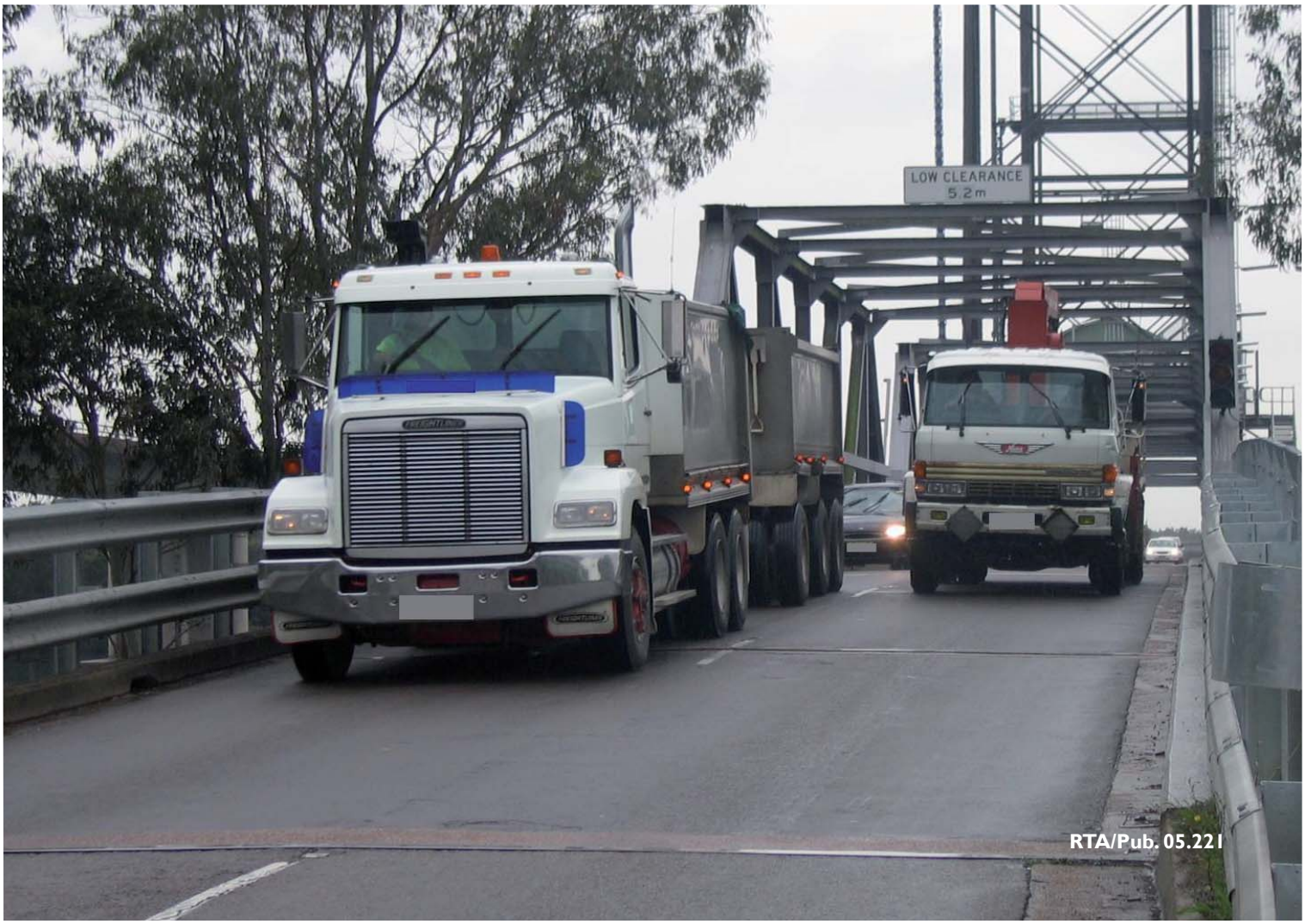
F3 to Raymond Terrace

Upgrading the Pacific Highway

ROUTE OPTIONS DEVELOPMENT REPORT
OCTOBER 2005



RTA/Pub. 05.221

Document Controls

Business Unit	Pacific Highway Services		
Project No.	20024404.04		
Document description	Pacific Highway Upgrade – F3 to Raymond Terrace Route Options Development Report		
	Name	Signed	Date
Approving Manager	L Rebec		18/10/2005
Reviewing Officer	L Rebec		18/10/2005

Person managing this document	Person(s) writing this document
Ken Conway	Ken Conway

Location	File
K:\20024404.00 F3 to Raymond Terrace Upgrade\Reports\Route Options\In RTA Format\F3RT-RPT-017 Route Options Development Report RevL1.doc	F3RT-RPT-017 Route Options Development Report.doc

Document Status	Date
Draft L	18 October 2005

ISBN 1920907416

Prepared by Maunsell Australia Pty Ltd

Prepared for:	Prepared by:
Greg Baird Project Development Manager - Pacific Highway Services Locked Bag 30 NEWCASTLE NSW 2300	Ken Conway Project Manager Maunsell Australia Pty Ltd Level 11, 44 Market Street SYDNEY 2000

Contents

Table of Figures

List of abbreviations

AADT	Annual Average Daily Traffic
AASS	Actual Acid Sulfate Soils
AEP	Annual Exceedence Probability
AHIMS	Aboriginal Heritage Information Management System
ANZECC	Australia New Zealand Environment Conservation Council
ASR	Acid Sulfate Rock
ASS	Acid Sulfate Soils
BCR	Benefit Cost Ratio
CAMBA	China-Australia Migratory Bird Agreement
CIS	Community Information Session
clg	Community Liaison Group
CO	Carbon Monoxide
CTGWM	Chichester Trunk Gravitation Water Main
DA	Development Application
DEC	Department of Environment and Conservation (NSW)
DEH	Department of Environment and Heritage (Commonwealth)
DG	Director General
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DoP	Department of Planning
DPI	Department of Primary Industries
EA	Environmental Assessment
ECRTN	Environmental Criteria for Road Traffic Noise
EEC	Endangered Ecological Community
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EP&A	Environmental Planning and Assessment Act 1979
EPBC	Environment Protection and Biodiversity Conservation Act 1999
EPI	Environmental Planning Instrument
EPL	Environmental Protection Licence
ESD	Ecologically Sustainable Development
FM Act	Fisheries Management Act 1994
GMA	Groundwater Management Area
ha	Hectares
HC	Hydrocarbons
HRBC	Hunter Region Botanic Gardens
HWC	Hunter Water Corporation
IRR	Internal Rate of Return
JAMBA	Japan-Australia Migratory Bird Agreement
kV	KiloVolt

LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
LOS	Level of Service
MCA	Multi Criteria Assessment
MHL	Manly Hydraulics Laboratory
MLEP	Maitland Local Environmental Plan 1993
MVK	Motor Vehicle Kilometres
MVKT	Motor Vehicle Kilometres Travelled
NES	National Environmental Significance
NLEP	Newcastle Local Environmental Plan 2003
Nox	Nitrous Oxides
NPV	Net Present Value
NPVI	Net Present Value per dollar of Investment
NPWS	National Parks and Wildlife Service
NRMA	National Roads Motor Association
NSW	New South Wales
OD	Origin - Destination
PASS	Potential Acid Sulfate Soils
PFM	Planning Focus Meeting
PHUP	Pacific Highway Upgrading Program
PM_{10}	Particulate Matter
POEO	Protection of the Environment Operations Act 1997
PSLEP	Port Stephens Local Environmental Plan 2000
RAAF	Royal Australian Air Force
REF	Review of Environmental Factors
REP	Regional Environmental Plan
RL	Reduced Level
RTA	Roads and Traffic Authority
SEPP	State Environmental Planning Policy
TSC	Threatened Species Conservation Act 1995
TSS	Total Suspended Solids
VOC	Vehicle Operating Cost
VOT	Vehicle Operating Time

- The CTGWM.
- The existing Hunter River bridges at Hexham.

Cultural and social areas which influenced route option selection within the study area include:

- Indigenous heritage areas.
- Non-indigenous heritage items.
- Existing land uses.

Some 20 options/combinations of options were assessed using the MCA against the framework of the above constraints.

Three broad corridors were shortlisted for further investigation (these are shown in **Figure 7.3** in the main section of this report).

One of these corridors was subsequently abandoned due to the length of very soft soils it traversed, the waterway area required for flood management and its impact on land use to the west of Heatherbrae.

Description of the options

Two options are suitable for further development and have been labelled Option A and Option B. Each option has been divided into three sections (western, central and eastern) and development of the preferred route will consider the best combination of these sections (see **Figure ES.1.5**).

Next steps

The project is being developed in a way that is both ecologically sustainable and achieves the best overall outcome for the whole community. The RTA recognises the importance of achieving a balance between social, ecological, engineering and cost factors while continuing to provide for future transport needs. Most importantly, dual carriageway roads and fewer highway connections will result in a safer road environment.

A preferred route has not been selected at this stage.

A preferred route will be selected by considering:

- The community's issues and comments on the route options.
- Information on the physical impact of each of these routes, in relation to economic, ecological, engineering and community issues.
- A value management process which will include a workshop. This workshop will be held with participants from the community, government and technical areas. The workshop will assess the performance of each of the route options against a range of agreed criteria.

Two feasible route options have been identified for further consideration and assessment (see Figure ES.1.5).

Community response to these feasible options is an important part of selecting a preferred route. The route options will be on display for approximately four weeks.

As the route options can be linked together in different ways, there are decisions to be made about a preferred route in the western, the central and eastern parts of the study area. The community is being invited to consider each of the three sections and provide comments on the reply paid feedback form included with the community update (the

feedback form is also available on-line). Community feedback will be integrated into the value management workshop.

Investigation of the two shortlisted options will continue in preparation for the value management process.

A value management workshop will be held to consider the full range of issues and constraints to locating a highway route. Following refinement of the preferred route the concept design and environmental assessment phases would commence.

Community consultation will continue. A community liaison group, updates in the local media, newsletters, meetings with individuals and groups, and a project website will continue to keep the community informed and assist community input.

Figure ES.1.5 – Options A and B

2 Need and justification for the project

This chapter documents the justification for the project through a review of strategic planning policies and analysis of the existing and forecasted traffic movements within the greater study area. The benchmark for investigating the project need is also examined in this chapter through a review of the 'do-nothing' approach, addressing the impacts for road user safety and Level of Service (LOS) forecasts over the next 20 years. A summary of the economic analysis (as detailed in **Chapter 9**) is also provided within this chapter.

2.1 Strategic context

The Pacific Highway between Newcastle and Brisbane forms part of the Australian Government's AusLink National Network. The AusLink National Network is based on national, regional and urban transport corridors, links to ports and airports, and intermodal connections between road and rail.

In January 1996, the NSW and Commonwealth Governments announced their joint commitment to the Pacific Highway Upgrade Program. The program is a $2.2 billion investment over 10 years to improve the standard of the highway, eliminate highway 'blackspots', and reduce journey times, by upgrading the highway between Hexham and the Queensland border. The program finishes in June 2006. The NSW and Commonwealth Governments are presently negotiating a new agreement after June 2006.

Key NSW and regional planning policies and guidance, that identify the need for the development of transport infrastructure between Hexham and the Queensland border include:

- North Coast Regional Environmental Plan (Department of Planning 1988).
- Lower Hunter Regional Strategy (DIPNR, current).
- Hunter Regional Environmental Plan (Department of Planning 1989).
- North Coast Road Strategy (RTA 1993).
- North Coast Urban Development Strategy (Department of Planning 1995).
- Upgrading of the Pacific Highway – 10-Year Pacific Highway Reconstruction Program Discussion Paper (RTA 1997).
- AusLink Program (Commonwealth of Australia 2004).
- Lower Hunter Transport Strategy (DIPNR, current)

2.1.1 Pacific Highway

The Pacific Highway forms part of the AusLink National Network and links two State capital cities, Brisbane and Sydney, Australia's largest city. It generally passes through the coastal areas of the North Coast region which continue to experience high rates of population growth and economic development, particularly in tourism. Although improvements have been made to the highway, they have not kept pace with the growth in traffic and increased freight movement, which has resulted in an overall deterioration in the LOS provided by the highway.

In order to improve safety, road conditions and travel times along the entire length of the Pacific Highway, the NSW and Commonwealth Governments have committed planned funds through a Pacific Highway Upgrade Program for major new and upgrading works along the length of the Pacific Highway from Hexham to the Queensland border.

Planning for the F3 Freeway to Raymond Terrace project is being funded by the NSW Government from its component of the $2.2 billion.

2.1.2 Pacific Highway between the F3 Freeway and Raymond Terrace bypass

Between the F3 Freeway and Raymond Terrace bypass, the existing traffic route follows John Renshaw Drive and the New England Highway before joining the Pacific Highway at the Hexham Bridge over the Hunter River. The length of the Pacific Highway between the Hexham Bridges and the roundabout at Heatherbrae is approximately 7.5 km. The New England Highway which forms part of the National Highway is an important connection between Newcastle and Brisbane for the carriage of interstate and regional road freight. The National Highway is a connector between the towns in the New England region, as a route for inland communities, including those in the far north-west of the state, to access the facilities located in Newcastle.

Within the study area there are currently two roundabouts located on the existing traffic route, at the F3 Freeway / John Renshaw Drive intersection and at the Pacific Highway / Masonite Road / Adelaide Street intersection at Heatherbrae. There is also one signalled intersection, at Hexham Bridge, where the Pacific Highway intersects with the New England Highway.

The intersection of the New England Highway and John Renshaw Drive is grade separated. The major traffic movement is north / south from John Renshaw Drive to the New England Highway and traffic travelling east / west, to continue along the New England Highway, must merge with the main traffic flow.

The Pacific Highway / Tomago Road intersection is currently unsignalised (give way) and a right turn lane is provided on the Pacific Highway.

The existing speed limit of the highway varies significantly as follows:

- 110 km/h – F3 Freeway (80 km/h on final approach to the at-grade roundabout junction with John Renshaw Drive).
- 90 km/h – John Renshaw Drive to the Hexham Bridge crossing.
- 100 km/h – Pacific Highway between the Hexham Bridge crossing and Heatherbrae.
- 80 km/h – Motto Farm to Kingston Motel.
- 70 km/h – Kingston Motel to the Masonite Road roundabout.

