Appendix C

Median Widening Assessment – Preliminary Scoping Investigation

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Roads and Traffic Authority

Pacific Highway Upgrade - Oxley Highway to Kempsey

Median Widening Assessment - Preliminary Scoping Investigation

February 2011

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Executive summary

The Environmental Assessment for the upgrade of the Pacific Highway between the Oxley Highway and Kempsey identified the need for aerial fauna crossings (glider poles) at a number of locations for arboreal fauna which do not utilise underpasses. In addition to the need for glider poles, a commitment was made in the Environmental Assessment that consideration would be given to the potential for median widening at those locations where it is reasonable and feasible to do so.

This preliminary median widening assessment has considered the feasibility of widened medians at locations currently proposed for glider poles.

Based on this preliminary assessment, it is recommended that the following sites require further investigation (as detailed in this report) to determine their suitability for median widening:

- Cairncross 1 (between station 10000 to 11600).
- Ballengarra 1b (between station 23200 to 23940).
- Maria River 1b (between station 33760 to 34380).

The next stage of the assessment would be the completion of detailed investigations into the suitability of these three sites for median widening as an alternative to the glider poles identified in the Environmental Assessment. This next stage would be carried out in consultation with relevant agencies.

1. Introduction

1.1 Purpose

The Environmental Assessment for the upgrade of the Pacific Highway between the Oxley Highway and Kempsey identified the need for aerial fauna crossings (glider poles) for arboreal fauna which do not utilise underpasses at a five locations. These proposed crossings have been located to link areas of key habitat and native vegetation, particularly within sub-regional and regional corridors.

The purpose of this report is to document the findings of the preliminary investigations into the feasibility of providing median widening at locations currently proposed for glider poles within the Oxley Highway to Kempsey Pacific Highway upgrade (the Proposal).

A commitment was made in the environmental assessment that consideration would be given to the potential for median widening at these locations where it is reasonable and feasible to do so, in consultation with relevant government agencies.

Median widening is an alternative means of providing for safe crossing opportunities for gliding species, essentially by retaining mature vegetation between carriageways to allow gliding species to cross the upgraded highway in a staged manner.

1.2 Assessment background

1.2.1 The Proposal

The Proposal is part of the Pacific Highway Upgrade Program being implemented by the NSW Roads and Traffic Authority (RTA).

The Proposal is 37 kilometres in length, commencing approximately 700 metres north of the Oxley Highway interchange, tying in with the existing dual carriageways to the south, and continues northwards to tie in at Stumpy Creek with the dual carriageways of the approved Kempsey to Eungai Pacific Highway upgrade currently under construction. At the northern end of the Proposal, the eastern service road would extend approximately 320 metres further to the north of Stumpy Creek to tie in with the southern interchange of the Kempsey bypass section of the approved Kempsey to Eungai upgrade. The majority of the Proposal (20 kilometres) would be a duplication of the existing Pacific Highway. Three sections of the Proposal would deviate from the alignment of the existing highway. These are in the vicinity of the Hastings River (four kilometre deviation), a bypass of Telegraph Point (eight kilometre deviation) and through the Maria River State Forest (five kilometre deviation). The existing highway would be retained wherever possible for use as a service road or local road connection.

A detailed description of the Oxley Highway to Kempsey Pacific Highway upgrade is found in the Oxley Highway to Kempsey Environmental Assessment prepared by RTA in September 2010.

1.2.2 Ecological context

Comprehensive ecological investigations have been undertaken for the Proposal, commencing during the route options development phase, and continuing through the preferred route selection, concept design and environmental assessment phases. This has allowed the development of an alignment that sought to minimise ecological impacts while achieving the Pacific Highway Upgrade Program and Proposal objectives.

The study area contains a range of habitats including low-lying floodplains, riparian zones and drier sclerophyll forest on hilltops in more undulating terrain. Approximately one third of the study area consists of cleared land, with the bulk of the remainder occupied by native vegetation. Most of the native vegetation within the study area is contained in State forests and nature reserves, though some occurs on private land. During the field surveys, 18 threatened fauna species and four endangered ecological communities were recorded within the study area. Additional threatened flora and fauna species have potential to occur, based on the availability of suitable habitat.

The following threatened species summarised in Table 1 are of relevance to this median widening assessment.

Table 1 Threatened gliders

Name	TSC Act	EPBC Act	Recorded	Predicted
Yellow-bellied glider *Petaurus australis*	Vulnerable	--	Ballengarra State Forest	Rawdon Creek Nature Reserve Cairncross State Forest Ballengarra State Forest Cooperabung Creek Nature Reserve Maria River State Forest Kumbatine National Park
Squirrel glider *Petaurus norfolcensis*	Vulnerable	--	No	

Aerial fauna crossings

The Environmental Assessment for the Proposal identified the need to consider aerial fauna crossings at a number of locations for arboreal fauna which do not utilise underpasses, as shown on Figure 1, Figure 2 and Figure 3. These proposed crossings have been located to link areas of key habitat and native vegetation, particularly within sub-regional and regional corridors.

The location and type of the crossings has also taken into consideration the fauna species that would be likely to utilise the individual aerial crossing locations. The crossing types proposed were comprised of:

- Rope ladders: principally catering for arboreal wildlife, such as possums and gliders.
- Glider poles: designed specifically for glider species.

The actual number, location and design of the aerial crossing points to be provided would be determined during the detailed design phase in consultation with the NSW Department of Environment, Climate Change and Water (DECCW), and finalised following completion of vegetation clearing during construction.

The spacing and height of glider poles is critical to the success of this aerial crossing type for glider species, with the maximum glide distance being directly proportional to the available launch height. The following generic design guidelines would be used to design glider poles to be installed as part of the Proposal:

- Poles should be positioned to ensure a continual and consistent line of poles linking vegetation on one side of the road to the other.
- Poles should be as tall as possible (at least 10 metres in height) to maximise the glide distance available to gliders.
- In circumstances where the road surface is lower (ie in cutting) than the landscape on either side, the central poles (within the median strip) would need to be taller to ensure gliders could glide to the nearest roadside pole.
- If reflective shields are placed around the base of glider poles, a gap should be retained to allow gliders the ability to climb back from the ground.
- Glider poles should be as natural as possible (avoid using treated pine) and could be constructed using local mature trees that are cleared for the Proposal.
- The location of aerial crossings in relation to overhead powerlines needs to be carefully assessed as they could pose a serious hazard to the effectiveness of the crossing.
- Because of the known risk to fauna, and gliders in particular, of entanglement, no barbed wire should be used in any boundary fencing erected as part of the Proposal in areas where glider poles are proposed.

Assessment of aerial crossing alternatives

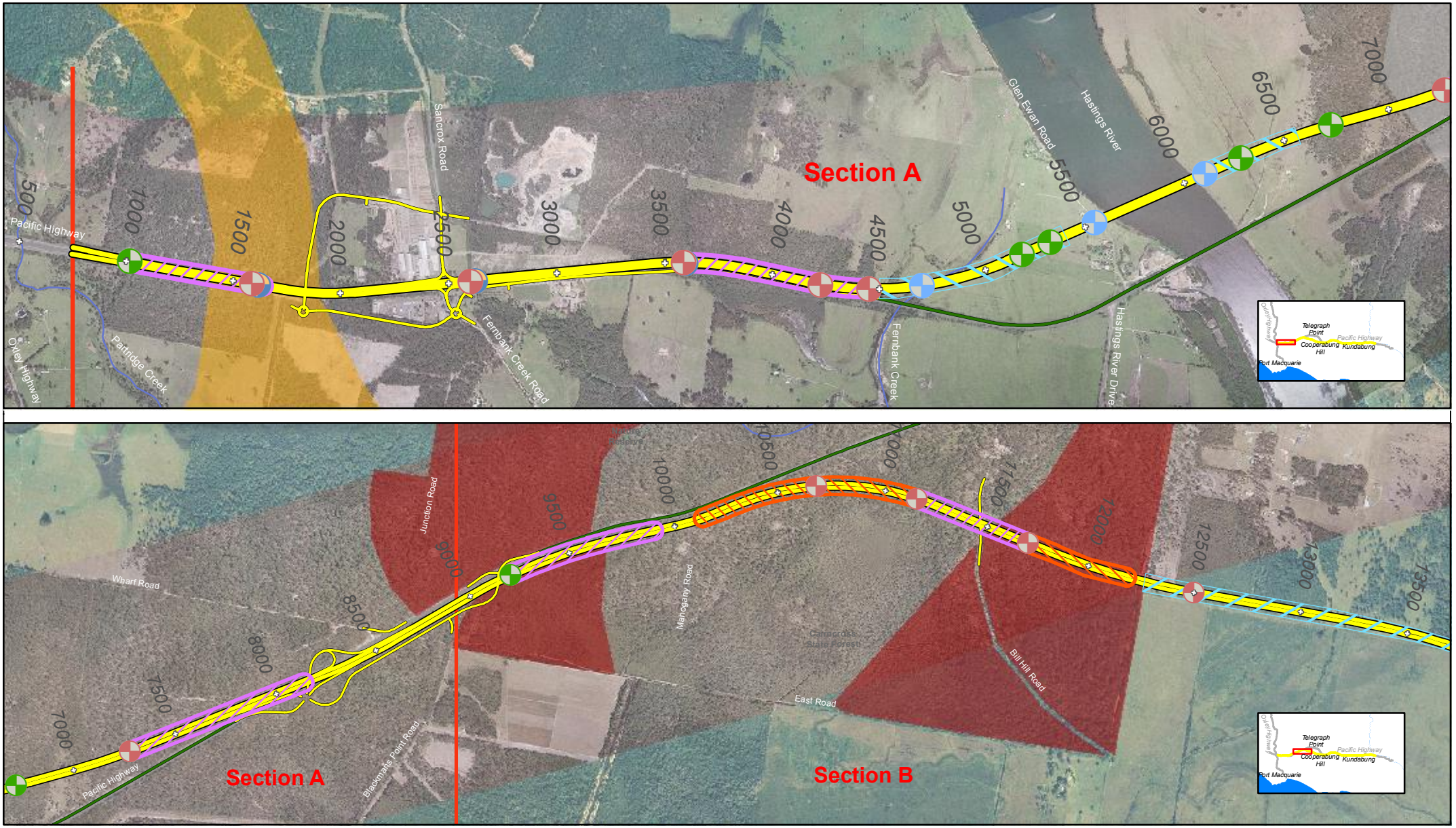
The RTA has received advice from DECCW during the planning of recent Pacific Highway upgrade projects that the provision of glider poles may not always offer safe crossing points for glider species. This is mainly due to the glide distances required to cross the two carriageways.

