suitability for future use as an ancillary site. • Avoid mature trees. • Revegetation of the section of the site in the road reserve or the entire site (if practicable).	Construction	3
	B52e	Ancillary facility - Section 3 Site 2: • Provide a buffer of 50 metres minimum from creek and sediment fencing where required. • Avoid mature trees. • Revegetation of the section of the site in the road reserve or the entire site (if practicable).	Construction	3

Issue	ID number	Mitigation measure	Timing	Relevant section
	B52f	Ancillary facility - Section 3 Site 4: • Ancillary site to be restricted to the western parts of the site adjoining Wooli Road. • Vegetation in the road reserve along Wooli Road to be protected from disturbance. • The population of the Slender Screw Fern plants is to be avoided. • Existing trails or disturbed areas to be used for access to site. Bostock Road not to be used for access.	Construction	3
	B52g	Ancillary facility - Section 3 Site 8: • Identify and mark *Angophora robur* during pre-clearing and provide exclusion fencing.	Construction	3
	B52i	Ancillary facility - Section 3 Site 9: • Provide buffer to the surrounding forest. • Identify and mark *Angophora robur* during pre-clearing and provide exclusion fencing • Provide sediment fencing on eastern boundary where required. • Avoid and buffer koala feed trees in the northwest corner of the site. Buffer required from edge of the forest to reduce edge effects, sediment fencing where required.	Construction	3
	B52j	Ancillary facility - Section 5 Site 6: • Consult with OEH on future use of this site post-construction, which may have offset potential with assisted regeneration and could be considered as a potential addition to Mororo Creek Nature Reserve • Flag and buffer habitat patch on southern boundary.	Construction	5
	B52k	Ancillary facility - Section 5 Additional site 9: Provide buffer around Mororo Creek and sediment fencing to protect riparian areas • Flag and buffer habitat patch on southern boundary	Construction	5
	B52l	Ancillary facility - Section 6 Site 3a and 3b: • Mark and avoid small dam in north-west corner of site and buffer activities from a large remnant patch adjoining to the north. • Avoid scattered mature trees where possible.	Construction	6
	B52m	Ancillary facility - Section 6 site 5: • Site is currently being used as a compound site for the Devils Pulpit upgrade. On completion of construction for that project, the site would be stabilised with a quick growing cover crop to stabilise the site. • A site inspection and survey is required prior to construction to confirm the suitability of the site.	Pre-construction, construction	6

Issue	ID number	Mitigation measure	Timing	Relevant section
		• Site to be rehabilitated post- construction.		
	B52n	Ancillary facility - Section 7 Site 1: • To be used for only low risk activities, no chemical or fuel storage on site.	Construction	7
	B52o	Ancillary facility - Section 7 Site 2a and 2b: • To be used for only low risk activities, no chemical or fuel storage on site.	Construction	7
	B52p	Ancillary facility - Section 7 site 3: • Provide sediment fencing along eastern boundary.	Construction	7
	B52q	Ancillary facility - Section 7 Site 4: • Provide buffer of minimum 50 metres from the wetland on northern boundary and sediment fencing where required. Avoid tree removal where possible	Construction	7
	B52r	Ancillary facility - Section 8 Site 2a, 2b and 2c: • Recommend use for stockpile only, no chemical or fuel storage on site.	Construction	8
	B52s	Ancillary facility - Section 8 Site 3: • Provide bunding around the site. No chemical storage.	Construction	8
	B52t	Ancillary facility - Section 9 Site 1: • Provide buffer and sediment fencing at southern end. • Provide sediment fencing at southern end of site, stockpiling only at northern half, no chemical storage	Construction	9
	B52u	Ancillary facility - Section 9 site 2: • Provide sediment fencing at southern end of site, stockpiling only at northern half, no chemical storage	Construction	9
	B52v	Ancillary facility - Section 9 site 3: • Provide sediment fencing at southern end of site, stockpiling only at northern half, no chemical storage	Construction	9
	B52w	Ancillary facility - Section 10 site 1b: • Revegetation of the section of the site in the road reserve or the entire site (if practicable).	Construction	10
	B52x	Ancillary facility - Section 10 site 3b: • Map and avoid strip of trees along northern boundary	Construction	10
	B52y	Ancillary facility - Section 10 site 4: • Revegetate site post-construction, focus on approaches to land bridge and avoid *Arthraxon hispidus*.	Construction	10
	B52a	Ancillary facility - Section 2 site 1a:	Construction	2