The highway passes along the southern limits of Beresfield and Tarro, and through the settlements of Motto Farm and Heatherbrae. These settlements have developed highway servicing roles with three service stations and other related businesses (i.e. take-away food outlets, motor vehicle servicing facilities, restaurants, overnight accommodation) developing a reliance on passing highway trade. Additionally this section of the Pacific Highway provides an important thoroughfare for a number of key transport movements including local access, intra-regional, and inter-regional travel.

2.2 Existing traffic volumes and patterns

The Pacific Highway and thereby this route performs an important function for freight transport from Sydney to Brisbane. Long distance through traffic shares the route with a large volume of local traffic making trips between Maitland, Port Stephens and Newcastle.

Dependence on private cars is high within the Hunter Region. In addition, a scattered pattern of development and urban expansion, particularly residential, will further increase demand on the road network into the future.

2.2.1 Existing traffic volumes

Traffic counts conducted in December 2004 recorded traffic flows at locations within the study area. Using these counts, peak mid block flows were estimated on each of the key links within

the area. A proportion of peak hour to daily flow was calculated from existing RTA traffic data and applied to the peak flows to estimate a daily flow for each key link. These are summarised in **Table 2.1**.

Table 2.1 – December 2004 Traffic volumes

Location	December 2004 Peak hour flow		Estimated two - way daily flow (December 2004)
	Northbound	Southbound	
John Renshaw Drive	850	600	19,600
New England Highway (near Hexham Bridge)	2,650	2,000	64,300
Existing Pacific Highway (north of Hexham Bridge)	1,500	1,450	47,000

Source: Maunsell survey (December 2004)

The highest traffic volumes were observed on the New England Highway between John Renshaw Drive and the Hexham Bridges.

2.2.2 Daily variations

There are six permanent RTA count stations in the area that provide traffic data relevant to the study area. The data from these can be analysed to investigate daily, weekly and annual profile of general traffic.

At all count stations in the study area the morning peak in traffic level occurred between 08:00 and 09:00 hours. In the evening the peak either occurred between 15:00 and 16:00 hours or 16:00 and 17:00 hours. The early evening peak hour may indicate heavy school and university car trips. At the weekend, the peak hour varied but was most commonly between 11:00 and 12:00 hours.

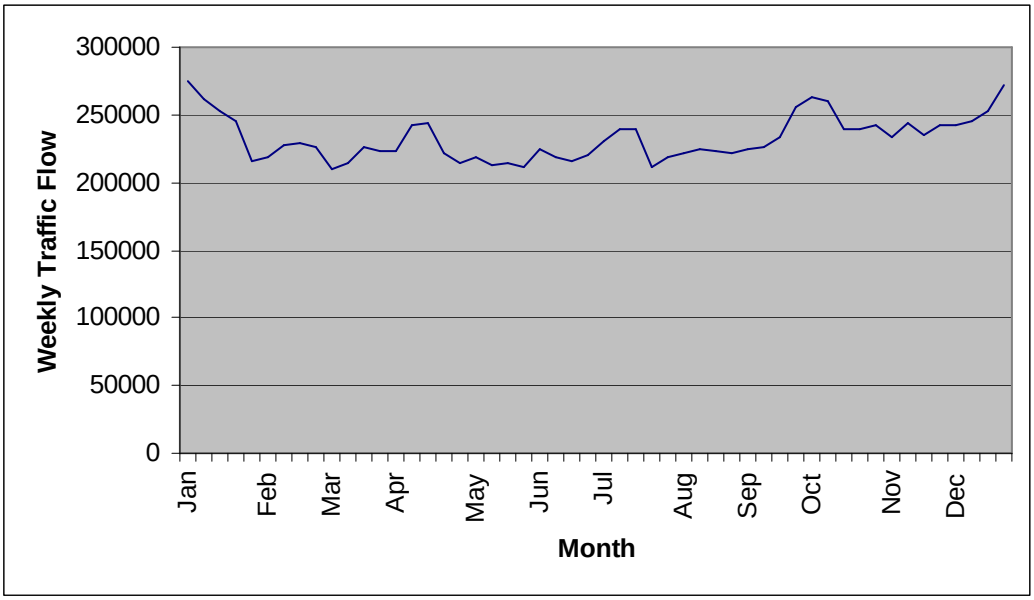
Analysis of available data collected during one week in August 2001 shows that Fridays experience the highest recorded traffic levels.

2.2.3 Seasonal variations

Traffic levels between the F3 Freeway and Raymond Terrace bypass were analysed for patterns over the course of a year. The highest flows (in the 2001 available data) occurred during school holiday periods at Christmas, Easter and in October.

On the Pacific Highway, north of Hexham Bridge, flows during Christmas week accounted for 2.3 per cent of yearly flows, that is, 17 per cent above the average weekly flow proportion.

Figure 2.1 – Seasonal variations in traffic flow, Pacific Highway north of Hexham Bridge



Source: RTA Traffic Volume Data for Hunter Region (2001)

2.2.4 Existing travel patterns

Based on the Origin-Destination (OD) survey undertaken in December 2004, the heaviest movement through the study area is between the F3 Freeway and Weakleys Drive.

After these short trips between the F3 Freeway and Weakleys Drive, the survey indicates the next heaviest through movements are between the New England Highway to Newcastle and vice versa.

The majority of trips originating within the study area were observed leaving via Maitland Road towards Newcastle. Most trips originating externally and ending their trips within the study area were recorded entering from the New England Highway at the junction with John Renshaw Drive.

2.2.5 Crash analysis

The crash data from the last three years (2001-2003) shows that 194 crashes have been recorded between the F3 Freeway at Woods Gully and the Pacific Highway/Masonite Road roundabout north at Heatherbrae. Three of these 194 crashes were fatal. Crash data was also available for part of 2004 and shows that between January and June, 29 crashes occurred on the existing highway route, of which one was fatal.

The most significant category of crashes were those involving vehicles travelling in the same direction (37 per cent). Of these, the majority are rear end crashes with about 33 per cent occurring at intersections. This data would suggest that a high proportion of crashes occur within queuing traffic. T-junctions on the Pacific Highway were the location of 27 crashes (15 per cent) and 13 crashes (seven per cent) were recorded at John Renshaw Drive roundabout.

2.2.6 Heavy vehicle movements

In 2002 the Pacific Highway was opened to B-double access for its full length between Newcastle and the Queensland border following the opening of the Yelgun-Chinderah Freeway. The opening of this upgrade has also reduced journey times and therefore the road user cost of the Pacific Highway in comparison with other inter-regional inter-state routes such as the New

England Highway. Further upgrades are expected to increase the attractiveness of the Pacific Highway for freight transport.

Within the Hunter Region, significant freight routes occur between Newcastle Port, industrial areas of Tomago and the mining industry of the Upper Hunter. Heavy vehicles constitute a significant proportion of the general traffic flow in the region and this is expected to continue with the planned expansion of Newcastle Port and Newcastle Airport.

A classified intersection count conducted in December 2004 found that the proportion of heavy vehicles was between 15 and 31 per cent of trips in the two hour morning period and between six and 20 per cent in the afternoon period within the study area. The proportions varied on each of the sections of the route as displayed in **Table 2.2**.

Table 2.2 – Heavy vehicle percentages by route section

Route section	Heavy vehicle percentage			
	Morning 0730 – 0930		Afternoon 1530 – 1730	
	Northbound	Southbound	Northbound	Southbound
John Renshaw Drive	15%	31%	20%	14%
New England Highway (at Hexham Bridge)	16%	16%	13%	6%
Pacific Highway (north of Hexham Bridge)	16%	20%	13%	9%

Source: Maunsell survey (December 2004)

2.2.7 Existing levels of service

LOS analysis is a measure to determine the operational efficiency of a roadway or intersection. The analysis is essential in planning and design of the transport network and can influence the number of lanes provided or the arrangement of a traffic control system under study.

LOS can be measured mid-block or at intersections. At intersections LOS is directly related to average delay for each vehicle whilst a mid block measure is a qualitative measure describing the operational conditions and their perception by a driver. **Table 2.3** shows the operational conditions that related to each mid block LOS, and the maximum free flow capacity of a two lane highway with a design speed of 100 km/h. During mid block LOS analysis, the free flow capacity is amended to reflect other factors that may reduce capacity, for example, the proportion of heavy vehicles, the shoulder width or the road alignment.

Table 2.3 – Level of service parameters

Level of Service	Conditions	Maximum Service Flow (two lanes)*
A	A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.	1300
B	In the zone of stable flow and drivers still have the reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with LOS A.	2000
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.	2600
D	Close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.	3200
E	Occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause break-down.	4000
F	In the zone of forced flow. Within it, the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow break-down occurs, and queuing and delays result.	variable

Source: Austroads Guide to Traffic Engineering Practice: Part 2: Roadway Capacity

Notes: * under ideal conditions at design speed 100 km/h. For example, the value would vary with differing heavy vehicle proportions.

Estimates of mid block performance indicate that most of the existing traffic route (i.e. F3 Freeway to Raymond Terrace bypass) performs at LOS C or better during typical peak periods, based on the Austroads methodology for the calculation. A LOS lower than C indicates that operational conditions are poor and even a minor disturbance could cause delays and queuing.

The New England Highway section, however, operates at a lower LOS D in the morning peak near Hexham Bridge in the southbound direction. A LOS C is reached closer to the John Renshaw Drive intersection in the morning peak, reflecting the impact of Newcastle bound traffic joining the route from the Beresfield and Tarro access points or interchanges.

A major congestion point on the existing traffic route through the study area is the Hexham Bridge precinct, especially from the New England Highway approach. This is exacerbated when the bridge is opened to allow maritime traffic to pass.

The intersection LOS is expected to be lower than the mid block estimates as they are defined by delay. A large portion of traffic movements would be stopped either at lights or delayed waiting for acceptable gaps in through or circulating traffic.

Average travel speeds through the route are currently estimated to be 60 km/h.

2.2.8 Forecast traffic volumes

In order to assess route options, traffic flows in the nominal project opening year of 2009 and 20 years after opening in 2029 have been forecasted. The following proposed network and land use changes have been considered in the development of the forecasts:

- National Highway F3 Freeway to Branxton Link, completed by 2009.
- A new interchange is planned at the Weakleys Drive / New England Highway interchange.
- Employment developments: Heatherbrae industrial estates (1500 jobs), Tomago Gas Fired Power Station, Weakleys Drive industrial estate (1050 jobs).
- Residential developments: Raymond Terrace and Thornton North (10,000 lots).
- Removal of the heavy railway line from Broadmeadow to Newcastle City Centre.
- Strategic bus routes: from Cessnock, Maitland and Hexham Bridge to Newcastle. The improvement of these routes may include bus priority measures on the New England Highway.
- Proposed expansion to operations at Newcastle Airport and Newcastle Port.

The most significant change to the operation of the road network in the Lower Hunter Region will be the F3 Freeway to Branxton link.

Traffic forecasts have been compiled for the nominal opening year 2009 and forecast year 2029. As a base, growth factors were extracted from the F3 Freeway to Branxton Link report (National Highway F3 Freeway to Branxton Link – Traffic and Transport Study, *Parsons Brinkerhoff, 2004*). The study involved construction of a strategic model to forecast flows of both local and regional trips for the years 2006, 2016 and 2016. Light and heavy vehicles were considered separately.

Trip generation resulting from proposed employment and residential developments in and around the study area was forecast within the model according to expected release rates. Following discussions with Port Stephens, Newcastle and Maitland Councils, a review of the developments within the Parsons Brinkerhoff study was found to be comprehensive and, therefore, considered suitable to base traffic forecasts for the F3 Freeway to Raymond Terrace Upgrade.

The medium forecast flows from the F3 Freeway to Branxton Link report were converted to annual growth rates from 2004 to 2009 and 2029. An appropriate growth rate was selected for each origin-destination movement according to assumptions of the type of trip, regional or local. By applying the growth rates, matrices were created that forecast the levels of traffic that could be expected to use the new highway route and the existing network under the two route options and a base case. **Table 2.4** summarises the forecast flows for significant links within the study area.

Table 2.4 – Existing and forecast (2009, 2029) traffic volumes

Link	Two - way AADT			
	2004	2009	2029	% Increase 2004-2029
John Renshaw Drive	28,020	33,340	65,290	57%
New England Highway (at Hexham Bridge)	48,880	58,170	113,890	57%
Pacific Highway (north of Hexham Bridge)	37,780	44,960	88,030	57%

Source: RTA Traffic Volume Data for Hunter Region (2004)

2.3 Consequences of no action

Should a new link between the F3 Freeway and Raymond Terrace bypass not be constructed, higher traffic volumes would be experienced on the present traffic route, with increases in travel time and conflicts associated with increases in traffic volumes.

2.3.1 Overall efficiency

Travel times would increase as the level of congestion increases, especially on the New England Highway. It could be necessary to widen the road to accommodate the expected volumes of traffic, upgrade the signalised intersections or reduce planned urban development.

The Pacific Highway between the Hexham Bridges and Heatherbrae would not experience as heavy traffic flows as the New England Highway. However, delays may be caused by local traffic conflicting with the major through traffic flows at intersections such as the Raymond Terrace roundabout.

Heavy delays would result in economic impacts, especially to freight traffic travelling either to local areas or long distance.

Table 2.5 illustrates the mid block LOS that has been estimated for the existing route should a new link not be constructed.

Table 2.5 – Forecast mid block level of service

Route section	Level of service			
	2009		2029	
	Northbound	Southbound	Northbound	Southbound
John Renshaw Drive	B	B	C	D
New England Highway (at Hexham Bridge)	E	E	F	F
Pacific Highway (north of Hexham Bridge)	C	D	F	F

Source: Maunsell calculations with RTA Traffic Volume Data for Hunter Region (2001) and Austroads methodology

2.3.2 Local road safety

The occurrence of crashes is likely to increase with increased traffic volumes especially at major intersections along the route, such as the roundabouts at the northern and southern ends of the study area. Works could be necessary to improve safety at these locations.

Hexham Bridge, a site that experiences high crash rates, would service higher levels of traffic and, in time, works to increase capacity or to create a second river crossing point may become necessary. Queues would increase on Hexham Bridge and this could cause increases in the types of crashes associated with queuing traffic, such as rear end collisions.

Traffic crossing the study area to travel to Newcastle along the New England Highway would not be separated from north-south traffic that would have used the new link road. Therefore the number of crashes associated with merging traffic at the John Renshaw Drive/New England Highway intersection would be likely to increase.