The success of the glider crossing points is dependant on the height of, and glide distance between, launching and landing sites such as trees or poles. The height of available launching sites, the overall width of dual carriageway roads, as well as any cross slope gradients, can makes it difficult to achieve suitable glide distances. Where suitable glide distances can not be achieved, it then becomes necessary to provide a staging point in the median area of these dual carriageway roads to provide safe passage for glider species.

An assessment of alternative options to the provision of glider poles in the median at aerial crossing locations is therefore warranted.

The assessment of potential median widening as an alternative for the proposed rope ladder crossing locations was however not considered to be necessary as the safe use of this crossing type by arboreal species is not necessarily dependant on the availability of a staging point in the median area. This median widening assessment is therefore only focused on those locations proposed for glider poles as shown on Figure 1, Figure 2 and Figure 3.

Should these potential locations be found not to be reasonable or feasible for median widening, glider poles would be installed as proposed in the environmental assessment.



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

The Proposal
- Upgraded highway
- Service road (existing facility)
- Section break
- Watercourse

- Indicative location of drainage structures
- Possible glider pole
- Possible rope crossing
- Key corridor - regional
- Key corridor - subregional

- Bridge
- Combined Crossing
- Dedicated Fauna Crossing
- Fauna - Drainage Negligible
- Incidental Crossing

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RTA

NSW Roads & Traffic Authority
OHK Median Widening Assessment

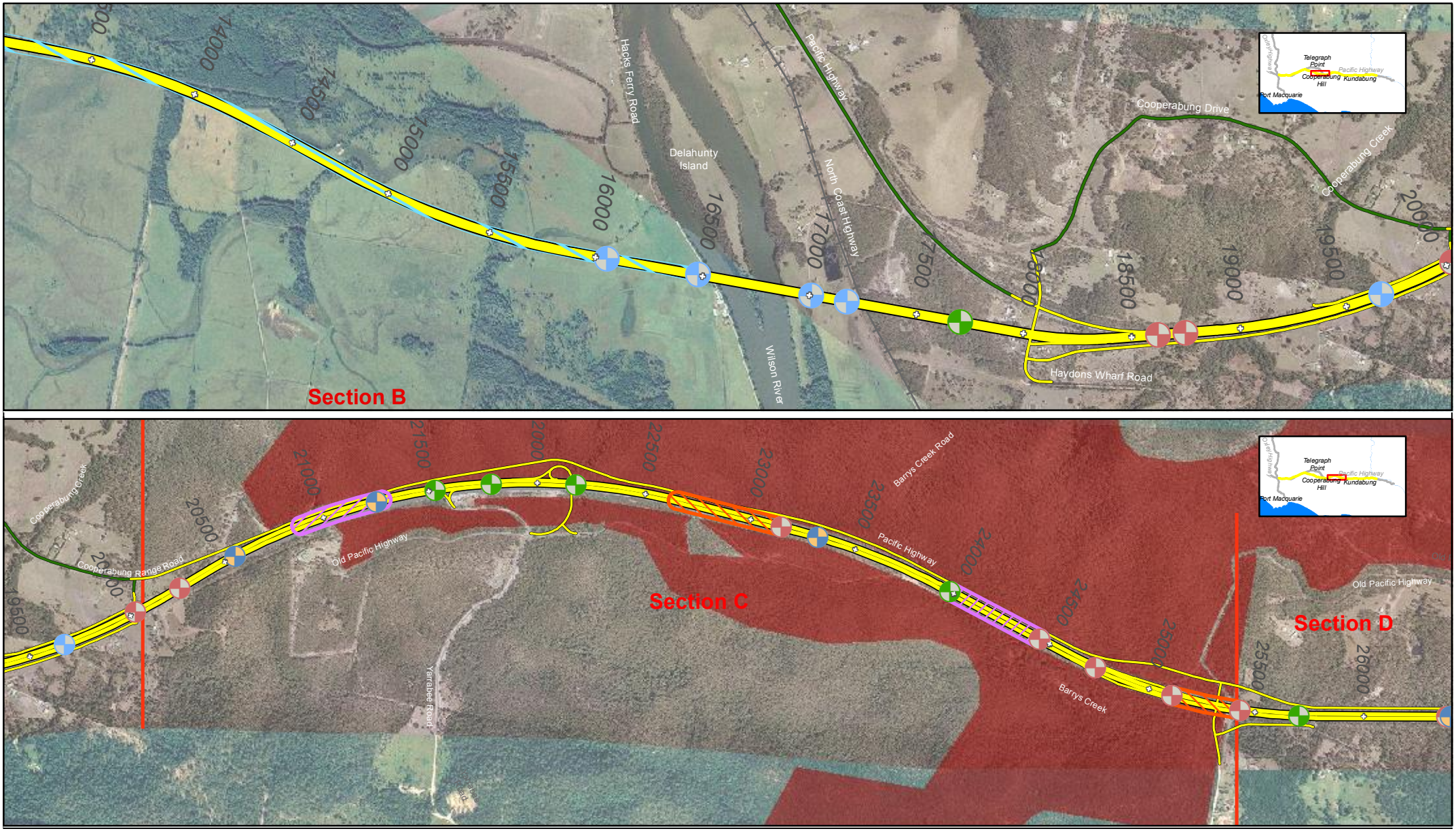
Job Number 22-1324522
Revision A
Date 30 AUG 2010

Fauna Crossings
Sheet 1

Figure 1

G:\22\1205704\CADD\ArcGIS\Maps\Median Widening Assessment\221324522_Fig_1_Fauna_Crossings_20100830.mxd
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com.au W www.ghd.com.au

Data Source: RTA: Aerial Photography - 2004. Created by: gmcdiarmid



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Horizontal Datum: Geocentric Datum of Australia (GDA)
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Revision A
Date 30 AUG 2010

Fauna Crossings
Sheet 2

Figure 2

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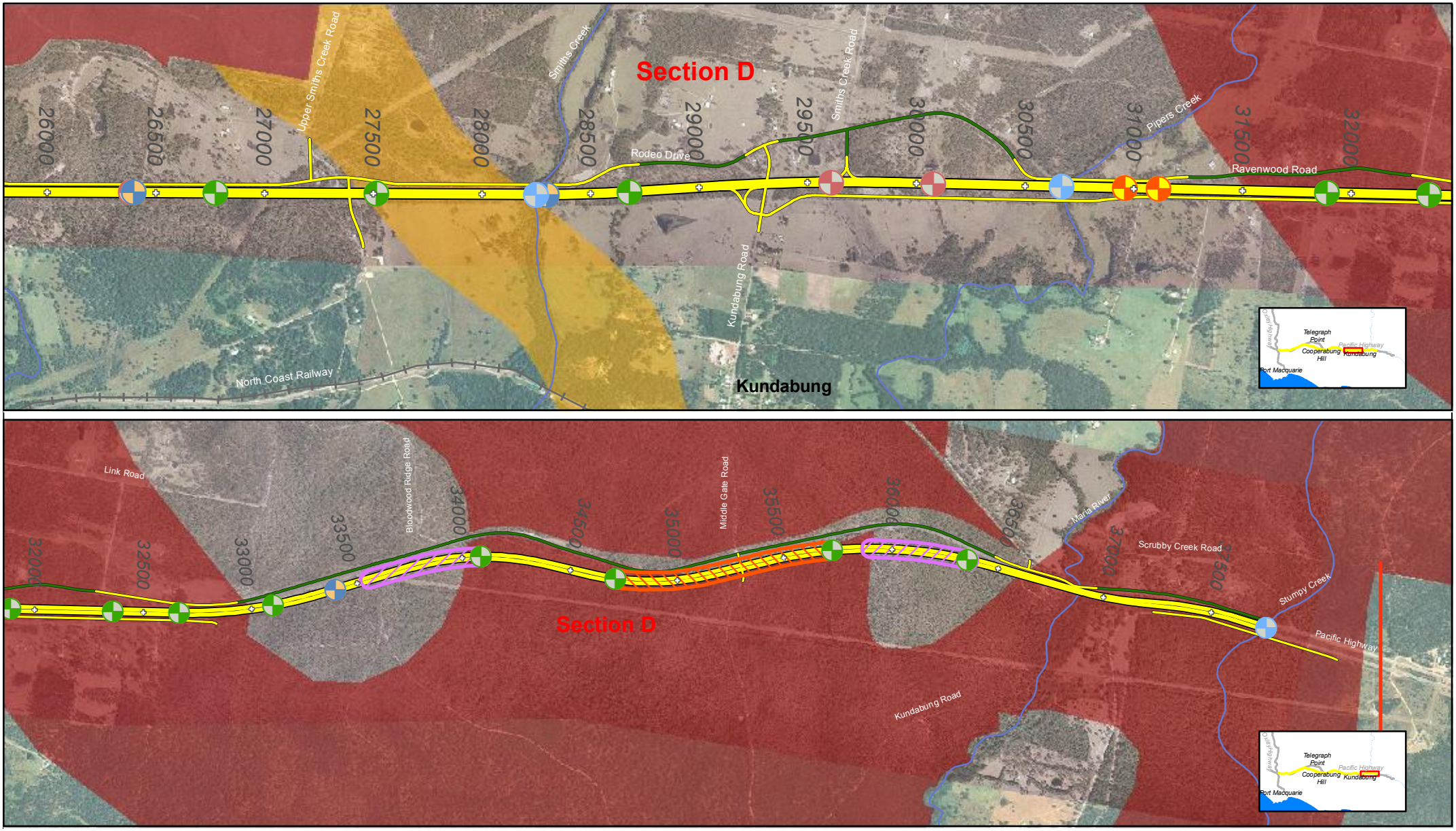
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