Issue	ID number	Mitigation measure	Timing	Relevant section
		• Flag and avoid hollow bearing trees • Revegetation of the section of the site in the road reserve or the entire site (if practicable).		
	B52b	Ancillary facility - Section 2 site 5a: • Avoid isolated trees and flag and avoid hollow bearing trees where possible. Site to remain cleared to benefit emus.	Construction	2
	B52c	Ancillary facility - Section 2 site 6a and 6b: • Site to remain clear (not vegetated) to benefit emus.	Construction	2
	B52d	Ancillary facility - Section 3 Site 1: • This compound site that was used for the Glenugie Upgrade and has been revegetated post-construction. A site inspection and survey is required prior to construction to determine its suitability for future use as an ancillary site. • Avoid mature trees. • Revegetation of the section of the site in the road reserve or the entire site (if practicable).	Construction	3

3.12.7 Summary of ancillary facility sites

Table 3-42 below summarises the environmental constraints identified for all ancillary facility sites. This includes the field investigation surveys undertaken for Aboriginal and historical (non-Aboriginal) heritage and biodiversity as detailed in the sections above. In addition, assessments undertaken for the EIS on hydrology (refer to Table 8-10 of the EIS) and noise (refer to Working paper- Noise and vibration), have been repeated here to provide a complete assessment. Where a property owner has not agreed to the use of the land as an ancillary facility, this has been noted in the summary table.

The final column of Table 3-42 specifies 'use location' for whether the site is proposed to be used for the project or not and is defined as follows:

- Avoid use of site entirely with reason provided.
- Apply general mitigation measures as provided in Chapter 5.
- Apply specific mitigation measures as provided in Chapter 5:
    - For specific Aboriginal heritage measures refer to AH14 to AH14v.
    - For specific historical heritage measures refer to HH5 and HH6.
    - For specific hydrology measures refer to HF22.
    - For specific biodiversity measures refer to B52a to B62y.

Table 3-42: Summary assessment of ancillary facilities

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
Section 1 – Woolgoolga to Halfway Creek							
2.5 to 3.4	1a	Impacts to five artefact scatters.	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	An area of regenerating threatened ecological community	Two sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
3.3 to 3.4	1b	Impact to one artefact scatter (highly significant)	No known or anticipated heritage sites	Low hydrological risk	Altering the hydrology of the site could affect an area of regenerating threatened ecological community (Subtropical Coastal Floodplain Forest)	No sensitive receivers exceeding noise criteria	**Avoid (Aboriginal heritage and biodiversity impacts)**
5.2 to 5.4	2	No known or anticipated heritage sites	Historical heritage site located adjacent, no direct impacts.	No hydrological risk Outside the floodplain area.	Limited biodiversity values	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
7.4 to 7.6	3	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity values	One sensitive receiver without mitigation exceeds noise criteria	Apply general mitigation measures
9.5 to 9.5	4a	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity values	One sensitive receiver without mitigation	**Avoid (Aboriginal heritage**

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
						exceeds noise criteria	**impacts and no agreement)**
9.4 to 9.6	4b	No known or anticipated heritage sites	Low historical heritage value. Possible early Pacific Highway remnants.	No hydrological risk Outside the floodplain area.	Vegetation to be cleared as part of project	One sensitive receiver without mitigation exceeds noise criteria	Apply specific mitigation measures
4.6 to 5.0	Additional site 5	Unknown	Low historical heritage value	Moderate hydrological risk	Remnant high quality TEC near Cassons Creek	No sensitive receivers exceeding noise criteria	**Avoid (biodiversity impacts)**
Section 2- Halfway Creek to Glenugie upgrade							
16.7 to 17.0	1a	No known or anticipated heritage sites	Low historical heritage value. Presence of an old shed on the site.	No hydrological risk Outside the floodplain area.	Small farm dam	Three sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
17.1 to 17.4	1b	Impact to one modified tree	Historical heritage site located adjacent, no direct impacts.	No hydrological risk Outside the floodplain area.	Small number of hollow bearing trees	Three sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
17.5 to 18.1	1c	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity values	One sensitive receiver without mitigation exceeds noise criteria	Apply general mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
19.3 to 19.6	2	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Numerous hollow bearing trees, floristic diversity and threatened fauna species	Two sensitive receivers without mitigation exceeds noise criteria	**Avoid (biodiversity impacts)**
20.3 to 20.5	3	Unknown	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity values	No sensitive receivers exceeding noise criteria	**Avoid (no agreement)**
21.7 to 22.2	4	Impact to one artefact scatter	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Hollow bearing trees in part of site (in project boundary)	One sensitive receiver without mitigation exceeds noise criteria	Apply specific mitigation measures
23.5 to 23.8	5a	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Nectar resources, threatened flora and fauna species	Four sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
23.6 to 24.0	5b	Impact to one artefact scatter	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity values	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
25.7 to 25.9	6	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity values	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
Section 3- Glenugie upgrade to Tyndale							
34.2 to	1	No known or	No known or	No hydrological risk	Re-vegetated	No sensitive	Apply specific