The Tomago Road / Pacific Highway intersection currently experiences heavy (northbound) right turn flows and these would increase with traffic growth in the future. Removal of through traffic to a new link would reduce the crash occurrence at this location as exposure is decreased.

Access to and from local roads is expected to become more difficult with increased volumes of through traffic. Drivers may take greater risks to make turns to and from local roads, as gaps in the flow of traffic would be less frequent.

2.3.3 Local and regional growth patterns

Increases in travel times could reduce the attractiveness of the local area to commercial traffic and the area may suffer economically. For example, Newcastle Port would be a less attractive option for freight shipping if access to the Port is constrained.

The anticipated impacts on the Hunter economic zone are unlikely to be significant as the zone would benefit from the F3 Freeway to Branxton link and it is not as dependent on links through the study area.

2.3.4 Local environmental setting

Heavier traffic levels are likely to result in increased levels of noise and air pollution to properties that are located close to the existing highway network. Properties close to the existing road network are located in Motto Farm and Heatherbrae settlements. As well as residences and local business, Hunter River High School would also be affected.

2.4 Benefit cost summary

To ensure that a project delivers value for money to the community, economic appraisals are undertaken to determine the magnitude of benefits generated for a given level of expenditure. Modelling for the economic appraisal has initially been carried out following cost benefit analysis guidelines outlined in the *RTA Economic Analysis Manual*, Version 2, 1999.

As an initial stage, the economic appraisal focuses on road user benefits and costs, which are expected to account for a significant proportion of total benefits and costs from a potential upgrade. The Benefit Cost Ratio (BCR) for the project was calculated as greater than one with a Net Present Value (NPV) between $135 million and $140 million. The NPV per dollar of investment was approximately 0.42 with an Internal Rate of Return (IRR) between 10.0 per cent and 10.4 per cent.

3 Community and stakeholder involvement

Since the then Minister for Roads announced the F3 Freeway to Raymond Terrace project in October 2004, community involvement has been integral to the route options development process. This chapter describes how the community and stakeholders have been involved in the route options development process, by detailing forums and activities that have already taken place and by summarising the key issues raised during the consultation activities.

3.1 Consultation objectives

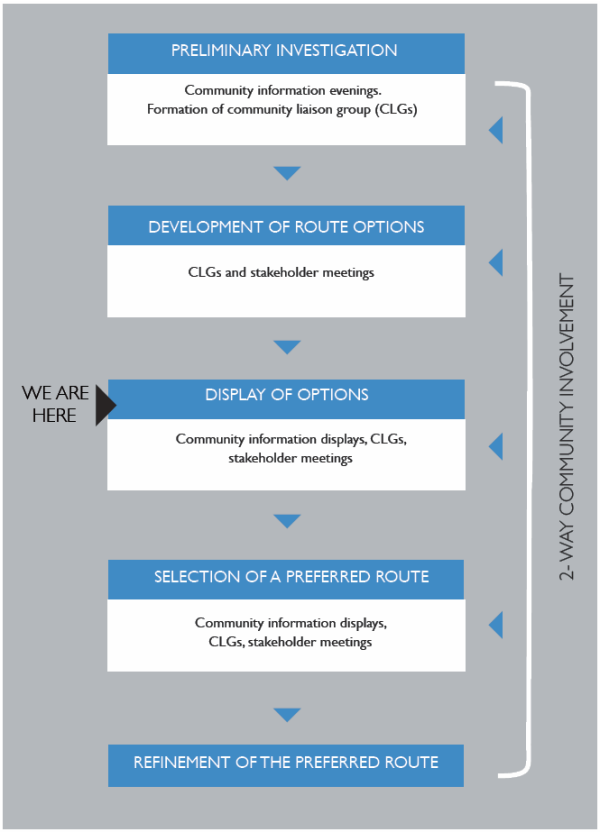
The needs and interests of the community and other key stakeholders residing within or having an interest in the study area are diverse. It is therefore paramount that effective consultation activities are implemented to maximise community involvement and the capture of views throughout all stages of project development, including the route options development process. A set of objectives, as documented in the Community Involvement Plan (Maunsell, 2005) has been developed for this project as follows:

- To ensure an open, accountable and transparent community involvement process.
- To ensure all potentially affected property owners and interested stakeholders are provided with sufficient information about the project and the likely impacts, so that they can provide informed input.
- To ensure appropriate and direct communication with property owners and/or managers in relation to access to, and investigations on landholdings within the study area by study team members and/or RTA representatives.
- To encourage community support and involvement in the project to facilitate better and more generally accepted outcomes.
- To provide a range of accessible opportunities for stakeholders, interested groups and the wider public to contribute to the project through issues identification, information provision, and options evaluation.
- To build an ongoing relationship between the RTA, its contractors and stakeholders in order to gain long term support for the project and in particular the Preferred Route.

3.2 Approach to consultation

The community involvement process during the route options development process is summarised in **Figure 3.1**.

Figure 3.1 – Community involvement process



Community involvement activities outlined in the following sub-sections for this project have been implemented in a coordinated manner by the RTA and Maunsell personnel. Key community involvement activities conducted during the project familiarisation and route options development stages have comprised:

- The distribution of two Community Updates in November 2004 and October 2005.
- A Community Information Session.
- A Planning Focus Meeting with representatives from various agencies and stakeholder groups.
- Establishment of a community liaison group (clg).
- Establishment of a 1800 free call number.
- Establishment of a project web page.
- Four formal meetings with the clg including a bus tour of the study area and a route options workshop.
- Individual meetings with local councils, Local Aboriginal Land Council representatives, Department of Environment and Conservation (DEC), Department of Primary Industries (DPI), Department of Planning (DoP) and Department of Natural Resources (DoNR).
- Key affected landowner interviews and local business surveys.
- Public display of feasible options.

These activities have provided the opportunity for the community and stakeholders to comment on the various issues in the study area and provide input for consideration in the development of route options. Importantly, these activities have raised the awareness of and interest in the project by members of the local community and those communities surrounding the study area.

3.3 Community information session

The Community Information Session held at the Hunter River High School on Monday, 15 November 2005, was attended by approximately 75 people from the local community and other interest groups. Key issues raised by the community at the session included:

- Understanding the process for the clg selection.
- The possibility of expanding the study area to avoid or minimise land disturbance to areas of archaeological sensitivity and/or native vegetation at Black Hill.
- Consideration of the disused rail line through Hexham Swamp and the potential opportunity for integration with the development of route options.

- Sensitive flora and fauna species and habitat areas at the Hunter Region Botanic Gardens and surrounding Tomago Sand Beds.
- Concerns regarding water quality controls during construction.
- Issues surrounding the potential constrictions of flood waters up-stream of the study area as a result of the project.

3.4 Planning focus meeting

A Planning Focus Meeting was also held on Monday, 15 November 2004. The meeting was attended by 20 representatives from key government agencies, local councils, utility companies and Mindaribba and Worimi Local Aboriginal Land Councils. Key issues raised at the Planning Focus Meeting and their incorporation into the route options development process to date are presented in **Table 3.1.**

Table 3.1 – Key issues raised at the Planning Focus Meeting

Issue	Integration with option development
Cultural Heritage	
Close consultation with Mindaribba and Worimi Local Aboriginal Land Council and other representative groups is required from the outset of project development to avoid late discovery of sensitive issues.	A protocol with the Local Aboriginal Land Councils (Mindaribba and Worimi) has been established for all field investigations.
Motto Farm homestead is the oldest house in the area and is of significant local historical value.	All options avoid the Motto Farm homestead.
Engineering	
Bridge crossings and particularly the location of piers, clearance to bridge structures and water depths will need to take into consideration impacts on commercial and recreational fishing on the Hunter River.	The number of piers in the Hunter River will consider environmental impacts, especially on fisheries. The height of the bridge deck will provide sufficient clearance so as to not restrict watercraft passage.
There is a need to maintain a connection to the New England Highway. Maitland City Council, supports an interchange with the New England Highway to maintain access to the Thornton region. Port Stephens Shire Council identified Tomago Road as another intersection that may require planning.	Interchange locations are currently being investigated. Connection into the existing road network will be identified as the study progresses.
Construction of the highway across the Hunter River floodplain.	Initial hydrological and hydraulic assessments have been completed to determine the type of structure (if any) that could be constructed across the floodplain without having significant upstream impacts.
Access controls, maintenance and issues associated with the existing highway once the project is constructed.	Should not impact on possible route option assessment.
Opportunity to integrate other infrastructure proposals, either an additional pipeline to the Tomago Sand Beds or a long term heavy rail	All options provide opportunity to parallel infrastructure. However, if a parallel rail corridor were constructed a separate

Issue	Integration with option development
connection to the Port Stephens LGA.	analysis would be required to assess the impacts on the physical and environmental attributes of the study area.
Process	
Similar to the community, attendees at the Planning Focus Meeting suggested that the study area be expanded to include areas south east of the current study area to avoid possible indigenous heritage sites and flood prone land.	The study area has been expanded to the south to allow consideration of options outside the initial study area. The current study area is shown in **Figure 1.2**.
Community	
Noise impacts for residential dwellings in Black Hill, Beresfield, Motto Farm and Heatherbrae.	Detailed noise investigations will be undertaken during route option refinement and preferred route selection.
Opportunity to provide a safe alternative for cyclists.	This would be addressed during the route options refinement and preferred route selection.
The new alignment must provide for the driver reviver facility at the Beresfield Highway Service Centre. It was noted that this is the busiest facility in NSW.	In all options an interchange is proposed for the F3 Freeway south of the John Renshaw Drive roundabout at Black Hill. This will allow for the driver reviver facility at Beresfield to continue to service the needs of the travelling public.

3.5 State government agencies and local councils

A number of meetings have been held between November 2004 and July 2005 with representatives from the government agencies and local councils. These meetings have assisted the study team in better understanding the various requirements and key issues that need to be considered by this project and have occurred in addition to issues raised in the clg (where representatives of the three local Councils are members) and the Planning Focus Meeting. Specific issues raised by particular stakeholders are outlined in **Table 3.2**:

Table 3.2 – State government agencies and local council issues

Stakeholder Group	Issues
Port Stephens Shire Council	Safety at the Pacific Highway/Tomago Road intersection.
	Proposed residential growth at Raymond Terrace.
	Flooding.
Newcastle City Council	The inclusion of an interchange at the New England Highway.
	Pedestrians and cyclists should be considered for both crossing and movement along the highway if appropriate.
	Flooding.
Maitland City Council	Future development of 10,000 residential dwellings is proposed for the Maitland urban area.
	The need to maintain good access to the area (for residents and

Stakeholder Group	Issues
	industry), including an interchange at the New England Highway.
	There is some concern regarding excessive traffic on the access roads.
	Flooding.
	Integration with other transport infrastructure in the region, for example F3 Freeway to Branxton.
DoP / DoNR	The need to consider both the Newcastle Airport and Newcastle Port expansions.
	As part of the Unsworth Review, a strategic bus corridor is proposed in Maitland.
	Flooding.
DEC	Indigenous heritage issues at Black Hill and the need to establish and maintain good contact with Local Aboriginal Land Council representatives of Mindaribba and Worimi as well as Native land owners.
	Hexham Swamp is considered a constraint and any option that passes through the swamp will not be supported.

3.6 Community liaison group

A clg was established in December 2004 to act as a reference source throughout the project. There are 22 members on the clg representing different geographical and interest groups. The participants represent:

- Landowners from the central study area section representing farming interests.
- Residents of Black Hill, Heatherbrae and Beresfield.
- Local Aboriginal Land Councils.
- Port Stephens, Maitland and Newcastle Councils.
- Raymond Terrace Chamber of Commerce.
- Businesses in Heatherbrae.
- The Green Coalition.
- Hunter Region Botanic Gardens.
- Millers Forest.
- Hunter River High School.

To date, four meetings have been held with the group as follows:

- Meeting No.1 introduced the project, the study team and discussed key issues relevant to the clg.
- Meeting No.2 involved a bus tour of the study area stopping at selected vantage points to allow the clg members to discuss key issues of concern.
- Meeting No.3 was a workshop session held at Motto Farm to provide the clg with the opportunity to identify and develop the route options that they believe to be most feasible.

- Meeting No.4 provided an update on the route options development process and discussed the next steps ahead.

Issues that have been raised by the clg between December 2004 and September 2005, are summarised in **Table 3.3**. The minutes of each clg meeting provide more detailed information about community issues and concerns. Copies of the meeting minutes are contained on the project website.

Table 3.3 – Key issues raised by the clg

Issue	Integration with Option Development
Visual impact at Black Hill, particularly for residents who live in Walter Parade and currently enjoy views towards the Hunter River and Hexham Swamp.	An urban design strategy will be developed for the route to minimise visual impacts
Noise impacts for the same residents at Black Hill.	Noise impacts will be addressed either through noise mounds or architectural treatments.
Opposing views on whether an alignment should pass through Hexham Swamp rather than at the end of the F3 Freeway.	Investigations indicate that a route through Hexham Swamp would have an adverse environmental impact on the wetland. DEC have indicated their agreement with this position. The deep soft soils of the swamp also represent a significant engineering constraint.
Flooding and drainage issues are consistently raised as key issues of concern by the clg. There is concern that the development of a highway route across the Hunter River floodplain could impede flood waters and cause water to back up affecting upstream farmland and properties.	A flood model is being prepared specifically for this project to assess flooding impacts.
Severance of properties. The properties east of the Hunter River would prefer an alignment to pass on the edge of properties. West of the river, the concern is more about residual lots that are still commercially viable.	In developing route options the desires of property owners have been considered. At least one of the options investigated seeks to optimise severance impacts whilst other options have followed a landowner preferred alignment in sections.
Severance of native vegetation areas at Black Hill is an issue and, whilst not in full agreement, the clg members tend to believe that the highway corridor should parallel an existing set of 330 kV overhead transmission lines or the CTGWM.	At least one option considered, in part, parallels the CTGWM. A range of alternative alignments through this vegetation area were also investigated including options that travel to the northern and southern edge as well as dividing the vegetation approximately in equal haves to ensure that the remnant parcels are not too small.
The Hunter Region Botanic Gardens are of significant value to the community and the clg is in agreement that route options should not impact on this facility.	All options seek to avoid or skirt the edge of the Hunter Region Botanic Gardens.
Through Heatherbrae, the business community would prefer a route that utilises the existing highway. Whilst it is	At least one option included in the assessment passes through the centre of Motto Farm and Heatherbrae.