Data Source: RTA: Aerial Photography - 2004. Created by: gmcdiarmid



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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The Proposal
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NSW Roads & Traffic Authority
OHK Median Widening Assessment

Job Number 22-1324522
Revision A
Date 30 AUG 2010

Fauna Crossings Sheet 3

Figure 3

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Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

Data Source: RTA: Aerial Photography - 2004. Created by: gmcdiarmid

1.2.3 Median widening

Median widening is an alternative means of providing safe crossing opportunities for gliding species in locations where mature vegetation between carriageways would allow gliding species to cross the upgraded highway in a staged manner.

Typical sketches of the desired median widening design are shown in Figure 4 and Figure 5.

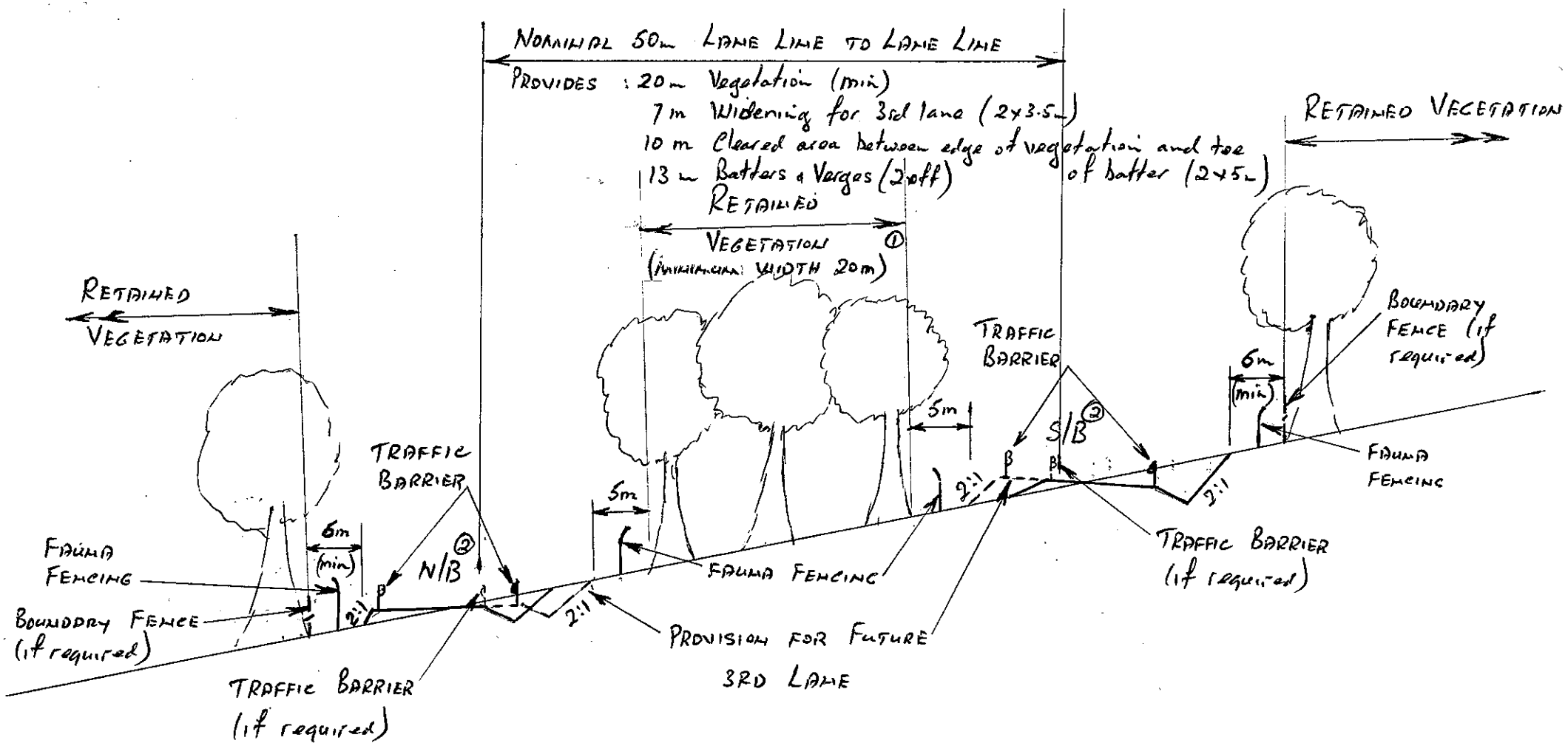
There are many factors that would influence the success or otherwise of median widening as a glider crossing option. These include:

- The height and density of adjacent vegetation, as well as the vegetation to be retained in the median area.
- Whether the carriageways are in cut or fill, the surrounding topography and the extent of cross slope.
- Whether or not there is an adjacent service road (in cut or fill), new or existing, or other adjacent potential barrier.
- Typical glide angles and distances (Table 2) for the target species.

Table 2 Typical glide angles and distances

Species	Average glide length	Spacing between structures
Squirrel glider *Petaurus norfolcensis*	80 m with a launch height of 45 m [A]. Maximum glide was 80 m with an average of 30-40 m [B]. Average glide length is 1 m with 1 m decrease in height.	Maximum distance of pole from other poles and trees is 60 m [C].
Yellow-bellied glider *Petaurus australis*	Maximum 30 m glide [D].	No more than 30 m.

Source: RTA (A: AMBS 2001, B: van der Ree 2006, C: Weston, D: Strahan 1995).



NOTES

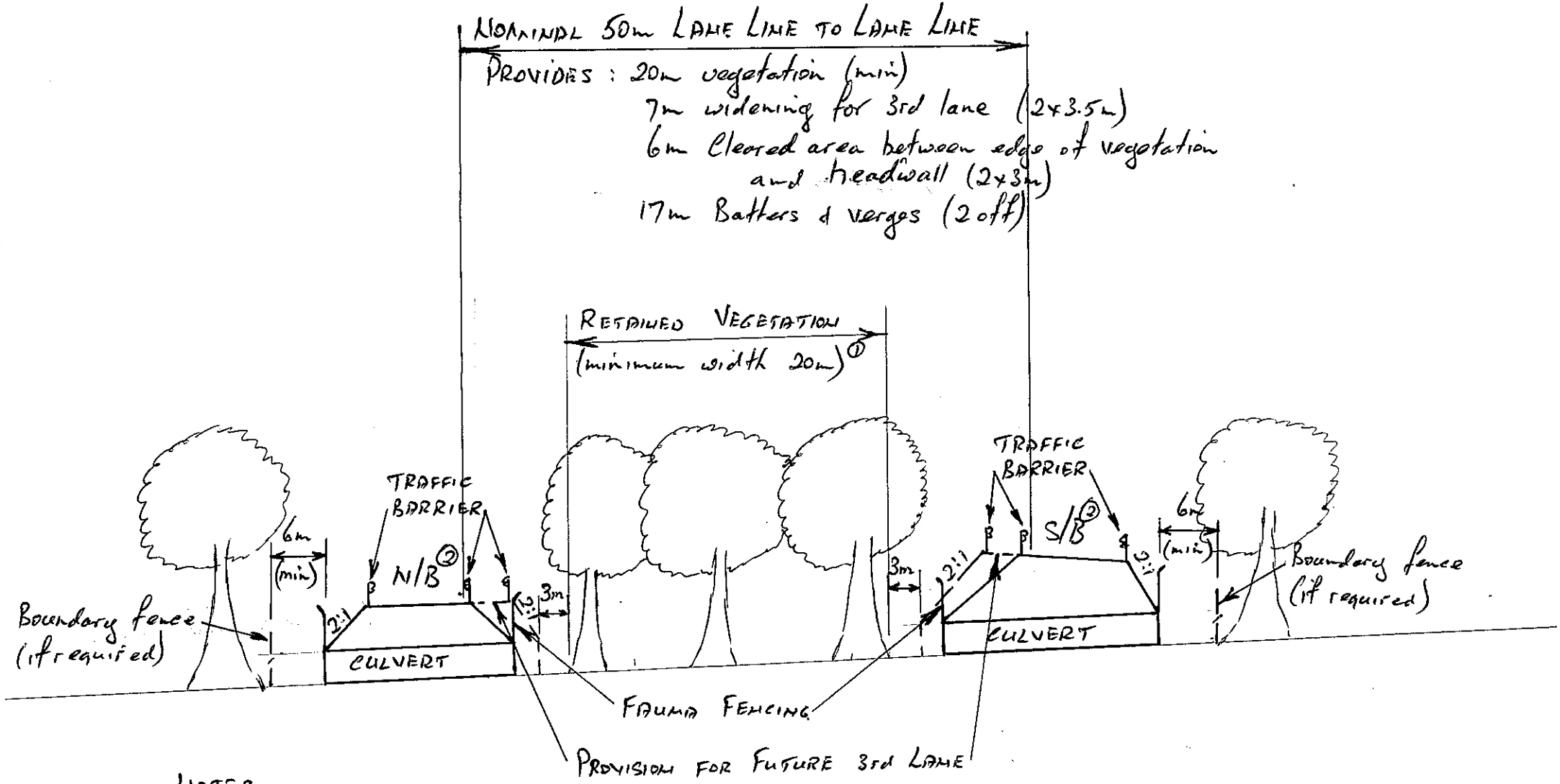
① Other than at start and finish of median widening.