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
34.4		anticipated heritage sites	anticipated heritage sites	Outside the floodplain area.	former ancillary facility	receivers exceeding noise criteria	mitigation measures
39.5 to 40.2	2	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk Blockage to small catchment waterway. Would cause flooding without sufficient drainage through site.	Scattered remnant trees and threatened fauna species	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
41.1 to 41.4	3a	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Seasonal nectar resources	One sensitive receiver without mitigation exceeds noise criteria	Apply general mitigation measures
41.1 to 41.4	3b	Impact to one artefact scatter	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Seasonal nectar resources	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
45.5 to 45.9	4	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk Mostly outside the floodplain area.	Threatened fauna habitat and threatened flora	Three sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
49.4 to 49.6	5	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk. Immediately adjacent to small unnamed creek near Mitchell Road, and partially blocking a main flow path. Likely to experience flooding, particularly during	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
				large events.			
51.4 to 51.5	6a	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited nectar resources, threatened flora	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
52.0	6b	Impact to one modified tree	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Some fauna resources, threatened flora	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
55.5 to 55.9	7a	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Vegetation to be cleared as part of project	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
56.1 to 56.3	7b	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Threatened flora	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
61.1 to 61.4	8	Impact to one artefact scatter (highly significant)	No historical heritage items detected during the survey.	No hydrological risk Outside the floodplain area.	Low number of hollow bearing trees. Threatened flora habitat	One sensitive receiver without mitigation exceeds noise criteria	**Avoid (Aboriginal heritage impacts)**
62.0 to 62.3	9	Impact to one artefact scatter	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Threatened fauna habitat and threatened flora	One sensitive receiver without mitigation exceeds noise criteria	Apply specific mitigation measures
67.2 to 67.4	10	No known or anticipated	No known or anticipated heritage	No hydrological risk Outside the floodplain	Seasonal nectar resources	Ten sensitive receivers without	Apply general mitigation