Issue	Integration with Option Development
acknowledged that direct access would not be provided, businesses believe that the visibility of their businesses is vital.	
If an alignment were to pass through the centre of Heatherbrae, the clg assume that connectivity across the highway would be maintained. The clg has discussed options such as a pedestrian overpass near the Hunter River High School.	Connectivity across the highway will be considered depending on the preferred alignment.
To the south of Heatherbrae, the clg believe that a route is not possible across the Tomago Sand Beds based on the difficulties encountered by other development proposals. Members also appreciate some of the sensitive flora and fauna values within this area. Many residents have noted the Koala habitat and have on occasions seen Koalas in the area.	Following consultations with Hunter Water Corporation route options will be confined to the northern edge of the Tomago Sand Beds to minimise potential impacts.
Process and certainty is a concern to all residents with a resolution of the preferred route sought as early as possible.	The RTA aims to do this.

Taking all these issues into consideration, the clg participated with members of the study team in a workshop held in February 2005 to generate possible route alignments on constraints maps. The outcome of this process is further discussed in **Chapter 7** with **Figure 7.2** indicating the routes options produced by the clg. Of note is the preference for a highway route that passes through the centre of Motto Farm and Heatherbrae or to the north with an apparent reluctance to identify routes to the south. Options also included route alignments parallel to the existing Pacific Highway.

3.7 Other interest groups

3.7.1 Property owners/occupants interviews

Between December 2004 and January 2005, major landowners were interviewed by representatives from the project team and the RTA to identify current land uses, key issues and any major constraints within the land parcels.

Key issues and their resolution are provided in **Table 3.4**.

Table 3.4 – Key issues raised during landowner interviews and resolution through option development

Issue	Integration with option development
Mitigation measures must be included so that operation of land use can continue, for example, crossing cattle.	Route option selection will consider potential livestock crossings on farmland.
Development applications have been submitted for a number of different land parcels within the study area - these should be considered in terms of option selection.	Relevant development application documents submitted on land within the study area have been considered in the development of route options.

Issue	Integration with option development
A number of landowners raised concerns with flooding, in particular the dispersal of floodwater following construction of a road that is effectively a barrier.	A flood model has been prepared as part of this project.
A number of land parcels are subject to very soft soil conditions	This has been reflected in the cost estimates and considered in the development of options.

3.7.2 1800 freecall number

Since the establishment of the 1800 freecall number in November 2004, 54 telephone calls have been registered up to the end of September 2005. Enquires from these telephone calls have mainly centred on:

- Process – At the commencement of the project a number of calls were related to requesting further information on the clg.
- Certainty – Affected landowners want further certainty. Many believe that the time taken to select a preferred route is excessive.
- Safety – Issues raised include the need to maintain driver reviver stops.
- Residential impacts – Issues include impacts on property prices, visual amenity and noise.

3.7.3 Project website

A project website was established in November 2004. Its primary function is to provide updated information on the project as it becomes available. This includes the posting of minutes from the clg meetings held between December 2004 and June 2005. The project website will continue to be progressively updated throughout all stages of project development.

3.7.4 Highway-related businesses/service facilities

At this stage, formal consultation has not occurred with the Port Stephens Chamber of Commerce other than issues raised through the clg. A presentation to the Chamber is proposed concurrent with the display of feasible options. A separate survey of local businesses at Motto Farm and Heatherbrae was conducted in June 2005 and will form part of the detailed socio-economic assessment to identify the preferred route.

4 Strategic and statutory planning

Recognition of the strategic objectives and statutory planning requirements in the context of the F3 Freeway to Raymond Terrace project and the planning approvals process is essential to the development of the project. This chapter provides a review of the current planning provisions which may require consideration under Commonwealth, State and other environmental planning policy legislation.

4.1 Assessment under the NSW EP&A Act

The NSW EP&A Act and Regulation 2000 provide the statutory context for environmental assessment of the project and ultimately planning approval. The project is to be assessed under the relevant provisions of the EP&A Act.

4.2 Changes to the Environmental Planning and Assessment Act 1979

The NSW Parliament passed the *Environmental Planning and Assessment Amendment (Infrastructure and Other Planning Reform) Act 2005 No 43* on 16 June 2005. This amendment came into force on 1 August 2005.

The amendment introduces a new Part 3A to the EP&A Act to cover the assessment of major infrastructure development in NSW. This type of development was previously assessed under Part 4 and/or Part 5 of the EP&A Act.

4.3 Application of Part 3A of the EP&A Act to the F3 Freeway to Raymond Terrace Project

By an order gazetted on 29 July 2005, the Minister for Planning declared that Part 3A applies to all projects for which the proponent is also the determining authority and which otherwise would have required an Environmental Impact Statement (EIS) to be obtained under Part 5.

Within the meaning of Part 5 of the EP&A Act, the RTA is both the proponent and the determining authority for the F3 Freeway to Raymond Terrace project. However, the RTA has not yet determined whether an EIS under Part 5 of the Act would be required for this project, and will not make that decision until a preferred route is selected. It is therefore too early to determine whether Part 3A would apply to this project.

If Part 3A does apply, the level of Environmental Assessment (EA) would be determined by the Director – General of Planning, who issues EA requirements after consultation with the relevant public authorities and local councils. If Part 3A does not apply, the project would be assessed under Part 4 or 5 of the EP&A Act.

4.4 Land zoning

The study area comprises land from three LGAs, Newcastle City Council, Maitland City Council and Port Stephens Shire Council. Relevant Local Environmental Plans (LEPs) within these LGAs include:

- Newcastle Local Environmental Plan 2003 (NLEP 2003).
- Maitland Local Environmental Plan 1993 (MLEP 1993).
- Port Stephens Local Environmental Plan 2000 (PSLEP 2000).

Within the Newcastle LGA, the study area crosses zonings including:

- 1(a) – Rural Residential Zone.

- 4(a) – Ports and Industry Zone.
- 5(a) – Special Uses Zone (Arterial Road).
- 5(a) – Special Uses Zone (Transport).
- 7(b) – Environmental Protection Zone.
- 7(c) – Environmental Investigation Zone.

Within the Maitland LGA, relevant zonings include:

- 1(a) – Prime Rural Land.

Within the Port Stephens LGA, relevant zonings include:

- 1(a) – Rural Agricultural "A".
- 1(c5) – Rural Small Holdings 2,000 Square Metres.
- 2(a) – Residential "A".
- 4(a) – Industrial General "A".
- 6(a) – Recreation General "A".
- 6(c) – Recreation Special "A".
- 7(a) – Environment Protection "A".
- 7(c) – Environment Protection "C" (Water Catchment).

LGA boundaries and relevant LEP zonings are illustrated in **Figure 4.1**.

Figure 4.1 – LGA boundaries and land zonings

4.5 Relevant statutory requirements and other approvals

The key statutory considerations relevant to the development of the project are presented in **Table 4.1** below.

Table 4.1 – Summary of relevant statutory requirements

Legislation (approval authority)	Relevant provisions	Approval/licence
Commonwealth Legislation		
Environment Protection & Biodiversity Conservation Act 1999 *(DEH)*	This Act governs the Commonwealth Environmental Impact Assessment (EIA) process, and ensures actions likely to have a significant impact on matters of National Environmental Significance (NES) or other listings, are subject to a rigorous assessment and approvals process.	Items listed under the EPBC Act and potentially in the vicinity of the study area include: • Hunter Estuary Wetlands (Ramsar site and listed on the RNE). • *Litoria aurea* (Green & Golden Bell Frog). • Various migratory bird species. If a protected item is likely to be significantly impacted, a referral under Section 68 is required to determine whether approval under the Act is necessary.
NSW State Legislation		
Environmental Planning & Assessment Act, 1979 *and the* ***Environmental Planning & Assessment Regulation 2000*** *(DoP / DNR)*	The EP&A Act provides the basis for development and environmental assessment in NSW. Part 3A provisions apply to major NSW government infrastructure projects and other projects, plans or programmes of works declared by the Minister for Planning. It also applies to development previously listed as 'State Significant Development'. An EA would be prepared for a 'major project' and lodged with a Project Approval application to the Minister for Planning for determination under Part 3A.	Until a preferred route is selected it is too early to determine whether Part 3A would apply to this project. If Part 3A does not apply, the project would be subject to environmental assessment by way of a REF prepared in accordance with Part 5 of the EP&A Act.

Other statutory approvals may be required to construct and operate the project such as (refer to Error! Not a valid bookmark self-reference.:

Table 4.2 – Summary of other potentially relevant statutory requirements

Legislation (approval authority)	Relevant provisions	Approval/licence
Other NSW State Legislation		
Protection of the Environment Operations Act 1997 *(DEC / EPA)*	The principal aim of this Act is to protect, restore and enhance the environment in the context of ESD guiding principles by regulating specific activities and development that have the potential to pollute air, water and land. It provides a single piece of legislation that integrates the approach to pollution control.	Activities listed under Schedule 1 of the Act, may require an Environment Protection License (EPL) for the following construction activities: • Bitumen pre-mix and hot-mix works. • Concrete works. • Any crushing, grinding or separating works. Other non-scheduled activities which may require licensing under the POEO Act include: • Discharge of pollutants into water from temporary sediment basins and permanent water quality control ponds. • Temporary on-site batching plants (if they are not attached to a construction site and are in operation for more than 12 months).
Roads Act 1993 *(RTA / Local Council)*	The primary purpose of this Act is to regulate the carrying out of various activities on public roads, including procedures for the opening and closing of such roads. This Act also establishes a classification of roads, i.e. 'classified' or 'unclassified' roads and their respective authorisation.	• Approvals and licenses under Section 138 of the Roads Act 1993.

Source: Maunsell Australia Pty Ltd, 2005

The intent of all relevant legislation has been considered in the development of the route options, and will provide ongoing input to the selection of a preferred route and preparation of a concept design.

The intent of the following State Environmental Planning Policies (SEPP's) has also been considered in the development of route options:

- *State Environmental Planning Policy No. 4 - Development Without Consent* (SEPP 4).
- *State Environmental Planning Policy No. 14 - Coastal Wetlands* (SEPP 14).
- *State Environmental Planning Policy No. 44 - Koala Habitat Protection* (SEPP 44).
- *State Environmental Planning Policy No. 55 - Remediation of Land* (SEPP 55).
- *State Environmental Planning Policy No. 71 - Coastal Protection* (SEPP 71).
- *State Environmental Planning Policy No. 74 - Newcastle Ports and Employment Lands* (SEPP 74).

A description of SEPP No. 14 and SEPP No. 44 in relation to the project is provided in **Chapter 5.1.5.**

5 The existing environment

The chapter provides a description of the existing environmental attributes within the study area and where appropriate incorporates notable attributes surrounding the study area. The environment has been defined as those features contained within the biophysical, social and cultural realms. Assessment and review of the existing environment enables potential constraints to the projects development to be identified and avoided or mitigated. Significant transport and utility infrastructure within the study area are discussed in **Chapter 6**.

5.1 Biophysical environment

5.1.1 Topography, geology and soils

GHD Longmac was engaged to carry out a two phased geotechnical study.

Phase 1 investigations have been completed and involved a desktop literature review, the collation of existing geotechnical site investigation data within the study area and preliminary numerical analysis to investigate the feasibility of various ground treatment options.

The study incorporates geotechnical logs from numerous developments within the study area including the TransGrid 330 kV overhead transmission lines, many RTA projects and Hunter Water Corporation records within the Tomago Sand Beds. The report identifies the main geotechnical feature associated with highway development within the study area to be the extensive presence soft soils associated with the alluvial and more specifically, estuarine deposits of the Hunter River floodplain.

Phase 2 investigations comprised field work investigations (i.e. excavation of test pits and drilling of boreholes), laboratory testing, liaison with relevant land/property owners and representatives from Mindaribba and Worimi Local Aboriginal Land Councils.

Topography

Landform across the study area is dominated by the Hunter River floodplain which covers approximately 1406 hectares (65 per cent) of the study area.

The F3 Freeway, near the offtake point for the project, has been constructed with only minor alteration to natural ground levels. East of the F3 Freeway, natural ground levels rise, forming a series of undulating ridges and hill crests before descending to the low lying Hunter River floodplain.

The landform at Black Hill is characterised by a gently undulating profile supporting a dense vegetation cover in places. Ground elevations vary by approximately 22 metres Australian Height Datum (AHD) at Black Hill dipping to a low point of 1.5 metres AHD on the floodplain.

The majority of the study area is situated on the low lying Hunter River floodplain where ground elevations range between ground surface and +one metre, with the existing Pacific Highway defining the southern extent of this landform. East of the Pacific Highway, ground levels gently rise to approximately 12 metres AHD within the densely vegetated aeolian deposits of the Tomago Sand Beds.

Regional geology

The study area is part of the Newcastle Bight embayment, located on the northern edge of the Sydney Basin. On a regional level, it is bounded by Carbonaceous Volcanics to the north and Permian bedrock hills to the south and west. At the southern end of the embayment the Hunter River has deposited estuarine and fluvial-deltaic sediments, consisting of gravels, sand, clay and silt from the Quaternary age. Holocene estuarine sedimentation over time, has developed fluvial

river and floodplain depositions. The consistency and depth of the sediments is highly variable as a result of various in filled paleochannels.

Structural geology

The Williams River Fault crosses the meandering Hunter River in a nominally north easterly direction. The Hunter River broadly follows the alignment of the fault within the study area and is documented as being up to 35 metres wide.

The Thornton Syncline crosses the study area near Black Hill, and is understood to be relatively shallow.

A normal fault is aligned approximately parallel to the northern end of the F3 Freeway.

These structural geology features are shown in **Figure 5.1**.

Figure 5.1 – Geotechnical constraints

Mining

The western end of the study area is underlain by the Tomago Coal Measures. Available information indicates that three significant coal seams are present in this area. In sequence of depth, these are the:

- Upper Donaldson Seam.
- Lower Donaldson Seam.
- Big Ben Seam.

These three seams have been subject to both underground mining and open cut commercial coal mining activities.

The 'Ironbark Colliery' mine lease is located immediately east of the F3 Freeway at Black Hill. It is currently unclear if mining has previously occurred at this location, or if future mining is proposed. Further studies will be undertaken to investigate the status of this lease.

The Tomago Sand Beds, located south of the Pacific Highway, have historically been subject to commercial mineral extraction (sand mining). There is currently no active sand mining within the study area and evidence indicates that previous activity has been restricted to open cut operations.