② Independantly graded carriageways.

WIDE MEDIAN

TYPICAL CROSS SECTION

(NTS)



NOTES

① Other than at start and finish of median widening

② Independantly graded carriageways.

WIDE MEDIAN

TYPICAL CROSS SECTION AT CULVERTS

(DRAINAGE STRUCTURES AND/OR FAUNA CROSSINGS)

2. Methodology

The assessment of the potential for median widening is a staged process. Those stages are:

- Preliminary scoping investigation: Identifying potential glider crossing locations and review of existing project information to determine the feasibility of adopting median widening at these locations (as detailed in this report).
- Stage 1 – Detailed investigation: Undertaking further detailed investigation into the suitability of the locations identified in the preliminary scoping investigation as median widening locations. This stage would include consultation with the relevant agencies (during detailed design).
- Stage 2 – Finalisation and approval: Finalisation and approval of locations identified in Stage 1 for median widening by relevant agencies (during detailed design).

2.1 Preliminary scoping investigation

The preliminary scoping investigation involved the following tasks as outlined below.

2.1.1 Workshop 1

This workshop was attended by senior RTA and GHD project team members with experience in project management, engineering design, environmental planning and environmental science. The workshop considered those aerial crossing sites identified in the Environmental Assessment together with several additional adjacent locations and established a series of selection criteria that would be applied to determine the feasibility of median widening at those sites.

2.1.2 Desktop review

A desktop review was undertaken of the existing information collected for the Proposal to identify the key features, issues and opportunities for the identified selection criteria (Appendix B). This review identified the limitations of the existing data, identified any additional data required to allow the assessment to be undertaken, and determined the extent of the area to be covered by the assessment at each site.

2.1.3 Workshop 2

This workshop examined the outcomes of the desktop review and other relevant information and used the information to identify the level of constraint for each site with regard to the selection criteria adopted in workshop 1 (Section 2.1.1). A recommendation was made on the feasibility of adopting median widening at each of the identified sites.

The following list sets out the level of constraint assigned for each of the assessment criteria in the workshop:

- Negligible (a score of 0).
- Low (a score of 1).

- Medium (a score of 2).
- High (a score of 3).
- Significant (a score of 4).

The level of constraint was determined relative to the current concept design at each site as follows:

- A negligible constraint indicates no difference between the existing concept design and proposed widened median at that location (eg similar amount of vegetation clearing).
- Constraints from low to high were allocated depending on the assessed difference between the existing concept design and proposed widened median at that location.
- A significant constraint indicates that the impact of the widened median is significantly worse when compared with the existing concept design (eg significantly greater amount of clearing of endangered ecological communities) at that location or the revised design would require significant modification from the existing concept design (eg realignment of Barrys Creek).

2.2 Future stages

2.2.1 Stage 1 – Detailed investigation

Those sites that are recommended by this preliminary scoping investigation (refer to Section 4 of this report) would be subject to further detailed investigation. This would include:

- Preliminary engineering design.
- Identification of additional property acquisition and footprint clearing requirements.
- Field investigations as necessary.
- Consultation with affected landowners.
- Preparation of preliminary cost estimates.
- Analysis to quantify the benefits and impacts based on the preliminary designs.
- Input from the relevant agencies.

Following completion of the above tasks, the selected sites would be reviewed at a workshop involving the RTA and agencies such as DECCW and Industry and Investment NSW (I&I NSW) to assess the level of relative constraint and impact, as well as the benefits to be gained by median widening at the recommended locations. While this investigation would be undertaken at a greater level of detail than that completed during the preliminary scoping investigation, the selection criteria used previously would be used as the basis for further investigations and discussions with the agencies.

The outcome of this stage would be the acceptance by the RTA and relevant agencies of the locations where median widening is considered to be a reasonable and feasible alternative to aerial crossings for adoption as part of the detailed design of the Proposal.

2.2.2 Stage 2 – Finalisation and approval

This stage would involve finalisation and approval of median widening site/s recommended during Stage 1.

The RTA would conduct an environmental impact assessment of the changes to the approved project. A consistency assessment to determine if a modification of the Minister's conditions of approval would then be necessary pursuant to section 75W of the *Environmental Planning and Assessment Act, 1979*.

3. Feasibility assessment

As discussed in Section 1.2.2, the ecological investigations undertaken for the environmental assessment of the Proposal identified a number of locations where aerial crossing points would be required to facilitate movement of arboreal and glider species. These locations were selected during the development phase of the Proposal based on the recorded or likely presence of threatened and other aerial species, as well as habitat connectivity. Further information on the consideration and selection of these fauna crossing points is provided in the *Flora and Fauna Working Paper* (GHD 2010) in Volume 2 of the Environmental Assessment.

3.1 Workshop 1

The workshop was attended by senior RTA and GHD project team members with experience in project management, engineering design, environmental planning and environmental science. The selection criteria used to assess the feasibility of the possible median widening sites was based on the criteria used during the preferred route selection phase of the project. These criteria were grouped in three categories as environmental, social/community or engineering issues. The specific issues to be considered with regard to the individual selection criteria were also identified.

The criteria adopted for the assessment of feasibility of the median widening options are detailed in Appendix B.

As discussed in Section 1.2.2, the aerial crossing sites to be considered would be limited to the proposed glider crossing sites identified in the Environmental Assessment. There were two sites in Cairncross State Forest, two sites in Ballengarra State Forest, and one site in Maria River State Forest.

3.2 Desktop review

Based on the outcomes of this workshop, specialists within the GHD project team undertook a desktop review of the existing information collected for the development of the Proposal to identify the key features and issues for each potential median widening site. This desktop review also looked at the constraints and opportunities of each site with regard to the selection criteria.

A review of the concept design identified the fact that the carriageways would need to be realigned well beyond the area of the proposed glider crossing point. This additional realignment would be required to achieve the minimum road design standards for each carriageway while achieving the minimum desired length and width at the crossing site. As a result, the potential impacts at each crossing site would need to be assessed as set out in Table 3.

In a number of locations the existing data for the Proposal did not extend far enough to cover the additional area impacted by the median widening realignment. As the area of additional impact was generally fairly small, it was decided in this situation to extrapolate the existing data for the adjacent areas that are not currently impacted by the Proposal. Additional field survey

would then be undertaken as required during Stage 1 as set out in Section 2.2.1 to confirm the validity or otherwise of the extrapolation of the existing data for these additional areas of impact.

The details of this desktop review are shown in Appendix B.

3.3 Workshop 2

The workshop was attended by senior RTA and GHD project team members with experience in project management, engineering design, environmental planning and environmental science . This workshop considered the outcomes of the desktop review to help to identify the potential median widening sites that could be feasible for further investigation in Stage 1 of the assessment.

Following on from the desktop review, it was decided to revise the location and length of all of the potential median widening options due to the engineering (highway alignment) design requirements and the constraints identified. It was also considered appropriate to include some additional sites in the Ballengarra and Maria River state forests that may be better suited to the management of the potential barrier effects of the Proposal through widening of the median.

The details of the original and revised locations for the proposed glider crossing points are set out in Table 3.

Table 3 Locations of proposed glider crossing points subject to feasibility assessment

Name	As proposed in EA		Revised for assessment	
	Station	Length	Station	Length
Cairncross 1	10100 to 11150	1050 metres	10000 to 11600	1600 metres
Cairncross 2	11700 to 12225	525 metres	11500 to 12800	1300 metres
Ballengarra 1a	22600 to 23200	600 metres	22680 to 24000	1320 metres
Ballengarra 1b [1]	n/a	n/a	23200 to 23940	740 metres
Ballengarra 2	25075 to 25425	350 metres	24600 to 25780	1180 metres
Maria River 1a	34700 to 35775	1075 metres	34600 to 35160	560 metres
Maria River 1b [1]	n/a	n/a	33760 to 34380	620 metres

1. Alternative location proposed based on the concept design review. This location was not proposed in the Environmental Assessment.

This assessment was undertaken using the criteria identified in workshop 1 to help define the benefits and constraints of the potential median widening sites. For each of the selection criteria, key features were recorded at these locations based on known information and extrapolation of known information (Appendix B) to form the basis of the constraints analysis.

The level of constraint assigned across each of the assessment criteria for these seven sites is set out in Appendix C.

The key considerations impacting on the feasibility of median widening at each of these sites is summarised in Table 4 based on the following:

- The identified high or significant constraints (noting that negligible, low or medium constraints could be managed).
- The likely additional construction cost of the widened median relative to the existing concept design. The likely additional costs are a strategic estimate only based on key additional construction items and indicative additional property acquisition. A breakdown is provided in Appendix D.

This desktop assessment does not include a detailed evaluation of the constraints and opportunities of median widening at these sites. Nor does it include a detailed cost benefit analysis to determine the most cost effective solution for the project.