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
		heritage sites	sites	area.		mitigation exceeds noise criteria	measures
Section 4- Tyndale to Maclean							
69.3 to 69.6	1	Unknown	No known or anticipated heritage sites	Low hydrological risk Partially located in low velocity backwater floodplain. Some removal of flood storage with minimal impacts.	Limited biodiversity value	One sensitive receiver without mitigation exceeds noise criteria	Apply specific mitigation measures
73.4 to 74.0	2	No known or anticipated heritage sites	No known or anticipated heritage sites	Medium hydrological risk Located on Shark Creek floodplain. Limited impact to regional flooding but considerable impact to drainage by blocking cane drains. Would incur some loss of flood storage.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
75.5 to 75.7	3	Unknown	No known or anticipated heritage sites	Low hydrological risk Partially located in low velocity backwater floodplain. Some removal of flood storage with minimal impacts.	Limited biodiversity value	One sensitive receiver without mitigation exceeds noise criteria	Apply specific mitigation measures
76.8 to 77.1	4a	Site located adjacent to Aboriginal heritage	No known or anticipated heritage sites	Low hydrological risk Mostly outside the floodplain area. Negligible impact.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
		artefacts, no impact from ancillary facility					
77.0 to 77.1	4b	Impact to one artefact scatter (highly significant)	No known or anticipated heritage sites	Low hydrological risk Located in area of low velocity backwater floodplain. Minor loss of flood storage and minor impact.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	**Avoid (Aboriginal heritage impacts)**
77.0 to 77.2	4c	Impact to one artefact scatter (highly significant)	No historical heritage items detected during the survey.	Low hydrological risk Mostly outside the floodplain area. Negligible impact.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	**Avoid (Aboriginal heritage impacts)**
78.1 to 78.3	5	Impact to one artefact scatter	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity value	Three sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
79.4 to 79.9	6	No known or anticipated heritage sites	No historical heritage items detected during the survey.	High hydrological risk Immediately adjacent to Clarence River South Arm channel. In an area of potentially high flood conveyance and likely to incur flood impacts during 20-year ARI flood event.	Limited biodiversity value	Four sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
80.5 to 81.1	7a	No known or anticipated heritage sites	No known or anticipated heritage sites	Moderate hydrological risk In low velocity backwater floodplain, close to low	Limited biodiversity value	33 sensitive receivers without mitigation exceeds noise	Apply specific mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
				point in Shark Creek catchment, experiences higher flooding conveyance and drainage than surrounding areas. Could incur some impacts to drainage and duration of inundation during large floods.		criteria	
80.4 to 80.7	7b	No known or anticipated heritage sites	No known or anticipated heritage sites	Moderate hydrological risk In low velocity backwater floodplain, close to low point in Shark Creek catchment, experiences higher flooding conveyance and drainage than surrounding areas. Could incur some impacts to drainage and duration of inundation during large floods.	Limited biodiversity value	33 sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
Section 5- Maclean to Iluka Road, Mororo							
83.3 to 83.5	1	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk Located in area of low velocity backwater floodplain. Expect minor loss of flood storage and minor impact.	Low condition TEC	One sensitive receiver without mitigation exceeds noise criteria	Apply general mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
85.8 to 86.0	2a	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk Adjacent to the southern bank of the Clarence River in an area of high conveyance and moderate flow velocities during 20-year ARI floods and larger. May incur some flood impacts during large events.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
85.8 to 86.1	2b	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk Totally obstructs the southern end of the Clarence River bridge adjacent to the main channel. It is in an area of high conveyance and moderate flow velocities during 20-year ARI floods and larger. Likely to incur considerable flood impacts if a large flood event was to occur during construction.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
85.8 to 85.9	2c	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk Adjacent to the southern bank of the main Clarence River channel in an area of high conveyance and moderate flow velocities. Site has minimal impact.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply general mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
85.9 to 86.2	2d	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk Adjacent to the southern bank of the Clarence River channel in an area of high conveyance and moderate flow velocities during 20-year ARI floods and larger. Site would be blocking southern end of the future bridge. Likely to incur considerable flood impacts during large events.	Limited biodiversity value	Four sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
86.9 to 87.2	3a	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk Adjacent to the northern bank of the Clarence River channel in an area of high conveyance and moderate flow velocities during 20-year ARI floods and larger. Partially buffered by the existing highway, but would be obstructing the northern end of the bridge. Likely to incur substantial flood impacts during large events.	Limited biodiversity value	44 sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
87.2 to 87.7	3b	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk Total obstruction of culverts at St 87.3, immediately north of the	Limited biodiversity value	44 sensitive receivers without mitigation exceeds noise	Apply specific mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
				Clarence River Bridge. Would experience unacceptable and substantial upstream impacts during large events.		criteria	
90.8 to 90.9	4a	No known or anticipated heritage sites	No known or anticipated heritage sites	Moderate hydrological risk Completely obstructs culverts on Chatsworth Island. Likely to incur moderate flood impacts during large flood events compared to project operational impacts.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
90.5 to 90.8 (multiple sites)	4b	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk Most areas is located in Chatsworth Island low velocity floodplain. Some removal of flood storage with minimal impacts. Impacts consistent with project operational impacts. One area completely obstructs culverts on Chatsworth Island. Likely to incur moderate flood impacts during large events in comparison to project operational impacts. Moderate	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
				hydrological risk.			
93.3 to 93.4	5a	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk Located in Chatsworth Island low velocity floodplain. Impacts consistent with project operational impacts.	Limited biodiversity value	Three sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
93.6 to 93.7	5b	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk Located in Chatsworth Island low velocity floodplain. Some removal of flood storage with minimal impacts. Impacts consistent with project operational impacts.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
93.55 to 93.8	5c	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
95.5 to 96.0	6	Impact to one artefact scatter	No known or anticipated heritage sites	Moderate hydrological risk Located on breakout channel during large floods in Mororo Creek catchment. Would incur substantial impacts to caneland to the north.	Large remnant trees and native shrubs Low number of threatened fauna habitat	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
95.0 to 95.4	Additional site 7	Site located adjacent to Aboriginal	No known or anticipated heritage sites	Moderate hydrological risk	Heavily vegetated, with potential threatened fauna	46 sensitive receivers without mitigation	**Avoid (biodiversity impacts)**