Soil landscapes

The study area contains a number of soil landscapes which are shown in **Figure 5.2**.

The western section of the study area south of Beresfield and Tarro is characterised predominantly by the Beresfield (be) soil landscape. This soil landscape is of residual origin and lies within the Mine Subsidence District. Limitations include high foundation hazard, water erosion hazard, seasonal waterlogging and high run-off on localised lower slopes.

The central section of the study area, south of Beresfield and Tarro and north of the Pacific Highway is underlain by an estuarine landscape identified as Millers Forest (mf) and is characterised by deep poorly drained soils. Limitations of this landscape include flood hazard, permanently high water tables, seasonal waterlogging, foundation hazard, and low wet bearing strength soils.

East of Old Punt Road and south the existing Pacific Highway, the study area is underlain by an Aeolian landscape identified as Tea Gardens (tn). The soil landscape is characterised by Pleistocene sand sheets.

Between the Hunter River and Tomago Road, a section of the Hexham Swamp (hs) soil landscape unit, characterised by deep soft soils, with a high flood and foundation hazard, high potential for acid sulfate soils and waterlogging is present.

Figure 5.2 – Soil landscapes within study area

Ground conditions

Based on the results of the preliminary geotechnical ground investigations, classification of geotechnical domains has been made. These domains can be directly correlated to the anticipated difficultly in constructing a highway through these areas and consequently aid in the identification of preliminary route options. The domains are discussed below.

Domain A exists within the elevated terrain of the Black Hill / Woods Gully area where the subsurface conditions generally comprise residual soils overlying sedimentary bedrock at relatively shallow depths of typically around one to three metres.

Northeast of Black Hill, the ground elevation falls rapidly to form the western extent of the Hunter River floodplain. A layer of alluvial/estuarine soft soils are present at this location. The soft soils are underlain at depth by sedimentary bedrock, with a generally thin transitional layer of residual soils (Domain B). The available information suggests that the soft soils in this region are highly variable in depth and consistency, but generally in the vicinity of five to ten metres deep up to as far east as Woodlands Close (Domain B1).

Northeast of Woodlands Close soft soils appear to increase, with depths up to 35 metres recorded to the east of Purgatory Creek and the New England Highway (Domain B2). These soft soil depths continue within the range of about 20 to 40 metres to the east of Purgatory Creek.

Within Domain B, it should be noted that the urban settlements of Tarro and Beresfield are predominantly constructed on shallow residual soil profiles overlying bedrock. The New England Highway generally follows the southern boundary between this residual soil profile and that of the alluvial deposits of the floodplain. The inferred outcome is that rock levels are generally closer to existing ground levels and soft soils depths generally shallower to the north of the study area, west of the Main Northern Railway line.

Notwithstanding this inference, it should be noted that the presence of infilled paleochannels are a significant geological feature within the study area which results in bedrock elevations and subsequent soft soil depths varying rapidly over short distances.

Approximately one to 1.5 km west from where the Hunter River crosses the northern part of the study area, sands and gravels underlie the soft soils (Domain C). The extent and continuity of the sand layer is not defined by the current information, and it may exist in discrete pockets of variable size. Where encountered within existing boreholes, the sand layer was typically around ten metres in thickness with gravel present.

Between the Hunter River and the Tomago Sand Beds at Heatherbrae the ground conditions are likely to comprise soft soils overlying sands and gravels overlying bedrock. Limited information is available within this area, however, preliminary information presented by Roy et al (1995) indicates that various paleochannels may be present in this region.

Preliminary information suggests that the Tomago Sand Beds are present at or near the surface in the immediate vicinity of Heatherbrae and to the south of Heatherbrae (Domain D). Regional information indicates that these sands may be expected to be in the vicinity of 20 to 40 metres deep, and may be underlain by deep clays and gravels prior to encountering bedrock at depths of up to 80 metres.

Acid sulfate soils

Acid Sulfate Soils (ASS) include Actual Acid Sulfate Soils (AASS), where the soil pH is below four and/or Potential Acid Sulfate Soils (PASS), which may form AASS when drained or exposed to oxidisation processes (i.e. the exposure of iron sulfate minerals such as pyrite to oxygen). The alluvial deposits of the Hunter River floodplain are classified as high probability for ASS. **Figure 5.3** shows the extent and classification of acid sulfate risk throughout the study area.

Pyrite can also be found in bedrock formations, and although usually present in low concentrations, can be found in sufficient concentrations to generate acid leachate when exposed to the atmosphere and moisture. While the presence of pyrite is not dependant on rock type, depositional environment or age it is more commonly found in igneous or metamorphic rocks. Its potential to produce acid depends on a number of factors which include the materials buffer capacity, or ability to neutralise any acid produced.

Typically ASS are found on low-lying coastal floodplains, particularly in areas associated with rivers, creeks, swamps, wetlands and mangroves below + five metres AHD. Depths to acid sulfate materials across the Hunter River floodplain range mainly between one and three metres below ground level. Around the major watercourses such as the Hunter River, Purgatory Creek and Windeyers Creek, ASS are likely to be encountered within one metre of the ground surface.

Acid Sulfate Rock (ASR) has been encountered adjacent to the study area at Grahamstown Dam and also on the Karuah Bypass. Further testing will be undertaken during the next phase of geotechnical investigations to investigate the likelihood of encountering Acid Sulfate Rock within potential cut locations at Black Hill and between Tomago Road and Old Punt Road on the existing Pacific Highway.

5.1.2 Hydrology and flooding

WBM Oceanics have been commissioned to undertake hydrology and hydraulic investigations for the project. The primary focus of these investigations is to assess the existing flooding regime and the potential impact of the project on the flooding behaviour of the Hunter River and extent of modifications to the local drainage network.

Catchment

The study area is located within the Hunter-Central Rivers Catchment. The catchment covers an area of 37,000 square km and extends from Taree in the north to Gosford in the south, and from Newcastle in the east to the Merriwa Plateau and Great Dividing Range in the west.

Major watercourses

The Hunter River is the principal watercourse in the study area. It flows in a predominantly south westerly direction from its headwaters at Glenbawn Dam in the upland areas of the Hunter-Central Rivers Catchment prior to its confluence with the Goulburn River at Denman. From Denman the Hunter River flows south east through Singleton and Maitland before ultimately discharging into the South Pacific Ocean at Newcastle. The Hunter River subcatchment is located in the centre of the Hunter-Central Rivers Catchment. The central part of the study area crosses the Hunter River once, approximately one kilometre south west of Motto Farm.

Figure 5.3 – Acid sulfate soil risk

Minor watercourses

All creeks and land drains in the study area are tributaries of the Hunter River. There are four minor watercourses that flow within the study area, namely:

- Purgatory Creek crosses the study area near the intersection of the Main Northern Railway and the New England Highway east of Tarro. The Creek initially flows northwards before heading south and discharging into the Hunter River approximately 750 metres north of the existing Hexham Bridge crossing.
- Windeyers Creek flows between Heatherbrae and Raymond Terrace before discharging into the Hunter River. It is located in the east of the study area. Windeyers Creek crosses the existing Pacific Highway approximately 250 metres north of the Pacific Highway and Masonite Road intersection.
- A small unnamed tributary, which extends from Heatherbrae and flows southwest before discharging into the Hunter River at two locations approximately two and three km downstream, respectively. The latter is located immediately north of a homestead known as Kennington Park.
- Viney Creek is located in the far west of the study area. Viney Creek flows northwards and joins Weakley's Flat Creek approximately 750 metres north west of the study area before discharging into a swamp near Beresfield. This swamp is connected to Woodberry Swamp, a SEPP 14 wetland.

Flooding

Over 200 floods have been recorded on the Hunter River since European settlement. The most severe flood recorded was the 1955 flood event, wherein the average distribution of rainfall over the entire Hunter River catchment between the 24 and 27 February 1955 was recorded as 270 millimetres. This flood event was later calculated as having an Annual Exceedence Probability (AEP) of approximately 0.5 per cent.

The one per cent AEP flood area of the Hunter River within the study area varies in width from approximately 2.5 km between Tarro and Tomago, to seven km between Motto Farm and Woodberry Swamp. The floodplain also constricts to approximately 1.5 km near Hexham Bridge where the New England Highway limits the flood extents. A significant proportion of the study area is within a very high hazard zone for flooding. The remaining proportion of the study area within the floodplain is categorised as high hazard (Patterson Britton and Partners, 1996).

The lateral extent of the one per cent AEP flood event is shown in **Figure 5.4**.

The flooding behaviour within the study area is influenced by a number of natural and constructed flow controls as summarised below:

- Constructed flow controls including the New England Highway, Main Northern Railway, CTGWM and Hexham Bridge impede the free passage of floodwater during large floods.
- A constriction in the Hunter River at Green Rocks upstream of the study area results in water backing up and flowing along a secondary pathway into the study area during events where the one per cent AEP peak flow is exceeded.
- The Hunter River forms a confluence with the Williams River upstream of the study area, with flows combining in this area resulting in flooding at Raymond Terrace and across Millers Forest.

- Raymond Terrace Road crosses the floodplain through Millers Forest between Woodberry and Raymond Terrace (upstream of the study area). The road is slightly elevated above the floodplain and is considered to act as a broad-crested weir during major floods.
- Within the study area boundary, a natural constriction formed by the peninsular at Tarro and high ground at Tomago influences flooding behaviour.

Currently, constructed levees provide protection from floodplain inundation during events up to approximately the 20 per cent AEP flood event. The levees also have the impact of increasing the stream energy over natural conditions during events where the flow depth exceeds the bank level and is artificially increased by the constriction imposed by the levees.

Figure 5.4 – Water features plan

Local drainage

Local drainage sub catchments within the study area are relatively ill-defined. A network of natural and constructed drains excavated within the floodplain by property owners convey runoff to the Hunter River.

Defined sub catchments and drainage pathways are shown on **Figure 5.5**.

Additional local catchment runoff enters the floodplain from more defined urban sub-catchments that fringe the floodplain. Constructed stormwater drainage lines concentrate and discharge stormwater into the floodplain at specific locations

The drainage of the local sub-catchments in the study area, illustrated in **Figure 5.5**, are briefly described below:

- W1 drains northwards along Lenaghans Drive to Weakleys Flat via a minor watercourse.
- W2 is an adjacent parallel watercourse to W1 and facilitates drainage northwards under John Renshaw Drive before discharging into Weakleys Flat Creek and through Beresfield Golf Course into Woodberry Swamp.
- W3 drains runoff from areas in Lenaghans Flat.
- W4 conveys runoff from residential areas in Black Hill.
- W5 drains from sections of Hexham Swamp to the north of the abandoned railway.
- W6 and W7 conveys runoff from residential areas in Beresfield and Tarro.
- W8 drains to Purgatory Creek from Hexham Swamp.
- W9 is the catchment for Tarro Swamp.
- W10 and W11 drain additional areas of land located between the Chichester Pipeline and the Hunter River through small constructed linear drains that convey flow via a central main drain to the Hunter River.
- W12 receives runoff from Tarro Swamp via two minor watercourses that direct flow to Purgatory Creek. A number of additional drains have been constructed along property boundaries in this area to drain low-lying properties.
- E1 drains the eastern side of the Pacific Highway near Heatherbrae and Motto Farm. Runoff in this sub catchment flows through an area of relatively undisturbed native bushland into the catchment for the Tomago Sand Beds that supplies a proportion of Newcastle's drinking water supply.
- E2 drains via Windeyers Creek into the Hunter River and includes sections of Heatherbrae and Kinross Gardens.
- E3 to E6 drain runoff from the urban areas in Motto Farm and Heatherbrae. The land falls in a north-westerly direction to the Hunter River floodplain where a number of constructed drains convey runoff to the Hunter River via a number of floodgates.
- E7 and E8 drain the floodplain through constructed drains which flow to the Hunter River.

Figure 5.5 – Drainage subcatchments

5.1.3 Water quality

Surface water quality

A formal water quality data collection program has been undertaken within the Hunter River estuary since 1972 although data was not collected regularly particularly in the period 1979 to 1987.

Hunter Water Corporation and the NSW DEC have monitored 103 sites on the Hunter River between the entrance to the Port of Newcastle and the tidal limits at Maitland. Of these sites, eight are within the study area located between the confluence of the Hunter and Williams Rivers and Hexham Island. The results are shown in **Table 5.1**

Table 5.1 – Summary of water quality monitoring results (Sanderson & Reddon, 2001)

Parameter	No Samples	No Sites Sampled	Mean	90%ile	10%ile	ANZECC Values*
Chlorophyll-a (µg/L)	28	1	14.1	24	5	4
DO (mg/L)	33	1	6.7	8.8	4.6	-
Faecal Coliform (col/100ml)	59 (7)	7	431.0	620	0	1000**
Enterococci (col/100ml)	33 (1)	1	524	2300	10	230**
Non-filterable residue (mg/L)	96 (7)	7	59.3	135	5.6	-
NH_3 (mg/L)	80 (7)	7	0.08	0.15	0.01*	-
NO_3 (mg/L)	33 (1)	1	0.11	0.19	0.01*	-
NO_2 (mg/L)	33 (1)	1	0.012	0.02	0.01*	-
NO_x (mg/L)	117 (8)	8	0.13	0.30	0.01*	0.015
pH	91 (7)	7	7.9	8.5	7.4	7-8.5
TKN (mg/L)	60 (5)	5	3.39	7.6	0.5	-
TP (mg/L)	121 (8)	8	0.25	0.46	0.08	0.03
Turbidity (NTU)	18 (4)	4	19.0	40	3.2	0.5-10

Source: WBM, 2005

* ANZECC default trigger values for the protection of slightly disturbed aquatic ecosystems (estuaries)

** ANZECC Guidelines for secondary contact recreation.

The Hunter River has elevated levels of nutrients (nitrogen and phosphorus) and chlorophyll-a. This is to be expected as it a disturbed ecosystem with agricultural and urban runoff.

Non-filtrable residue (total suspended solids) impacts on the transparency and turbidity of the water. Turbidity in the river is generally higher than ANZECC values. This lack of transparency may be limiting the concentration of chlorophyll-a (algae) in the river.

Dissolved oxygen (DO) levels below five mg/L may adversely affect the function and survival of biological communities (Chapman, 1996). Levels in the river are generally good but the 10 percentile concentration for DO is 4.6 mg/L indicating that for a proportion of time, biological communities may be slightly stressed.