Table 4 Key considerations

Consideration		Glider pole location						
		Cairncross 1	Cairncross 2	Ballengarra 1a	Ballengarra 1b	Ballengarra 2	Maria River 1a	Maria River 1b
Significant constraints	Environment	--	--	Proposed fauna underpass	Proposed fauna underpass	Riparian habitat Tree height	--	--
	Community	--	--	--	--	--	--	--
	Engineering	--	--	--	--	Bridge / structures	--	--
High constraints	Environment	Habitat connectivity (to regional corridor) Endangered ecological communities Fauna habitat Groundwater dependent ecosystems	Regional corridor Endangered ecological communities Fauna habitat Groundwater dependent ecosystems	Regional corridor Vegetation clearing Endangered ecological communities Fauna habitat Riparian habitat Tree height	Regional corridor Riparian habitat Tree height	Regional corridor Endangered ecological communities	Regional corridor Proposed fauna underpass	Regional corridor Proposed fauna underpass
	Community	--	--	--	--	Noise	--	--
	Engineering	--	--	Earthworks Service road	--	Earthworks	--	--

Consideration		Glider pole location						
		Cairncross 1	Cairncross 2	Ballengarra 1a	Ballengarra 1b	Ballengarra 2	Maria River 1a	Maria River 1b
Additional construction costs	Key items	Acquisition (public) Structures Bill Hill Road overbridge	Acquisition (public and private) Structures Soft soils	Acquisition (public) Structures Barrys Creek Earthworks	Acquisition (public) Structures Barrys Creek Earthworks	Acquisition (public and private) Structures Mingaletta Road overbridge Barrys Creek realignment Noise treatment Earthworks	Acquisition (public) Structures Middle Gate Road overbridge Earthworks	Acquisition (public) Structures Earthworks
	Approximate additional cost estimate	$3.0M	$2.5M	$5.0M	$5.0M	$4.0M	$11.0M	$11.0M

3.4 Discussion

Based on the key considerations in Table 4, the feasibility of median widening at each of the aerial crossing locations is discussed in Table 5.

Table 5 Feasibility assessment outcomes

Location	Discussion
Cairncross 1	• No private property would need to be acquired as this site would be wholly located within state forest. • Median widening at this location would require lengthening of the proposed Bill Hill Road overbridge resulting in some further ecological impacts. • Adequate separation of the realigned carriageways from the existing Pacific Highway would need to be maintained to provide a viable stand of vegetation. • There are two incidental fauna crossings proposed in this area that could require lengthening and the continued effectiveness of these for the target species requires further investigation. • Approximate additional cost estimate - $3.0M.
Cairncross 2	• Median widening at this location would require further private property acquisition. • Potential to affect dwellings in close proximity as a result of noise and visual amenity impacts. • Soft soils exist in this location. • Additional clearing of regional wildlife corridor would be required to facilitate median widening at this location. • Additional clearing of endangered ecological communities would be required to the north of Cairncross State Forest. • Potential to impact regionally significant farmland. • Approximate additional cost estimate - $2.5M.
Ballengarra 1a	• The existing trees are not likely to be high enough and glider poles could still be required between the service road and northbound carriageway in conjunction with widened median. • A dedicated fauna crossing at this location would require lengthening, potentially reducing its effectiveness. • The proximity of the service road to the west combined with the cuts and fills in this area constrain opportunities for realignment of carriageways without resulting in additional potentially significant impacts. • No private property would need to be acquired as this site would be wholly located within state forest. • Increased clearing of endangered ecological communities would be required. • Potential to impact upon hill climb track operation to the east. • Approximate additional cost estimate - $5.0M.

Location	Discussion
Ballengarra 1b	• Would assist in movement of gliders in the northern section of Ballengarra State Forest. • Median widening at this location is constrained by the proposed service road to the west and extent of cuts and fills, potentially resulting in additional significant impacts. • No private property would need to be acquired as this site would be wholly located within state forest. • The existing trees are not likely to be high enough given the topography and glider poles could still be required between the service road and northbound carriageway in conjunction with widened median. • Median widening would also require lengthening of a dedicated fauna crossing and further investigation would be required to determine its continued effectiveness. • Potential to impact upon hill climb track operation to the east. • Extension through to approximately station 24600 would assist movement of predicted gliders in the northern section of Ballengarra State Forest. • Approximate additional cost estimate - $5.0M.
Ballengarra 2	• Additional requirements for private property acquisition north of Ballengarra State Forest. • The existing trees are not likely to be high enough given the topography and glider poles could still be required between the service road and northbound carriageway in conjunction with widened median. • Significant engineering constraints (Mingaletta Road overbridge, service and access roads and rest areas). • Increased clearing of endangered ecological communities would be required. • Major realignment of Barrys Creek. • Additional clearing of endangered ecological communities and riparian habitat at Barrys Creek. • Potential to impact upon rural residences to the east. • Approximate additional cost estimate - $4.0M.
Maria River 1a	• Median widening at this location could require design adjustments to the proposed Middle Gate Road overbridge, resulting in further impacts. • Two combined fauna crossings in this area could require lengthening and their continued effectiveness would require further investigation. • Maintaining adequate separation of the realigned carriageways from the existing Pacific Highway would be required to provide a viable stand of vegetation. • Existing trees could be high enough however, glider poles could still be required between the service road and northbound carriageway in conjunction with the widened median. • No private property would need to be acquired as this site would be wholly located within state forest. • Approximate additional cost estimate - $11.0M.

Location	Discussion
Maria River 1b	• No private property would need to be acquired as this site would be wholly located within state forest. • One combined fauna crossing in this area could require lengthening and its continued effectiveness would require further investigation. • Further investigation is required to confirm that the surrounding vegetation is of sufficient height relative to the road level to provide the required glide distances. • Approximate additional cost estimate - $11.0M.

4. Conclusion

Table 6 provides a summary of the outcomes of the feasibility assessment and identifies those sites which would require further investigation during stage 1. This information will be obtained as part of the stage 1 investigations described in Section 2.2.1.

Table 6 Conclusions

Location	Summary	Conclusion
Cairncross 1	As no private property acquisition would be required and given favourable topographical conditions, further consideration of median widening in this location is recommended.	Requires further investigation in consultation with agencies in stage 1.
Cairncross 2	Due to the additional private property and endangered ecological community impacts, median widening is not considered suitable at this location and glider crossings should be provided via proposed glider poles.	Median widening not considered feasible at this location.
Ballengarra 1a	Due to the height of existing trees, design limitations and endangered ecological community impacts, median widening is not considered suitable at this location and glider crossing should be provided via proposed glider poles.	Median widening not considered feasible at this location.
Ballengarra 1b	As no private property would be required and given fewer design constraints, further consideration of median widening in this location is recommended. Extension through to approximately station 24600 would assist movement of predicted gliders in the northern section of Ballengarra State Forest.	Requires further investigation in consultation with agencies in stage 1, with consideration of opportunities to improve glider movement in the northern half of Ballengarra State Forest.
Ballengarra 2	Due to the additional private property acquisition required, design constraints and endangered ecological community impacts, median widening is not considered suitable at this location and glider crossing should be provided via proposed glider poles.	Median widening not considered feasible at this location.
Maria River 1a	Due to the implications for the Middle Gate Road overbridge and other design constraints, median widening is not considered suitable at this location and glider crossing should be provided through the proposed glider poles.	Median widening not considered feasible at this location.
Maria River 1b	As no private property acquisition would be required and there are fewer design constraints. further consideration of median widening in this location is recommended.	Requires further investigation in consultation with agencies in stage 1.

5. Recommendations

This median widening assessment has considered the feasibility of widened medians at locations currently proposed for aerial fauna crossings (glider poles). The assessment carried out to date has not included a detailed evaluation of the constraints and opportunities of median widening at these sites. Nor has a detailed cost benefit analysis been undertaken to determine the most cost effective solution for the Proposal.

Based on this preliminary assessment, it is recommended that the following sites require further investigation to determine their suitability for median widening:

- Cairncross 1 (between station 10000 to 11600).
- Ballengarra 1b (between station 23200 to 23940).
- Maria River 1b (between station 33760 to 34380).

Further investigation of the above sites as part of the stage 1 and 2 assessments during the detailed design phase would include:

- Preliminary engineering design and cost analysis.
- Field investigations as necessary.
- Consultation with affected landowners.
- Consultation with relevant agencies.
- Analysis to qualify the benefits and impacts based on the preliminary designs.
- Confirmation of those sites where median widening would be feasible and reasonable.

Following completion of the above tasks, a workshop would be held, involving the RTA and relevant agencies to discuss the outcomes of the assessment.

Appendix A

Selection criteria

Category	Assessment criteria	Considerations (Widened median relative to existing concept design)
Environment	Vegetation clearing generally	Greater area of all vegetation clearing?
	Endangered ecological communities (EEC)	Greater area of EEC clearing?
	Threatened flora and fauna species – TSC and EPBC	Greater loss of recorded species?
	Fauna habitat	Greater loss of mapped “high value” habitat?
	Regional corridors	Would it create a larger barrier to mapped regional corridors?
	Fauna underpasses – would need to be lengthened	Assuming any underpasses would have to cross the widened median in addition to the main carriageways in one passageway, and that this is less desirable to most target species, would it create a greater barrier to fauna movement? Greater emphasis would be given to dedicated crossings, and less emphasis to incidental crossings.
	Fish passage - any bridges / major creeks?	Greater barrier / impact on fish passage?
	Groundwater dependent ecosystems (GDE)	Greater area of GDE clearing?
	Impact on riparian zones	Greater intrusion into / clearing in riparian zone?
	SEPP 14 wetlands, mangroves and seagrasses	Greater area of clearing?
	Need in that location – species recorded v likely v predicted	Not rated. Need has already been determined based on recorded species and habitats.
	Trees high enough?	Is the existing vegetation likely to be tall enough and located close enough to edges of carriageways (following clearing for the Proposal) for target glider species to safely glide across the separated carriageways to the widened median? Also need to consider whether upgraded highway is in cut or fill and presence of other adjacent barriers such as service roads.
Social/community	Proximity to dwellings – noise; visual	Would the realigned carriageway be closer to rural residences?