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
		heritage artefacts, no impact from ancillary facility			habitat	exceeds noise criteria	
95.5 to 95.8	Additional site 8	Site located adjacent to Aboriginal heritage artefacts, no impact from ancillary facility	No known or anticipated heritage sites	Moderate hydrological risk	Heavily vegetated, with potential threatened fauna habitat	42 sensitive receivers without mitigation exceeds noise criteria	**Avoid (biodiversity impacts)**
94.9 to 95.5	Additional site 9	Impacts to two artefact scatters	No known or anticipated heritage sites	Moderate hydrological risk	Limited biodiversity value	Four sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
Section 6- Iluka Road to Devils Pulpit upgrade							
98.1 to 98.3	1	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Vegetation to be cleared for project	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
100.1 to 100.5	2	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Vegetation to be cleared for project	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
103.0 to 103.7	3a	No known or anticipated heritage sites	Low heritage value. A historical heritage site was found on the property (Item 41).	High hydrological risk Outer regions of site located in Tabbimoble Creek floodplain with complete obstruction of	Threatened fauna habitat	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
				culverts. Would incur substantial flood impact without mitigation.			
102.9 to 103.7	3b	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk Site partially located in Tabbimoble Creek floodplain with total obstruction of existing bridge. Would incur substantial flood impacts upstream.	Threatened fauna habitat and TEC	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
105.6 to 106.0	4	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Vegetation cleared as part of project	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
108.5 to 108.8	5	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Vegetation cleared as part of adjoining project	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
Section 7- Devils Pulpit upgrade to Trustums Hill							
109.9 to 110.2	1	Unknown	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
114.0 to 114.3	2a	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Vegetation cleared as part of project	No sensitive receivers exceeding noise criteria	Apply general mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
114.2 to 114.4	2b	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Vegetation cleared as part of project	No sensitive receivers exceeding noise criteria	Apply general mitigation measures
121.2 to 121.7	3	Impact to one artefact scatter	No known or anticipated heritage sites	Low hydrological risk Partial inundation in Oakey Creek floodplain. Some increase in upstream flood impacts. Considered low risk given extent of inundation and probability of flooding during construction.	Threatened fauna and migratory bird habitat	Six sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
125.1 to 125.5	4	Impact to one artefact scatter	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited nectar resources	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
Section 8- Trustums Hill to Broadwater National Park							
129.7 to 130.1	1	No known or anticipated heritage sites	No known or anticipated heritage sites	Moderate hydrological risk. Located in Lower Richmond river floodplain. Would incur some loss of flood storage and minor obstruction to Tuckombil Canal floodplain flow.	Limited biodiversity value	Six sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
131.2 to	2a	No known or	No known or	High hydrological risk.	Drainage channel	Three sensitive	Apply specific

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
132.5		anticipated heritage sites	anticipated heritage sites	Site located in Lower Richmond floodplain. Location would incur blockage of culverts. Would incur substantial upstream flood impacts.	next to TEC	receivers without mitigation exceeds noise criteria	mitigation measures
131.8 to 132.1	2b	No known or anticipated heritage sites	Low historical heritage value. The concrete footings of a former dairy were found on the property (Item 42).	High hydrological risk. Site located in Lower Richmond floodplain. Location would incur blockage of culverts. Would incur substantial upstream flood impacts.	Drainage channel next to TEC	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
132.1 to 132.2	2c	No known or anticipated heritage sites	No known or anticipated heritage sites	Moderate hydrological risk. Site located in Lower Richmond floodplain. Location would incur partial blockage of culverts.	Adjacent to TEC	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
134.8 to 135.1	3	Site located adjacent to Aboriginal heritage artefacts, no impact from ancillary facility	No known or anticipated heritage sites	Low hydrological risk. Site located in Lower Richmond backwater floodplain. Some removal of flood storage with minimal impacts.	Limited biodiversity value	No sensitive receivers exceeding noise criteria	Apply specific mitigation measures
Section 9- Broadwater National Park to Richmond River							
136.7 to	1	No known or	No historical heritage	Moderate hydrological	TEC, threatened	No sensitive	Apply specific