The Hunter River generally meets ANZECC Guidelines for secondary contact recreation for faecal coliforms but not enterococci. It does not generally meet guidelines for primary contact.

Groundwater quality

The Tomago Sand Beds cover an area of 106 square km along a strip of coastal land that varies in width from approximately three km at Lemon Tree Passage to six km at Tomago. The Tomago Sand Beds extend to the eastern side of the Hunter River between Hexham and Raymond Terrace, and part of the eastern section of the study area is located within the catchment for these sand beds. This section of the sand beds forms part of the Tomago GMA which is classified as a 'special area' under the *Hunter Water (Special Areas) Regulation 2003*. This classification is based on the Tomago GMA forming part of the sensitive water supply catchment area for Newcastle and the Lower Hunter.

Locations including Lemon Tree Passage, Tanilba Bay, Salt Ash, Williamtown, Heatherbrae and Tomago are all situated within the catchment for the Tomago Sand Beds. The sand beds are comprised mainly of highly permeable sands with hydraulic conductivities between 10-30 metres per day (MHL, 2003). The groundwater in the catchment is utilised by vegetation and extracted and treated for water supply or drains to the estuary.

Groundwater extraction commenced in 1939 and was increased in 1992 and 1993 to provide a back up potable supply in the event of blue green algae bloom in Grahamstown Dam. There are now in excess of 20 pumping stations within the Tomago GMA operated by Hunter Water Corporation. After aeration, the water undergoes treatment at Tomago including dosing with lime, alum and chlorine. The water is then filtered prior to delivery to service reservoirs (HWC, 2004).

The groundwater quality in the catchment is currently impacted upon by land uses including residential, industry, manufacturing, construction, transport, agriculture, mining, utilities, defence force activities and recreation (HWC, 2004). Raw water quality sampled from groundwater at Tomago is summarised in **Table 5.2**.

Table 5.2 – 2003/04 raw water quality at Tomago (HWC, 2004)

Parameter	No. Samples	Median	Maximum	Minimum
Total Nitrogen (mg/L)	-	0.58	1.93	-
Total Phosphorus (mg/L)	-	0.018	0.029	-
Conductivity (µS/cm)	-	209	211	-
Faecal coliforms (cfu/100ml)	-	0	0	-
Arsenic (µg/L)	20	2.70	4.10	1.40
Barium (µg/L)	2	40.0	45.0	35.0
Boron (mg/L)	2	0.078	0.118	0.038
Lead (µg/L)	7	2.0	4.0	2.0
Nickel (µg/L)	2	2.5	3	2

Source: WBM, 2005

5.1.4 Terrestrial ecology

Biosis Research Pty Ltd was commissioned to conduct a terrestrial flora and fauna assessment. The purpose of this assessment was to identify and evaluate the issues and influences associated with terrestrial flora and fauna on the development of potential route options. This included consideration of the presence of threatened species, populations (and their habitats) and ecological communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The study area is located in the Sydney Basin Bioregion and is characterised by a range of wetland, forest and woodland habitats distributed both west and east of the Hunter River. These habitats exhibit varying levels of structure, species assemblage and diversity, and disturbance. Those areas identified as being of high conservation value are shown in **Figure 5.6** and include:

- The Hunter Estuary Wetlands Ramsar site.
- Hexham Swamp Nature Reserve.
- Core and potential Koala habitat.
- SEPP 14 wetlands.
- Endangered Ecological Communities (EECs).
- The Hunter River and smaller tributaries.
- Undisturbed native vegetation areas situated in the west and south-west of the study area near Lenaghans Drive and John Renshaw Drive at Black Hill.
- Undisturbed bushland areas east of the Hunter River, extending northwards from the Tomago Industrial area to the south of Heatherbrae on the Tomago Sand Beds. These are known to contain numerous threatened flora and fauna species, habitats of high conservation value and EECs.

Figure 5.6 – Protected habitats and threatened species

Vegetation communities

The central part of the study area is generally characterised by cleared farmland with some small fragmented patches of vegetation. The vegetation in the western section of the study area is continuous with vegetation to the west of the study area and forms part of a regional corridor, extending from Sugarloaf in the west to Hexham Swamp in the east. The vegetation in the south east of the study area is continuous with a particularly large area of dense vegetation, extending to throughout the Tomago GMA, to the east of Motto Farm and Heatherbrae. Hexham Swamp Nature Reserve adjoins the south western boundary of the study area.

Vegetation communities can be listed as threatened under Commonwealth and State (NSW) legislation as:

- Critically endangered, endangered or vulnerable under Subdivision C of the EPBC Act.
- Endangered or vulnerable under Schedule 1 and 2 of the TSC Act.

Vegetation within the study area was mapped by DEC (NPWS) in 2003. Based on this mapping (and confirmed during the surveys undertaken in November/December 2004 and July 2005 by Biosis Research) seven vegetation communities/fauna habitats are present within the study area, which are listed in **Table 5.3**.

Table 5.3 – Vegetation communities/fauna habitats recorded in the study area

Vegetation community	Canopy dominants	Condition	
		Vegetation	Fauna habitat
Coastal Sand Apple – Blackbutt Forest	*Angophora costata, Corymbia gummifera, Eucalyptus pilularis, Banksia serrata.*	Extremely good condition, high diversity of natives. Few exotics recorded, generally confined to tracks and edges.	Very good condition containing a high level of breeding, nesting, feeding, and roosting resources.
Swamp Oak Rushland Forest – equivalent to the EEC Swamp Oak Floodplain Forest (TSC Act)	*Casuarina glauca, with Melaleuca styphelioides. Some patches in the western section dominated by Melaleuca quinquenervia.*	Poor. Highly degraded, grazed by cattle. Isolated patches of scattered trees with understorey dominated by exotic species.	Poor condition providing very few suitable fauna habitat resources.
Swamp Mahogany – Paperbark Forest - equivalent to the EEC Swamp Sclerophyll Forest (TSC Act)	*i. Eucalyptus robusta with some Melaleuca styphelioides in the eastern section. ii. Eucalyptus robusta with Melaleuca quinquenervia in the western section.*	i. Extremely good condition, few exotics recorded in the eastern section. ii. Poor. Degraded, scattered trees and exotic dominated understorey in the western section.	i. Very good condition containing valuable fauna habitat resources including Koala feed trees. ii. Moderate condition providing roosting and

Vegetation community		Canopy dominants	Condition	
			Vegetation	Fauna habitat
				feeding resources.
Plantation/exotic dominated		*Pinus radiata.*	Poor. Extremely degraded, dominated by exotic species.	Poor condition providing few breeding, feeding, nesting and/or roosting resources.
Mangrove-Estuarine Complex	Mangrove variant	*Avicennia marina ssp. australasica.*	Relatively good condition, but restricted to thin strips of vegetation adjoining the Hunter River.	Moderate condition providing reasonable fauna habitat resources
	Saltmarsh variant - equivalent to the EEC Coastal Saltmarsh	*Juncus kraussii* ssp. *australiensis, Phragmites australis, Sarcocornia quinqueflora* ssp. *quinqueflora, Sporobolus virginicus* var. *virginicus.*		
Lower Hunter Spotted Gum-Ironbark Forest – (listed as an EEC under the TSC Act)		*Corymbia maculate and Eucalyptus fibrosa with Angophora costata,* *E. eugenioides,* *E. paniculata and E.umbra less dominant.*	Extremely good condition, high diversity of natives. Exotics generally confined to tracks and edges.	Very good condition containing a high level of breeding, nesting, feeding, and roosting resources.
Freshwater Wetland Complex - equivalent to the EEC Freshwater Wetlands on Coastal Floodplains		*Alternanthera philoxeroides with Persicaria decipiens, Triglochin procerum. Few scattered trees of Casuarina glauca.*	Poor. Extremely degraded community dominated by exotic species.	Moderate condition providing suitable habitat mainly for wetland bird species.

Source: Biosis Research 2004 and 2005

Endangered ecological communities

Five of the seven vegetation communities recorded in the study area are listed as EECs under Schedules 1 and 2 of the TSC Act (see **Figure 5.6**). The EEC designations and locations within the study area include:

- Lower Hunter Spotted Gum- Ironbark Forest, located at Black Hill.
- Swamp Sclerophyll Forest, located at Black Hill Tomago Sand Beds, located at Black Hill, Motto Farm, and Heatherbrae.
- Swamp Oak Rushland Forest, located at Black Hill, Hexham Swamp, Hunter River floodplain and Heatherbrae.
- Freshwater Wetland Complexes located on coastal floodplains, (part of) Hexham Swamp and at the Tomago Sand Beds.
- Coastal Saltmarsh, located on low-lying areas adjacent to the main channel of the Hunter River and associated tributaries, and near mangrove forests.

Terrestrial flora

A total of 327 vascular plant species were recorded within the study area during surveys undertaken in November/December 2004 and July 2005. Of this total 257 were locally indigenous species (79 per cent) and 70 exotic species (21 per cent).

Database research (DEC Atlas of NSW Wildlife and DEH Online Database) concluded that ten threatened plant species (listed on the TSC Act) and eight threatened plant species (EPBC Act) have been previously recorded within 10 km of the study area.

During the targeted surveys one threatened flora species, *Callistemon linearifolius* ('red bottlebrush') was recorded in the western section of the study area within the Lower Hunter Spotted Gum-Ironbark Forest EEC.

Based on previous recordings potential habitat for an additional four threatened flora species exists within the study area (**Table 5.4**).

Table 5.4 – Threatened flora species that have the potential to occur in the study area

Threatened species	Status under TSC Act	Status under EPBC Act
Callistemon linearifolius	V	-
Eucalyptus parramattensis	V	V
Persicaria elatior	V	V
Tetratheca juncea	V	V
Zannichellia palustris	E1	-

Endangered (E1), Vulnerable (V)

Source: Biosis Research 2004 and 2005

Tetratheca juncea was not recorded in the study area during the targeted searches undertaken in November/December 2004 and July 2005. However a population of *Tetratheca juncea* was recorded in 1985 within the eastern section of the study area. The area has since been cleared and developed. It is possible that *Tetratheca juncea* does occur within the bushland areas of the eastern section of the study area and further targeted searches for this species should be conducted along the preferred route once it is selected.

Terrestrial fauna

A total of nine frog, eight reptile, 128 bird (six introduced) and 19 mammal (four introduced) species were recorded within the study area during the targeted surveys undertaken in November/December 2004 and July 2005.

Additionally database research concluded that 48 threatened animal species (listed on the TSC Act), 12 threatened animal species or their habitat (listed on the EPBC Act) and 20 migratory birds or their habitat have been previously recorded within 10 km of the study area.

Five threatened fauna species were recorded within the study area during the surveys:

- Glossy Black Cockatoo.
- Grey-crowned Babbler.
- Grey-headed Flying-Fox.
- Koala.
- Masked Owl.

A total of 28 migratory birds were recorded within the study area during the surveys (refer to **Table 5.5**). An additional three threatened and six migratory fauna species have been recently recorded within and/or adjacent to the study area.

Table 5.5 Terrestrial fauna listed on the TSC Act or EPBC Act that have been recorded or have potential habitat within the study area (species highlighted in bold were recorded during the recent surveys).

Table 5.5 – Terrestrial fauna

Common name	Status		Common name	Status	
	TSC Act	EPBC Act		TSC Act	EPBC Act
Amphibians			Marsh Sandpiper	-	M
Green and Golden Bell Frog	E1	V	**Masked Lapwing**	**-**	**M**
Birds			**Masked Owl**	**V**	
Australasian Bittern	V	-	**Nankeen Kestrel**	**-**	**M**
Australasian Shoveler	**-**	**M**	Osprey	V	M
Australian Hobby	**-**	**M**	**Pacific Black Duck**	**-**	**M**
Australian Painted Snipe	E1	V	**Peregrine Falcon**	**-**	**M**
Australian Wood Duck	**-**	**M**	Pied Oystercatcher	V	-
Barking Owl	V	-	Powerful Owl	V	-
Black Bittern	V	-	Regent Honeyeater	E1	EM
Black Kite	**-**	**M**	**Rufous Fantail**	**-**	**M**
Black Swan	**-**	**M**	Satin Flycatcher	-	M
Black-breasted Buzzard	V	M	Speckled Warbler	V	
Black-chinned Honeyeater	V		Square-tailed Kite	V	M
Black-faced Monarch	**-**	**M**	**Swamp Harrier**	**-**	**M**
Black-necked Stork	E1		Swift Parrot	E1	EM
Black-shouldered Kite	**-**	**M**	Tawny Grassbird	-	M
Black-winged Stilt	**-**	**M**	Turquoise Parrot	V	-
Brown Falcon	**-**	**M**	**Wedge-Tailed Eagle**	**-**	**M**
Brown Goshawk	**-**	**M**	Whimbrel	-	M
Brown Treecreeper	V	-	**White-bellied Sea-Eagle**	**-**	**M**
Cattle Egret	**-**	**M**	**White-throated Needletail**	**-**	**M**
Chestnut Teal	**-**	**M**			
Cicadabird	**-**	**M**			
Clamorous Reed-Warbler	**-**	**M**	*Mammals*		
Collared Sparrowhawk	**-**	**M**	Brush-tailed Phascogale	V	-
Comb-crested Jacana	V	-	Eastern Bent-wing Bat	V	C
Common Greenshank	-	M	Eastern False Pipistrelle	V	-
Eastern Curlew	-	M	Eastern Freetail-bat	V	-

Common name	Status		Common name	Status	
	TSC Act	EPBC Act		TSC Act	EPBC Act
Freckled Duck	V	M	Greater Broad-nosed Bat	V	-
Glossy Black-Cockatoo	**V**	**-**	**Grey-headed Flying-fox**	**V**	**V**
Grey Teal	**-**	**M**	**Koala**	**V**	**-**
Grey-crowned Babbler	**V**		Large-eared Pied Bat	V	V
Hardhead	**-**	**M**	Large-footed Myotis	V	-
Hooded Robin	V	-	Little Bentwing-bat	V	-
Latham's Snipe	**-**	**M**	Long-nosed Potoroo	V	V
Little Tern	E1	M	Squirrel Glider	V	-
Magpie Goose	V	-	Yellow-bellied Sheathtail-bat	V	-

Endangered (E), Vulnerable (V), Endangered (E1),

Conservation Dependent (C), Covered under migratory provisions (M)

Source: Biosis Research 2004 and 2005

5.1.5 State environmental planning policies (SEPPs)

SEPP 14 wetlands

State Environmental Planning Policy No. 14 (SEPP 14) applies to coastal wetlands that have been identified for preservation and protection under state legislation.