Category	Assessment criteria	Considerations (Widened median relative to existing concept design)
	Aboriginal heritage	Greater impact on known or high potential Aboriginal heritage sites?
	Non-Aboriginal heritage	Greater impact on known or high potential Non-Aboriginal heritage sites?
	Changes to property access	Greater impacts on public or private property access?
	Property acquisition	Greater public or private acquisition requirements?
	Impact on nature reserves and national parks	Greater acquisition from nature reserves or state forests?
	Impact on regionally significant farmland	Greater acquisition of mapped regionally significant farmland?
	Impact on state forests	Greater acquisition of productive state forest lands?
	Commercial / business impacts (other than state forests)	Greater impact on commercial businesses or activities?
	Impact on communities	Greater social impacts on communities?
	Impacts on land development potential	Greater constraints on development potential?
Engineering	Maintaining design speed	Can design speeds be achieved?
	Alignment	Can alignment design criteria be achieved?
	Impact on bridges, culverts, overbridges	Greater need for widening or redesign of structures?
	Reuse of existing assets eg existing carriageway	Less use of existing asset?
	Earthworks balance and magnitude	Impact on overall cut/fill balance?
	Flooding	Intrusion into flood zones?
	Drainage	Greater issues for overall road drainage?
	Service road location	Adjacent service / access road?
	Utilities	Greater impact on utilities?
	Soft soils	Greater intrusion into areas of soft soils or acid sulphate soils?
	Safety	Can road safety targets be achieved?
	Cost	Greater costs of construction?
	Capacity to stage	Is staging project staging still achievable?

Appendix B

Key features

Category	Assessment Criteria	Glider Crossing Location & Key Features					
		Cairncross State Forest			Ballengarra State Forest		Maria River State Forest
		Cairncross 1		Cairncross 2	Ballengarra 1a	Ballengarra 2	Maria River 1a
		st10100-st10500	st10500-st11150	st11700-st12225	st22600-st23200	st25075-st25425	st34700-st35775
Environment	Vegetation clearing generally	Yes	Yes	Yes	Yes	Yes	Yes
	EECs	None mapped. Possible but unlikely to the east.	Yes at northern end. Yes to west (at northern end) Yes to east.	Yes for majority of alignment. Yes to west (at nth & sth end) Yes all areas to east.	Yes to west (at northern end) No to east & west (otherwise)	Yes to east No to west	No
	Threatened flora and fauna species – TSC and EPBC	Yes in vicinity	Yes in vicinity	Yes in vicinity	Yes in vicinity (1)	Yes in vicinity	Yes in vicinity
	Fauna habitat	High	High	High/Medium	High (mostly) / Medium	High	High
	Regional corridors	SF linkage?	SF linkage?	SF linkage?	Regional (entire SF)	Regional (entire SF)	Regional (entire SF)
	Fauna underpasses – would need to be lengthened	Nil	Yes (1 at each end) (incidental)	Yes (1 at sth end) (incidental)	Yes (1 at nth end) (incidental)	Yes (1 at each end) (incidental)	Yes (1 at each end) (combined)
	Fish passage - any bridges / major creeks?	No.	No.	No.	No.	No. (but Barrys Creek immediately to east)	No.
	GDEs	None mapped. Possible but unlikely to the east.	Yes at northern end. Yes to west (at northern end) Yes to east. "Limited" (some) to west	Yes for majority of alignment. Yes to west (at nth & sth end) Yes all areas to east.	"limited" to west (at northern end) "unlikely" to east & west (otherwise)	"limited" to west some "limited" to west, otherwise "unlikely"	"unlikely" to east & west "limited" further east
	Impact on riparian zones	unlikely	unlikely	unlikely	Possible	Possible (Barrys Creek)	unlikely
	SEPP 14 wetlands, mangroves and seagrasses	No.	No.	No.	No.	No.	No.
	Need in that location – species recorded v likely v predicted	Predicted (habitat)	Predicted (habitat)	Predicted (habitat)	Predicted (habitat)	Recorded (YBG)	Predicted (habitat)
	Trees high enough?	Yes	Yes	Yes	Yes	Yes	Yes
Social / Community	Proximity to dwellings – noise; visual	1800m north east of nth end	1500m north east of nth end	660m to north west of nth end 920m east from nth end	800m from sth end	350m west from north end 450m north east / east from nth end	700m north west from nth end
	Aboriginal heritage	OHK 219/A	Nil known	AHIMS site approx. 350m east	Nil known	Nil known	Nil known
	Non-Aboriginal heritage	OHK7 tree stump to west of ex hwy	Nil known	OHK8 Drainage channels to nth	OHK3 Old Pac Hwy to east?	Nil known	Nil known
	Changes to property access	Nil private (may be some SF trails?)	Nil private (may be some SF trails?)	Nil private (may be some SF trails?)	Hill Climb track to east	Old Pac Hwy to west Mingaletta Road to east Accesses to west (opp Ming Rd)	Nil private Middle Gate Road (east & west)
	Property acquisition	Cairncross SF (east & west) Rawdon Ck NR (west) Nil private	Cairncross SF (east & west) Rawdon Ck NR (west) Nil private	Cairncross SF (east & west) Nil private	Ballengarra SF (east & west) Nil private	Ballengarra SF (east & west) Private land - nth end (east & west)	Maria River SF (east & west) Kumbatine NP (west) Nil private
	Impact on nature reserves and national parks	Unlikely (west of ex hwy)	Unlikely (west of ex hwy)	Nil	Nil	Nil	Unlikely (west of ex hwy)
	Impact on regionally significant farmland	Nil	Nil	Immediately nth of SF	Nil	Nil	Nil
	Impact on state forests	Yes (zones 3V, 4 & 8) seed trees?	Yes (zones 2, 4 & 8) seed trees?	Yes (zones 2, 4 & 8) seed trees?	Yes (zones 3V, 4 & 8)	Yes (zones 3A, 3V & 8)	Yes (zones 3V, 4 & 8)
	Commercial / business impacts	Forestry (zone 4)	Forestry (zone 4)	Forestry (zone 4) Tea Tree (north)	Forestry (zone 4) Hill Climb Track	Forestry (zone 4) Agricultural (north)	Forestry (zone 4)
	Impact on communities	Nil	Nil	Nil	Nil	Mingaletta Road	Nil
	Impacts on land development potential	Nil	Nil	Ag land to north?	Nil	Mingaletta Road	Nil