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
137.1		anticipated heritage sites	items detected during the survey.	risk. Site located in Lower Richmond floodplain. Site would incur some removal of flood storage and minor flood impacts.	fauna feed trees	receivers exceeding noise criteria	mitigation measures
137.3 to 137.8	2	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk. Site located in Lower Richmond floodplain. Some removal of flood storage with minimal impacts.	Regenerating TEC, threatened fauna	One sensitive receiver without mitigation exceeds noise criteria	Apply specific mitigation measures
142.2 to 142.7	3	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk. Site partially located in Lower Richmond backwater floodplain. Some removal of flood storage with minimal impacts.	Limited seasonal nectar resources	Ten sensitive receivers without mitigation exceeds noise criteria	Apply general mitigation measures
Section 10- Richmond River to Coolgardie Road							
145.3 to 145.6	1a	Unknown	No known or anticipated heritage sites	High hydrological risk. This site is currently located on the floodplain adjacent to the Richmond River. The site is blocking the southern underpass of the Richmond River Bridge, causing a major obstruction to flows during 20 and 50-year ARI floods.	Low biodiversity value	11 sensitive receivers without mitigation exceeds noise criteria	**Avoid (no agreement)**

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
146.2 to 146.4	1b	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk. Site located in Lower Richmond backwater floodplain. Minimal impact expected.	Low biodiversity value	One sensitive receiver without mitigation exceeds noise criteria	Apply general mitigation measures
147.8 to 148.1	2	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Limited biodiversity value	One sensitive receiver without mitigation exceeds noise criteria	Apply general mitigation measures
152.1 to 152.5	3a	Site located adjacent to Aboriginal heritage artefacts, no impact from ancillary facility	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Low number of threatened fauna habitat	One sensitive receiver without mitigation exceeds noise criteria	Apply specific mitigation measures
152.5 to 152.7	3b	No known or anticipated heritage sites	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Low number of threatened fauna habitat	Eight sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
156.0 to 156.5	4	Site located adjacent to Aboriginal heritage artefacts, no impact from ancillary facility	Local historical heritage significance. An extension of the drainage channels from Item 29 (Stonehenge) are located on the site	No hydrological risk Outside the floodplain area.	Disturbed creek, threatened flora, potential for threatened fauna	Two sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
			(Item 43).				
157.3 to 157.4	5	Impact to one artefact scatter	No known or anticipated heritage sites	No hydrological risk Outside the floodplain area.	Some fauna habitat	11 sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures
158.2 to 158.5	6	Impact to one artefact scatter	Low historical heritage value. Concrete and stone footings, potentially related to a dairy or other farming activity (Item 44) are located on the site.	No hydrological risk Outside the floodplain area.	Areas of TEC	12 sensitive receivers without mitigation exceeds noise criteria	**Avoid (biodiversity impacts)**
Section 11- Coolgardie Road to Ballina bypass							
159.3 to 159.8	1a	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk. In Ballina Bypass backwater floodplain. Location would cause minor loss of flood storage and minimal impacts.	Limited biodiversity value	One sensitive receiver without mitigation exceeds noise criteria	Apply specific mitigation measures
159.6 to 159.9	1b	No known or anticipated heritage sites	No known or anticipated heritage sites	Low hydrological risk. In Ballina Bypass backwater floodplain. Location would cause minor loss of flood storage and minimal impacts.	Limited biodiversity value	12 sensitive receivers without mitigation exceeds noise criteria	Apply general mitigation measures

Station	Site No.	Environmental assessment					Use location
		Aboriginal heritage	Historical (non-Aboriginal) heritage	Hydrology	Biodiversity	Noise	
163.6 to 164.4	2	No known or anticipated heritage sites	No known or anticipated heritage sites	High hydrological risk This site is currently located in front of major drainage culverts. The location is considered unable to accommodate a construction site without unacceptable impacts to flooding.	Limited biodiversity value	Five sensitive receivers without mitigation exceeds noise criteria	Apply specific mitigation measures