There are seven designated SEPP 14 wetlands within the study area (see **Figure 5.7**):

- SEPP 14 wetland no. 840 – Hexham Swamp.
- SEPP 14 wetland no. 829 – Tarro Swamp.
- SEPP 14 wetland nos. 826, 826a, 830 and 831 – Hunter River.
- SEPP 14 wetland no. 832.

These wetlands contain a mosaic of critical estuarine and freshwater habitats that are of regional and national importance for a range of amphibian, fish and bird species. In addition, these wetlands support significant populations of indigenous shorebirds and transient migratory birds some of which are protected under the Japan-Australian Migratory Bird Agreement (JAMBA) and/or the China-Australian Migratory Bird Agreement (CAMBA).

Figure 5.7 – Location of SEPP 14 Wetlands

SEPP No. 44 Koala habitat

SEPP No. 44 (SEPP 44 Koala Habitat) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas. The identification of 'core' Koala habitat areas is one of the major aims of this policy. 'Core' Koala habitat is defined as an area with a resident population of Koalas as evidenced by attributes such as females with young, recent sightings and historical records of a Koala population. 'Potential' Koala habitat is defined as areas of native vegetation where Koala feed trees species account for at least 15 per cent of the total number of trees in the upper or lower strata of the tree component. The presence of 'potential' Koala habitat warrants further investigations into whether there is 'core' Koala habitat.

Eucalyptus tereticornis and *E.robusta* are the only Koala feed trees that were recorded in the study area. *E.robusta* was recorded in the western section of the study area in densities less than 15 per cent and is therefore not considered 'potential' or 'core' Koala Habitat. Both *Eucalyptus tereticornis* and *E.robusta* were recorded in the eastern section at densities greater than 15 per cent and are therefore considered 'potential' Koala habitat. Koalas have been sighted within the *Eucalyptus tereticornis* and *E.robusta* trees within the eastern section of the study area and therefore these areas are considered to be 'core' Koala habitat.

5.1.6 Aquatic ecology

The Ecology Lab was commissioned to investigate issues relating to aquatic habitats and fisheries as part of the route options development process.

Aquatic habitat includes a wide range of habitat types such as:

- Marine and estuarine habitats including seagrass, mangroves and saltmarsh (important fish feeding and nursery habitats).
- Freshwater habitats, including wetlands.

The study area crosses a number of freshwater and estuarine habitats, including the Hunter River, Purgatory Creek, an unnamed creek in the central section and Windeyers Creek in the eastern section.

The type and distribution of aquatic habitats throughout the study area are shown in **Figure 5.8**.

Fish habitat classification

The classification of fish habitat ranges from Class 1 (Major Fish Habitat) through to Class 4 (Unlikely Fish Habitat) and is based on the Department of Primary Industries (Fisheries) requirements. Application to the study area is described in **Table 5.6**. Field inspections of the major aquatic habitats within the study area were undertaken in December 2004 and July 2005 by The Ecology Lab.

Figure 5.8 – Aquatic ecology

Table 5.6 – Fish habitat areas

Classification	Watercourse type	Watercourses within the study area	Preferred engineering solution
Class 1 Major fish habitat	• Large river or creek • Permanent flow • 'Critical habitat'	• Hunter River	• Bridge or tunnel only • Single span
Class 2 Moderate fish habitat	• Small-medium stream • Defined channel • Pools or wetlands	• Purgatory Creek • Windeyers Creek • An unnamed creek • A dam	• Large box culverts or bridge
Class 3 Minimal fish habitat	• Named or unnamed stream • Intermittent flow • Potential refuge • Minimal defined channel	• Two freshwater wetlands in the western portion of the study area.	• Culverts designed to allow fish passage
Class 4 Unlikely fish habitat	• Named or unnamed stream • Intermittent flow rain only • No pools after rainfall • No aquatic vegetation	• There are no Class 4 watercourses identified within the study area.	• Causeway, floodway or culvert

Source: DPI (Fisheries)

Threatened species of concern

The Hunter River is habitat for the green sawfish and black cod, which are listed as a Threatened and Protected Species under Part 7A of the *Fisheries Management Act 1994* (FM Act).

Aquatic vegetation

In addition to SEPP 14 wetlands, other aquatic habitats such as mangroves and seagrasses (protected under the FM Act) and saltmarsh vegetation protected under the *Threatened Species Conservation Act 1995* (TSC Act) are known to occur within and/or in proximity to the study area.

There are two threatened aquatic ecological communities (listed under the TSC Act) within the study area:

- Coastal saltmarsh.
- Freshwater wetland complex.

These communities are located on the floodplain areas, along the Hunter River corridor and/or on the western edge of the Tomago Sand Beds.

Fisheries and aquaculture

The Hunter River estuary is an important commercial fishery and supports species including; Mullet; Eastern King and School Prawns and Whiting (Hunter Valley Research Foundation, 2003).

5.1.7 Climate and air quality

Existing environment

A description of the ambient air quality and climatic conditions within the study area has been obtained from Williamtown Royal Australian Air Force (RAAF) Base - Monitoring Station 61078. The records discussed below are based on over 50 years of historical measurements.

Temperature

The study area is subject to a temperate climate, characterised by warm summers and cool winters. During the summer months mean daily maximum temperatures range between 16.5°C and 27.8°C while the winter months experience cold to cool mean daily temperatures between 6.4°C and 16.9°C.

Rainfall

The number of rain days within each month is fairly consistent throughout the year ranging from an average of 9.5 rain days in September to 13 rain days in March. The summer and autumn months typically experience more rainfall compared with the winter and spring months. Historically March has experienced the highest mean rainfall (121.5 millimetres) and September the least amount of mean rainfall (57.4 millimetres). Total mean annual rainfall is about 1120 millimetres.

Humidity

Mean relative humidity is fairly consistent throughout the year ranging between 64 per cent in October and 80 per cent in June for measurements recorded at 9am. The recordings taken at 3pm in August and September are approximately 51 per cent in August and September and 62 per cent in February.

Wind speed

Wind speeds at the Williamtown RAAF Base monitoring station are relatively low ranging between 9.9 km/h in March to 16.3 km/h in August for 9am readings and 15.7 km/h in May to 23.3 km/h in November for 3pm readings.

Mornings (at 9am) in March are historically the calmest periods of the year with calm conditions for 26 per cent of the time. This decreases to a low of 13 per cent in November. In comparison, afternoons (recorded at 3pm) are historically windier with calm conditions occurring for only one per cent in December and January and remaining below 10 per cent for each month for the majority of the year.

Wind direction

The prevailing annual wind direction recorded at 9am is predominantly from the west and north west changing to southerlies and south easterlies by 3pm. Seasonally summer is dominated by southerlies and south easterlies, winter by westerlies and north westerlies, with autumn and spring historically exhibiting variable wind directions.

Local air quality

Air quality is affected by environmental factors such as topography and temperature, as well as anthropogenic factors such as traffic, vehicle type, and the type, height and density of development adjacent to the road. Key air pollutants of concern associated with the development of the upgrade include:

- Carbon monoxide (CO).
- Hydrocarbons (HC).
- Nitrogen oxides (NOx).
- Particulate matter (PM_{10}).
- Lead (pb).
- Dust.

Existing sources of air pollution within the study area include local industry such as the Tomago Aluminium Smelter and vehicle emissions from traffic utilising the existing traffic route roads.

A specialist air quality assessment will be undertaken for the preferred route once it is selected and the results incorporated into the preferred route option report.

5.2 Social and cultural environment

5.2.1 Indigenous heritage

Aboriginal land council areas and native title

The western part of the study area is located within the Mindaribba Local Aboriginal Land Council area whilst the eastern section of the study area is within the Worimi Local Aboriginal Land Council area.

Land within the study area is not subject to any current native title claims. Review of the National Native Title Tribunal Register of Native Title Claims, Schedule of Native Title Applications, National Native Title Register, Register of Indigenous Land Use Agreements and Indigenous Land Use Agreements Notifications show there are:

- No applications for determination of native title, registered or otherwise.
- No Indigenous Land Use Agreements.
- No native title determinations in the vicinity of the study area.

The native title databases will be regularly reviewed throughout all stages of project development.

Historical sites

The study area traverses three physiographic regions, and each of these has a distinctive archaeological sensitivity. The western end of the study area occurs in the East Maitland Hills, the majority of the study area is situated on the Lower Hunter Plain, and the eastern end of the study area is situated on the Tomago Coastal Plain (Matthei 1995). These three sections are referred to as the Black Hill Precinct, the Hunter Floodplain, and the Tomago Sand Beds.

A search of the NSW DEC Aboriginal Heritage Information Management System (AHIMS) was conducted by Biosis Research on Tuesday 26 October 2004. The search area encompassed an area measuring 17 km by 17 km, with the study area central to the search location. The search identified 90 known Aboriginal archaeological sites within the search area, and of these, 18 were located within the study area itself as shown **Figure 5.9**. Kuskie (1997) identified that there is one known site at Black Hill not registered in the DEC AHIMS. Notably, 16 of the 18 sites within the study area were located in the Black Hill Precinct, and two were located in the Tomago Sand Beds, with no previously recorded sites located on the Hunter River Floodplain.

The search results clearly demonstrate that by far the most abundant type of site previously recorded in this section of the Lower Hunter Valley are stone artefact sites. These comprise both isolated stone artefacts and stone artefact scatters, also sometimes referred to as 'open

camp sites.' Scarred Trees are rare (probably due to the amount of land cleared for pastoral activities and industrial development), axe grinding grooves are located where suitable geology – horizontal sandstone outcrop – is found, whilst shell middens are rare in the swamp / estuarine environments around the study area.

The Black Hill precinct

The Black Hill Precinct is an area of high archaeological significance and cultural sensitivity. Over the past 12 years elevated landforms adjacent to the Hexham Swamp have been consistently demonstrated to contain a continuous distribution of artefacts, and sites that contain remarkable densities of stone artefacts. In the study area itself Kuskie (Kuskie 1997, 2002) has shown there is a high occurrence of surface archaeological material, which based on what is known of the area, is indicative of a significant and valuable sub-surface resource. Black Hill area is an area of high cultural and social importance to the Aboriginal community, and this has been demonstrated through the management of previous projects, especially the extension of Lenaghans Drive.

Hunter River floodplain

The Hunter Floodplain is classified as having a low archaeological potential and cultural sensitivity. Existing models of Aboriginal hunter-gatherer occupation of the Lower Hunter suggest that there is not likely to be significant amounts of archaeological material located in this area which is considered to be of low archaeological sensitivity. During an initial site walk over on Friday 3 December 2004, representatives from the Mindaribba and Worimi Local Aboriginal Land Council and Traditional Owner representatives expressed their concern about the floodplain being categorised as an area of low sensitivity because very little work had been conducted there previously. Small areas of vertical differentiation on the floodplain, such as old natural levee banks, may contain potential archaeological resources. The determination of low sensitivity should therefore be considered provisional, and should be tested by systematic surveys as part of the preferred route selection process.

Tomago Sand Beds

The Tomago Sand Beds are classified as having a moderate to high archaeological potential and cultural sensitivity. The section of the study area forms the edge of a Pleistocene dune field, and provides elevated landforms immediately adjacent to the Hunter River floodplain.

This is an indicator that, like Black Hill, the area would have been favourable to Aboriginal occupation, both during the later Pleistocene and the Holocene periods. Reasonably large surface sites, including hearth remains have been found in, and immediately adjacent to, the study area at Raymond Terrace, and these are suggestive of considerable archaeological potential. Whilst the Moffats Swamp material is associated with the special landform case of a lacustrine bordering dune, there is also the potential for very ancient sites to exist within the study area. These may be associated with remnant swamps or drainage lines, however such a hypothesis needs to be tested with field survey. Representatives of the Worimi Local Aboriginal Land Council believe this area to be the most archaeologically sensitive.

5.2.2 Non-indigenous heritage

A search of existing heritage listings, review of historic maps and consultation with local councils and the Raymond Terrace and District Historical Society has been undertaken, identifying the following items of historical interest within the study area. These items are illustrated in **Figure 5.9**.

Figure 5.9 – Indigenous / non indigenous heritage areas

Table 5.7 – Listed heritage items within study area

ID	Item name and description	Location	Listing
037 & 1323	'Kinross', a private residential house including stone shed / outbuildings, landscaping and curtilage.	68 Wahroonga Street, Raymond Terrace (adjacent to Windeyers Creek)	• Port Stephens LEP 2000 • 'Registered' on Register of National Estate
069	Two Moreton Bay Fig Trees (*Ficus macrophylla*), which are significant features in the landscape character of the area.	Pacific Highway, just north of Hank Street	• Port Stephens LEP 2000
1296	The Hunter Estuary Wetlands are internationally significant wetlands and waterbird habitat.	The Hexham Swamp and related SEPP 14 wetlands fall partially within the study area between Black Hill and Hexham.	• 'Registered' on Register of National Estate
N/A	Hannel Family Vault	398B Maitland Road, Hexham	• Newcastle LEP 2003 • National Trust Register
4301049	Hexham Bridge (southbound). Built in 1952, this was one of the last steel truss opening span bridges constructed. Still used for southbound travelling traffic.	Pacific Highway, Hexham	• Newcastle LEP 2003 • S170 Heritage Register (RTA)

Source: Maunsell 2005

The old Hexham Bridge is located outside, but directly adjacent to the study area. The structure was built in 1952 and is listed on the NLEP 2003 and S170 Heritage Register (RTA). This structure was one of the last steel truss opening span bridges constructed and is still in use for southbound travelling traffic.

The Oak Factory located in Hexham at 189 Maitland Road, is also outside, but directly adjacent to the study area and is also listed on the NLEP 2003.

A small number of non-listed items of historical interest have also been identified during the desk-top investigations and site walkover, however due to modification and development within the study area, very little, if any, remains of these items.

5.2.3 Land use

Land use within the study area is characterised by a mix of bushland, rural land, urban settlements, semi-rural holdings, light industrial and commercial premises, tourism operations, transport corridors and utility infrastructure (refer **Figure 5.10**). In a broader context the Lower Hunter Region comprises a range of industries and commercial activities including coal mining and handling, steel production, port activities, agriculture and tourism.