		Glider Crossing Location & Key Features					
		Cairncross State Forest			Ballengarra State Forest		Maria River State Forest
		Cairncross 1		Cairncross 2	Ballengarra 1a	Ballengarra 2	Maria River 1a
Category	Assessment Criteria	st10100-st10500	st10500-st11150	st11700-st12225	st22600-st23200	st25075-st25425	st34700-st35775
Engineering	Maintaining design speed	Desirable minimum radii of R1200 has been used for curved alignment through this area. Therefore, NB curve remains as is and SB curve (inside) could be flattened to a larger radii to achieve section of widened median. Flatter curve for SB impacts on a straight section (min length) to south (Ch 10200 to 10300), that is between reverse curves. To overcome this, the dual carriageway alignment to the south will have to be realigned (moved) to the west to remove reverse curve. Therefore, total length of alignment impacted by median widening is guesstimated at 1400 m (Ch 10000 to 11400 - between 2 straight sections).		Desirable minimum radii of R3500 (+ 4% normal xfall - no super - 0.5% longitudinal grade) has been used for curved alignment through this area. Therefore, SB curve remains as is and NB curve (inside) could be flattened to a larger radii to achieve section of widened median. Therefore, total length of alignment impacted by median widening is guesstimated at 1300 m (Ch 11500 to 12800 - between 2 straight sections). The widened median would be just inside forest area as centre of curve is ch 12140 - cleared area at ch 12250. We could have tighter curves (eg 2000) and apply super, but we had trouble with applying safe super transitions with the flat longitudinal grades of 0.5% - large flat area through super transition - ponding in rain.	In area where duplication of existing hwy - exist hwy is the NB carriageway. Adjust SB alignment only to achieve vege in widened median. No point in adjusting the NB carriageway as only netts road pavement UNLESS you do a major redesign and get SB over exist hwy and do switch to other side further north. Impact on Hill Climb Track on RHS. Major redesign and realignment to west would result in impact on SR and benched cutting. Having said that, SR would require realignment further to the west to achieve some exist vege between NB and the SR. SR would probably go up to next bench in cut at least. One very long curve(s) have been used through Cooperabung Range ch 20420 to 22680 (2.3 km) - a very tough section and was extremely difficult to design. Aim would be to stay out of these curves and do something with alignment north of ch 22680. If not you'll impact on 2.3 kms of design, involving deep cuttings and the Yarrabee Rd underpass bridges. To achieve widened median between 22600 to 23200 approx total length of alignment impacted would be 1320 m (22680 to 24000 - Barrys Ck). Much better location would be the curved alignment between ch 23200 to 23940 (R 300	Why are we trying to widen at this location? Rest areas left a right, Mingaletta Overbridge and very high fill embankments. There will be major clearing, lighting, noise and a traffic focal point. In area where duplication of existing hwy - exist hwy is the NB carriageway. Designed this way to take advantage of exist wide corridor to the north. So, adjust SB alignment only to achieve vege in widened median. Curved alignment between ch 24600 to 25780 (R 2460) could be amended by tightening the outside curve to achieve widened median around ch 25200, which is that area between the northern end of the NB rest area and the Mingaletta o'bridge. Turn the sed basin around so east/west and minimise vege clearing there will be vege between NB and the SR - 40 to 50 m wide. Major impact on Mingaletta o'bridge. Currently 64 m long - 3 spans. Would go to approx 100 m long and 5 spans. Realignment of SB curve would impact on Barrys Ck alignment, which runs parallel to SB on eastside around Mingaletta Rd.	Desirable minimum radii of R1200 has been used for curved alignment through this area ch 34600 to 35160. Therefore, SB curve (outside) has to remain as is and NB curve (inside) flattened to a larger radii to achieve section of widened median. Flatter curve for NB impacts on existing vege between carriageway and the existing hwy, which is about right with current design. To overcome this, the dual carriageway alignment between ch 34400 and 35400 would have to be realigned (moved) to the east to get realignment further away from exist hwy so inside curve could be flattened and maintain vege to exist hwy. Therefore, total length of alignment impacted by median widening could be as much as 1700 m (Ch 33700 to 35400) to achieve curve shift and maintain min straight sections between curves. Impact on overbridge for access to the Maria River State Forest (extra length) as flattened curve will commence north of the o'bridge. Why not do at curve at ch 33760 to 34380 (R 1200) where SB could be flattened to > R 1200 with min impacts? Target ch 34100 as wide median area?
	Alignment						
	Impact on bridges, culverts, overbridges	Bill Hill Road overbridge	Minor drainage culverts	Minor drainage culverts	Barrys Creek and culverts	Barrys Creek and culverts	Middle Gate Road overbridge
	Reuse of existing assets eg existing carriageway	Yes	Yes	Yes	Yes	Yes	Yes
	Earthworks balance and magnitude	Minor cuts/fills	Minor cuts/fills	Minor fills	Major cuts/fills	Minor fills	Major cuts/minor fills
	Flooding	Above major flood area	Above major flood area	Above major flood area	Nil	Barrys Creek	Nil
	Drainage	to be determined	to be determined	to be determined	to be determined	to be determined	to be determined
	Service road location	Yes - ex hwy approx. 40m west	Nil	Nil	Yes - new road approx. 30m west	Yes - new road approx. 80m west Rest area to west	Yes - ex hwy approx. 40-60m west
	Utilities	Nil	Nil	Yes (to north)	Nil	Nil	Yes (east & south)
	Soft soils	Yes (to east)	Yes (to east)	Yes (to east(?) & north)	No	No	No
	Safety	Minimum design standards will be met	Minimum design standards will be met	Minimum design standards will be met	Minimum design standards will be met	Minimum design standards will be met	Minimum design standards will be met
	Cost	to be determined	to be determined	to be determined	to be determined	to be determined	to be determined
	Capacity to stage	Yes	Yes	Yes	Yes	Yes	Yes

Appendix C

Constraints analysis

Category	Assessment Criteria	Glider Crossing Location - ASSESSMENT																					
	Level of Constraint 0 = Negligible 1 = Low 2 = Medium 3 = High 4 = Significant	Cairncross State Forest						Ballengarra State Forest										Maria River SF					
		Cairncross 1			Cairncross 2			Ballengarra 1a			Ballengarra 1b			Ballengarra 2			Maria River 1a			Maria River 1b		
		EA station: st10100 to st11150			EA station: st11700 to st12225			EA station: st22600 to st23200			EA station: n/a			EA station: st25075 to st25425			EA station: st34700 to st35775			EA station: n/a		
		Revised station: st10000 to st11600			Revised station: st11500 to st12800			Revised station: st22680 to st24000			Revised station: st23200 to st23940			Revised station: st24600 to st25780			Revised station: st34600 to st35160			Revised station: st33760 to st34380		
		Preliminary engineering: move southbound carriageway to the east			Preliminary engineering: move northbound carriageway to the west			Preliminary engineering: move southbound carriageway to the east. Need to keep north of Yarrabee Road traffic arrangement			Preliminary engineering: move southbound carriageway to the east. Need to keep north of Yarrabee Road traffic arrangement			Preliminary engineering: move southbound carriageway to the east.			Preliminary engineering: move northbound carriageway to the west.			Preliminary engineering: move southbound carriageway to the east.		
Environment	Vegetation clearing generally (total area)	Low	1		Low	1		High	3		Medium	2		Medium	2		Medium	2		Low	1	
	EECs	High	3		High	3		High	3		Low	1		High	3		Negligible	0		Negligible	0	
	Threatened flora and fauna species – TSC and EPBC	Low	1		Low	1		Low	1		Low	1		Low	1		Low	1		Low	1	
	Fauna habitat	High	3	Habitat in median would not be useable for ground-based species.	High	3	Habitat in median would not be useable for ground-based species.	High	3		Medium	3		Medium	2		High	3		Medium	2	
	Regional corridors	Medium - High	2.5	state forest containing contiguous native habitat, regional corridors in vicinity	High	3	state forest containing contiguous native habitat, regional corridor to east and west	High	3	regional corridor to east and west. Cooperabung Creek Nature Reserve to south.	High	3	regional corridor to east and west. Cooperabung Creek Nature Reserve to south.	High	3	regional corridor to east and west.	High	3	regional corridor to east and west.	High	3	regional corridor to east and west.
	Fauna underpasses – would need to be lengthened	Medium	2	2 incidentals, lengthening would further constrain movement	Medium	2	2 incidentals, lengthening would further constrain movement	Significant	4	1 dedicated, 1 incidental & 1 combined fauna crossing. lengthening would further constrain movement	Significant	4	1 dedicated & 1 incidental fauna crossing. lengthening would further constrain movement	Medium	2	3 incidental & 1 combined (at nthn end) fauna crossing. lengthening would further constrain movement	High	3	combined fauna crossings	High	3	combined fauna crossings
	Fish passage - any bridges / major creeks?	Negligible	0		Negligible	0		Medium	2		Medium	2		Medium	2		Low	1	actual creeks shown on topo	Low	1	actual creeks shown on topo
	GDEs	High	3	same as EEC's	High	3	same as EEC's	Low	1		Negligible	0		Low	1		Negligible	0		Negligible	0	
	Impact on riparian zones	Low	1		Low	1		High	3		High	3		Significant	4	Barrys Creek	Low	1		Low	1	
	SEPP 14 wetlands, mangroves and seagrasses	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
	Need in that location – species recorded v likely v predicted			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded			yellow belly glider observed to the north			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded
	Trees High enough or close enough?	Low	1	Road is in minor fill. Trees could be high enough	Low	1	Road is mostly in minor fill. Trees could be high enough	High	3	Road is in cut & fill. Adjacent service road to west also on fill. Trees probably not high enough.	High	3	Road is in cut & fill. Adjacent service road to west also on fill. Trees probably not high enough.	Significant	4	Road and service / access roads in cut & fill. Rest areas, Mingaletta Rd overbridge and Barrys Creek. Trees very unlikely to be high enough.	Medium	2	Road in cut & fill. Existing Pac Hwy to west. Trees could be high enough.	Low	1	Road in two large cuts with minor fill between. Trees could be high enough
Social / Community	Proximity to dwellings – noise; visual	Negligible	0		Medium	2	property owner refuses access	Negligible	0		Negligible	0		High	3		Negligible	0		Negligible	0	
	Aboriginal heritage	Low	1		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
	Non-Aboriginal heritage	Negligible	0		Low	1		Negligible	0		Negligible	0		Low	1	old pac hwy	Negligible	0		Negligible	0	
	Changes to property access	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Low	1		Low	1	
	Property acquisition	Low	1	Requires negotiation of forestry land	Low	1		Low	1		Low	1		Low	1		Low	1		Low	1	
	Impact on nature reserves and national parks	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
	Impact on regionally significant farmland	Negligible	0		Medium	2		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
	Impact on state forests	Medium	2	More harvestable land and zone 2 impact, seed trees likely avoided	Low	1	More harvestable land and zone 2 impact, seed trees likely avoided	Medium	2		Low	1		Medium	2		Medium	2		Low	1	
	Commercial / business impacts other than state forests	Negligible	0	already considered forestry above	Low	1		Medium	2	Hill climb track	Medium	2	Hill climb track	Negligible	0		Negligible	0		Negligible	0	
	Impact on communities	Negligible	0		Low	1	closer to Moorside Drive	Negligible	0		Negligible	0		Low	1		Negligible	0		Negligible	0	
	Impacts on land development potential	Negligible	0		Negligible	0	ref to LEP	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
Engineering	Maintaining design speed	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
	Alignment	Negligible	0		Low	1	(no superelevation due to long grade)	Negligible	0		Negligible	0		Low	1	Rest areas, sedimentation basins	Low	1	existing curve constraints	Negligible	0	
	Impact on bridges, culverts, overbridges	Medium	2	Bill Hill Road overbridge will require lengthening (another span?), culverts (and fauna crossings) lengthened	Low	1	minor drainage culverts	Medium	2	Barrys Creek and culverts	Medium	2	Barrys Creek and culverts	Significant	4		Medium	2	Middle Gate Road overbridge impacted	Low	1	
	Reuse of existing assets eg existing carriageway	Negligible	0	NA	Negligible	0	NA	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
	Earthworks balance and magnitude	Low	1		Low	1		High	3		Low	1		High	3	Barrys Creek	Medium	2		Medium	2	
	Flooding	Negligible	0		Negligible	0		Negligible	0		Low	1		Medium	2	Barrys Creek	Negligible	0		Negligible	0	
	Drainage	Low	1	subject to impacts on vertical and horizontal alignment	Low	1	subject to impacts on vertical and horizontal alignment	Negligible	0		Low	1		Low	1		Low	1		Low	1	
	Service road location	Low	1	subject to design alignment and location	Negligible	0	NA	High	3		Negligible	0		Low	1		Low	1	service road constraint to west	Low	1	service road constraint to west
	Utilities	Low	1		Low	1	Optic fibre on eastern side	Negligible	0		Negligible	0		Negligible	0		Low	1	11kv and Telstra FO	Low	1	11kv and Telstra FO
	Soft soils	Low	1	Also acid sulphate soils	Low	1		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
	Safety	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met
	Cost			costs will increase as detailed above (bridges, land etc)			costs will increase as above (soft soils, land, drainage structures)			costs Higher (wider cuttings, bigger culverts across Barrys Creek)			costs Higher (wider cuttings, bigger culverts across Barrys Creek)			costs Higher (Barrys Creek, Mingaletta Road Bridge, land etc)			costs Higher (impacts on bridge, earthworks, culverts, fauna crossings, drainage)			costs Higher (impacts on bridge, earthworks, culverts, fauna crossings, drainage)
	Capacity to stage	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0	
			28.5	0	0	33	0	0	39	0	0	31	0	0	44	0	0	28	0	0	22	0

Appendix D

Strategic cost estimate – additional costs

Item	Strategic cost estimate ($)						
	Cairncross 1	Cairncross 2	Ballengarra 1a	Ballengarra 1b	Ballengarra 2	Maria River 1a	Maria River 1b
Additional clearing	300000	300000	300000	300000	150000	350000	350000
Additional topsoil strip	64000	64000	64000	64000	30000	70000	70000
Additional pavement	Nil	180000	360000	360000	200000	Nil	Nil
Additional cut	520000	160000	1950000	1950000	390000	6682000	6682000
Additional fill	160000	400000	Nil	Nil	Nil	Nil	Nil
Additional barrier	80000	80000	80000	80000	60000	80000	80000
Fauna fencing	160000	160000	160000	160000	120000	160000	160000
Cross drainage	150000	126200	745700	745700	151300	236200	236200
Pavement drainage	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Bridge extension	640000	Nil	Nil	Nil	1968500	460000	460000
Public Utilities	50000	50000	Nil	Nil	Nil	Nil	Nil
Additional acquisition	75000	375000	100000	100000	200000	75000	75000
Sub Total	**2199000**	**1895200**	**3759700**	**3759700**	**3269800**	**8113200**	**8113200**
Contingency + 30%	659700	568560	1127910	1127910	980940	2433960	2433960
Total	**2858700**	**2463760**	**4887610**	**4887610**	**4250740**	**10547160**	**10547160**
Rounded Total	**Say $3.0M**	**Say $2.5M**	**Say $5.0M**	**Say $5.0M**	**Say $4.0M**	**Say $11.0M**	**Say $11.0M**

Strategic cost estimate assumptions

Cairncross 1

- Clearing and mill to stockpile (state forest) - additional 60000 sq m @ $5 sq m = $300000
- Topsoil strip to stockpile - 6400 cu m @$10 = $64000
- Pavement - Nil
- Cut - allow 10 wide x average depth 3m x 700m = 20000 cu m @ 26/cu m = $520000
- Fill - allow 20m wide x 3m average depth x 400m = 24000 cu m - cut = 4000 import @ $40/cu m = $160000
- Barrier - 400m each side in median due to vegetation being closer. $100/m = $80000
- Fauna fencing - 400m each side @ $200/m = 160000
- Cross drainage - assume 20m extension for No 32 and 32A:
  - No 32 - 1200 x 900 PCBC. $2000/m. Assume 20m extension = $40000
  - No 32 - 3000 x 2400 PCBC. $5260/m. Assume 20m extension = $105200
- Bill Hill Overbridge - assume 20m bridge extension + additional pier. 8m wide x 20m = 160 sq m @ $4k sq m = $640000
- Public utilities - optical fibre cable at Bill Hill Rd - additional impact. Allow provisional amount of $50000
- Property acquisition – state forest - additional area of 20 (average) x 1600 = 32000 sq m. RTA property estimate + $75,000

Cairncross 2

- Clearing and mill to stockpile (state forest) - adopt same as Cairncross 1 = $300000
- Topsoil strip to stockpile - adopt same as Cairncross 1= $64000
- Pavement - additional pavement at emergency crossover 200 cu m x $900 cu m = $180000
- Cut - allow 10 wide x average depth 3m x 200m = 6000 cu m @ 26/cu m = $160000
- Fill - allow average 20m wide x 2m average depth x 400m = 16000 cu m - cut = 10000 import @ $40/cu m = $400000
- Barrier - 400m each side in median due to vegetation being closer. $100/m = $80000
- Fauna fencing - 400m each side @ $200/m = $160000
- Cross drainage - assume 20m extension for No 32B and 33:
  - No 32B - 3000 x 2400 PCBC. $5260/m. Assume 20m extension = $105200
  - No 33 - 3/600 diameter RCPs. Assume 20m extension - 60m at $350/m = $21000
- Public utilities - optical fibre cable at Bill Hill Rd - additional impact. Allow provisional amount of $50000
- Property acquisition – state forest - additional area of 20 (average) x 1100 = 22000 sq m.

RTA property estimate + $75,000

- Property acquisition – private - additional area of 50 x 50m + 25 x 750 = 21250 sq m. RTA property estimate + $300,000

Ballengarra 1a / 1b

- Clearing and mill to stockpile (state forest) - adopt same as C1 = $300000
- Topsoil strip to stockpile - adopt same as C1 = $64000
- Pavement - additional pavement at emergency crossover 400 cu m x $900 cu m = $360000
- Cut - 2 separate cuttings that will yield approx 75000 cu m @ 26/cu m = $1950000
- Fill - additional fill required at northern end = 15000 cu m = nil cost as allowed in cut to fill above
- Barrier - 400m each side in median due to vegetation being closer. $100/m = $80000
- Fauna fencing - 400m each side @ $200/m = $160000
- Cross drainage - assume 20m extension for No 71, 72, 73, 74 and 75:
  - No 71 - 3000 x 2100 PCBC at $4955/m. Assume 20m extension = $99100
  - No 72 - 900 x 600 PCBC at $1495/m. Assume 20m extension = $29900
  - No 73 - 5 cell 3000 x 3000 at $20945/m. Assume 20m extension =$418900
  - No 74 - 3000 x 1800 PCBC at $4570/m. Assume 20m extension = $91400
  - No 75 - 3000 x 2400 PCBC at $5320/m. Assume 20m extension = $106400
- Overbridge - Nil
- Public utilities - nil
- Property acquisition - State Forest - additional area of 50 (average) x 1050 = 52500 sq m. RTA property estimate + $100,000

Ballengarra 2

- Clearing and mill to stockpile (state forest) - short length x area = $150000
- Topsoil strip to stockpile - smaller area than C1 = $30000
- Pavement - additional pavement at for Mingaletta Rd 1000 sq m x $200 sq m = $200000
- Cut - cutting at southern end that will yield approx 15000 cu m @ 26/cu m = $390000
- Fill - additional fill required at northern end = 15000 cu m = nil cost as allowed in cut to fill above
- Barrier - 300m each side in median due to vegetation being closer. $100/m = $60000
- Fauna fencing - 300m each side @ $200/m = $120000
- Cross drainage - assume 20m extension for No 75, 76 and 78:

  - No 75 - 3000 x 2400 PCBC at $5320/m. Assume 10m extension = $53200
  - No 76 - 1500 diameter RCP at $1675/m. Assume 20m extension = $33500
  - No 78 - 3000 x 1500 PCBC at $4305/m. Assume 15m extension = $64575
- Overbridge - Mingaletta Overbridge extension - additional 30m span x 11m wide = 330 sq m at 5965/ sq m = $1968500
- Public utilities - nil
- Property acquisition - state forest - additional area = 15000 sq m. RTA property estimate + $50,000
- Property acquisition - private - additional area = 5000 sq m. RTA property estimate + $150,000

Maria River 1a / 1b

- Clearing and mill to stockpile (state forest) - > C1 in area = $350000
- Topsoil strip to stockpile - > area than C1 = $70000
- Pavement - Nil. Emergency crossover has to be moved to the south
- Cut - 3 reasonable sized cuttings - 8000 + 136500 + 112500 cu m @ 26/cu m = $6682000
- Fill - minor fill throughout = approx 10000 cu m = nil cost as allowed in cut to fill above
- Barrier - 400m each side in median due to vegetation being closer. $100/m = $80000
- Fauna fencing - 400m each side @ $200/m = $160000
- Cross drainage - assume 20m extension for No 102, 103 and 104:
  - No 102 - 3000 x 1800 PCBC at $4570/m. Assume 20m extension = $91400
  - No 103 - 3000 x 3000 PCBC at $6190/m. Assume 20m extension = $123800
  - No 104 - 3/600 diameter RCPs. Assume 20m extension - 60m at $350/m = $21000
- Overbridge - Access to Maria River State Forest - additional 10m span x 8m wide = 80 sq m at $5750/ sq m = $460000
- Public utilities - nil
- Property acquisition - state forest - additional area = 15000 sq m. RTA property estimate + $75,000

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