Key commercial centres in the region are Newcastle, Maitland and Cessnock with new employment areas / zones emerging at Thornton Industrial Estate and the F3 Freeway Business

Park at Beresfield. Key commercial centres within the study area are Motto Farm and Heatherbrae, with Beresfield, Tarro, Hexham, Tomago and Raymond Terrace in the immediate surrounds.

Agriculture and fisheries

Rural land uses such as grazing and stock rearing for beef and dairy cattle are practiced throughout the study area. The agricultural land capability is moderate with little land within the study area used for cropping. The majority of land within the study area is situated on river flats, which form part of the Hunter River floodplain.

Agricultural land capability (based upon soil conservation information) within the study area has been mapped using DoP / DNR data. Land is classified as follows:

- The majority of the western section of the study area is classified as 'Suitable for grazing with occasional cultivation' with small pockets which are deemed unsuitable for cultivation.
- The central section, and a section of the eastern end of the study area, is classified as being 'Suitable for regular cultivation'.
- The remainder of the study area in the east is described as 'Suitable for grazing with no cultivation' and pockets comprising an urban area (Heatherbrae) and 'Other', which in this case appears to be drainage lines, swamp or floodplain, and a small area utilised for mining and quarrying.

The Hunter River estuary supports an important commercial and recreational fishery. Commercial prawn trawling is a particularly important activity carried out in the Hunter River.

A major land use in the central section of the study area is stud farms, for the breeding and training of thoroughbred race horses, for re-sale else where including countries such as Japan.

Urban settlement

The following urban settlements are located within the study area:

- Black Hill / Woods Gully and Lenaghan which are low density residential developments adjacent to the existing F3 Freeway with combined populations of around 395 people.
- Beresfield, Woodberry and Thornton are mostly low / medium density residential areas with populations of around 4600, 3400 and 5800 people respectively.
- Tomago is primarily rural, with an aluminium plant (Tomago Aluminium Smelter) and a local population of around 150 people.
- Heatherbrae is mostly a highway-related commercial and industrial area.
- Hexham is a small semi-rural community of around 150 people, with an element of industrial development situated between the Main Northern Railway line and the Hunter River.
- The larger town of Raymond Terrace is situated to the north of the study area with a population of 12,500 people is the major regional centre.

Figure 5.10 – Land use patterns

Industry and employment

The Weathertex factory site, producing modified timber products occupies approximately 10 hectares of land. The factory is situated with a larger parcel owned by the company. The site is bounded by the Pacific Highway to the north and Masonite Road to the east. Vehicular access to the site is from Masonite Road.

Serviced industrial land is proposed on two areas fronting Masonite Road. The proponents of this development are the Weathertex factory owners and Port Stephens Council.

A proposal to build a gas fired power station adjacent to the Pacific Highway between Old Punt Road and Tomago Road was approved in 2003 however construction had not commenced at the time of this report. The proponents of this development are Macquarie Generation.

The Tomago Aluminium Smelter is located to the east of the study area, but is a notable land use occupying approximately 120 hectares east of the Pacific Highway. The smelter is bounded to the south by Tomago Road and provides employment for a large number of people.

The industrial area around Weakleys Drive is located at the northern end of the F3 Freeway and is a significant employment source and further industrial development is proposed at this location.

SEPP 14 wetlands and nature reserves

Six SEPP 14 wetlands are located with the central and western parts of the study area. These wetlands contain a mosaic of critical estuarine and freshwater habitats that are of regional and national importance for a range of amphibian, fish and bird species. SEPP 14 wetland locations are shown in **Figure 5.7** and attributes discussed in **Chapter 8**.

The northern extent of Hexham Nature Reserve (Hexham Swamp Complex) is located within the study area. This Nature Reserve is a gazetted SEPP 14 wetland and listed on the Register of the National Estate.

The Kooragang Nature Reserve is located approximately four km south of the study area, on Kooragang Island.

The Hunter Region Botanic Gardens are situated south of Heatherbrae and comprise 140 hectares of privately run gardens, most of which has been preserved as natural bushland with other plantings developed for recreational, educational and scientific purposes. The Hunter Region Botanic Gardens is a significant tourist and local visitor attraction, year round.

Water catchment

A portion of the eastern section of the study area is Hunter Water Corporation freehold land, located within the Tomago Special Area boundary. This area is described as the Tomago Sand Beds and together with the Tomaree and Stockton Sand Beds, forms a 'GMA'.

5.2.4 Demographics

Household and community structure

Approximately 7300 residents live within the broader study area that encompasses Raymond Terrace, Heatherbrae, Motto Farm, Tomago, Beresfield, Tarro and Woodberry. Analysis of census data indicates that residents reside in just below 3000 households of which the average size is between two and three people. Detached houses are the most common type of dwelling, housing 93 per cent of residents. Residents over 65 years old account for 14 per cent of the local adult population, which is similar to the NSW regional profile. Two per cent of the local residents do not speak English as their first language.

Socio-economic patterns

Of the residents of working age, 30 per cent work full time. The unemployment rate in the area is 13.5 per cent, although this varies between 3.3 and 39.4 per cent for individual census districts. The most common weekly employee income bracket (14 per cent) is $200 to $299. Four per cent of the local population are educated to a bachelor degree level or above, which is lower than the NSW figure of 14.5 per cent. The most common employment sector is retail (19 per cent) and the second most common the manufacturing industry (16 per cent). Residents employed as managers, administrators, professionals and associate professional accounted for 24 per cent of the workforce. Car ownership is high with only 13 per cent of households do not own any form of motorised transport.

5.2.5 Noise and vibration

A number of sensitive receivers are present within the study area and along the existing highway route. These include:

- Residential dwellings.
- Hunter River High School.
- The Hunter Region Botanic Gardens.
- Caravan Parks.

Many of the above receivers are subjected to road traffic noise generated from speed environments less than highway standard through the townships of Motto Farm and Heatherbrae. Heavy vehicles applying exhaust brakes through Heatherbrae on approach to the Masonite Road roundabout would also generate additional road traffic noise which would be particularly noticeable during the night-time hours.

Residential dwellings in Tarro, adjacent to the New England Highway and northern study area boundary experience road traffic noise from vehicles travelling along this stretch of road.

The application of compression or exhaust brakes by heavy vehicles on approach and within the 80 km/h zone at end of the F3 Freeway have been raised as a significant traffic noise issue by Black Hill residents.

5.2.6 Urban design, landscape and visual amenity

The landscape character and visual setting within the study area is greatly influenced by the Hunter River and its floodplain. The floodplain is characterised by open, low-lying farmland, incised by a network of natural/artificial drainage lines. Individual trees, patches of trees wetlands and areas of swampy ground punctuate the floodplain.

The western and eastern edges of the study area are framed by elevated, gently undulating ridges and hill crests. These edges are largely covered by blocks of native vegetation comprising a mosaic of habitats which support a number of threatened flora/fauna species. The urban areas of Black Hill, Motto Farm and Heatherbrae are also situated on this elevated ground contain a range of building types.

The openness of the floodplain is interrupted by a network of transport and utility infrastructure which traverse the central and eastern parts of the study area. The existing Hexham Bridges define the southern boundary of the study area and form a visual barrier along this stretch of the Hunter River.

The existing traffic route also passes through this landscape affording traveller views of the floodplain and river corridor. These traveller views are filtered by landform, native vegetation and intervening development along the F3 Freeway and John Renshaw Drive in the western part of the study area and by urban development at Motto Farm and Heatherbrae. From the

elevated ground in the western and eastern sections of the study area residents at Black Hill, Motto Farm and Heatherbrae experience panoramic views across the floodplain.

There are three primary landscape character zones which determine the visual characteristics within the study area. From west to east, these are as follows:

- Hexham Swamp visual catchment.
- Tarro Swamp/Purgatory Creek/Hunter River floodplain visual catchment.
- Heatherbrae/Hunter River floodplain visual catchment.

The regional visual catchment areas are shown on **Figure 5.11**.

The following sections describe broad vegetation types identified within each visual catchment area. A summary of viewpoints is also provided, as taken from existing major road and rail corridors, residential areas and major infrastructure items.

Figure 5.11 – Regional visual catchment areas

Hexham Swamp visual catchment area

Vegetation types

Hexham Swamp forms a major freshwater wetland complex extending across the Hunter River floodplain providing a range of attractive panoramic views.

Visual assessment from existing major roads and rail

The F3 Freeway to John Renshaw Drive:

This view corridor is limited to immediate views of the native vegetation areas which straddle the F3 Freeway on approach to John Renshaw Drive. The Black Hill urban area is obscured from traveller views by timber noise walls and vegetation screening along the eastern edges of the F3 Freeway.

The New England Highway and Pacific Highway

This stretch of road affords interrupted elevated southern views of the Hunter River floodplain to Hexham Swamp. The northern section of this road is flanked by urban development on the southern edge of Tarro, and features noise walls, and roadside vegetation extending to the junction with the Main Northern Railway line. Elevated views of the Hunter River floodplain are available from the bridge over the Main Northern Railway line, and provide approximately 300 degree wide views from north west to south west.

Main Northern Railway line

Near the Hexham Railway Station, views of the Hunter River corridor and floodplain characterise the northbound carriageway of the Pacific Highway. A set of overhead transmission lines crossover the railway line and continue in a north-east direction across the floodplain. The Main Northern Railway line is slightly elevated above the floodplain. The Pacific Highway passes over the railway line on a concrete bridge with Tarro Railway Station (with Victorian Platform Shelter) within view of the bridge.

Visual assessment from residential areas

Woods Gully/Black Hill Precinct:

To the north east, the visual character comprises the Hunter River with the Pacific Highway and overhead transmission lines in the distance. To the east long-distance views extend across Hexham Swamp to Hexham and Kooragang Island and to the southeast, views extend to Hexham Swamp.

Weakleys Flat Industrial Precinct:

Within this area a range of industrial buildings define the local visual characteristics. This is a major stopping point at the end of the F3 Freeway for refuelling, with fast food chain outlets and an RTA driver reviver centre located on the northbound carriageway of the existing traffic route.

Tarro

Residential properties on the outskirts of Tarro experience panoramic views of the Hunter River floodplain. These views are interrupted by the Pacific Highway and Hexham Bridges to the south, and the Main Northern Railway line to the north and east.

Beresfield

The link road to Woodberry affords good views of the agricultural landscape and wetlands west of the Hunter River. Residential properties on the outskirts of Beresfield experience open views of the floodplain and Hunter River corridor. Intermittently these views are obscured by the Main Northern Railway line to the north and east.

Hexham

The Tomago Village Van Park and Tomago Aluminium Smelter are visible from the northern parts of Hexham. Industrial development at Hexham is located on the edge of the Hunter River and provides a 'gateway' to Newcastle as a major industrial city.

Visual assessment of major infrastructure items

Overhead transmission lines

A set of 330 kV overhead transmission lines are a dominant feature in view from the Pacific Highway and the urban areas at Black Hill and Woods Gully.

Telecommunication Tower

A telecommunication tower located to the south of Tarro is a significant structure in the local landscape.

F3 Freeway overbridge

The overbridge that connects Black Hill to the Woods Gully community is a dominant structure on the F3 Freeway.

Tarro Swamp/Purgatory Creek/Hunter River Floodplain visual catchment area

Vegetation types

Vegetation communities in this region comprise of scattered stands of Swamp Mahogany, including Paperbark Forest and Swamp Oak Rushland Forest located within the Hunter River floodplain.

Visual assessment from existing major roads and rail

Main Northern Railway

The Main Northern Railway line skirts the north eastern edge of Tarro and Beresfield urban areas affording expansive views of the Hunter River floodplain.

Pacific Highway east of the Hunter River to Heatherbrae

Along this section of the Pacific Highway, northerly views, of the Hunter River are obstructed by a dense community of mangroves to the east. The mangroves and wetland areas associated with the river are evident from the Pacific Highway to the west. The area of native vegetation to the east including the Hunter Region Botanic Gardens, define this section of the Pacific Highway. Roadside advertising boards are located on both sides of the highway.

Visual assessment from residential areas

Woodberry

This residential area is characterised by a range of heritage building types and federation style houses. The link road to Woodberry affords views of the local agricultural landscape and the farming characteristic of the township are strongly evident. Residential dwellings on the outskirts of Woodberry have almost 300 degree uninterrupted views of the Hunter River floodplain.

Newcastle

The Hexham Bridges and Pacific Highway connections are visible from the outskirts of Newcastle and form dominant features in the landscape.

Visual assessment of major infrastructure items

Overhead transmission lines

A set of 330 kV overhead transmission lines traverse the Hunter River floodplain with a series of tower structures strung together by sagging cables. This transmission line is a visually dominant feature in the landscape.

Main Northern Railway Bridge

The Main Northern Railway line is elevated up to approximately nine metres above the floodplain in this area and is a dominant structure that can be seen from Tarro Railway Station and the existing traffic route.

Hunter River crossing

The historic steel bridge located north of Hexham contrasts with the relatively new adjacent concrete structure. The concrete structure has a curved horizontal alignment and is not symmetrical about the horizontal or vertical axis. The concrete structure is utilitarian, dominant in the landscape.

Heatherbrae/Hunter River Floodplain visual catchment area

Vegetation types

East of the Pacific Highway, the area is dominated by Costal Sand Apple Blackbutt forest of high visual and ecological value.

Visual assessment from existing major roads and rail

Pacific Highway

The western side of the Pacific Highway through Heatherbrae is framed by *Ficus hillii* trees (18 to 25 years old). The highway forms a north-south 'spine' through Heatherbrae and delineates the residential area to the west and commercial/retail to the east.

Visual assessment from residential areas

Heatherbrae

Residential dwellings located on the northwest edge of the Heatherbrae urban area experience panoramic views of the Hunter River floodplain and the river corridor. Residential dwellings on the western side of the Pacific Highway that do not have floodplain views are visually separated from the highway by the *Ficus hillii* trees and the Hunter River High School grounds.

Visual assessment of major infrastructure items

Overhead transmission line

A 132 kV overhead transmission line is a dominant infrastructure item in the local views for residence on the western edge of Motto Farm / Heatherbrae.

6 Design considerations

Design related matters pertinent to the F3 Freeway to Raymond Terrace project are outlined in this chapter. This chapter provides background information relating to not only the design criteria which must be adhered to, but existing environmental and infrastructure features that would influence design of the project. Ancillary to design are potential construction issues, which have also been briefly summarised. Buildability of a highway upgrade in the study area is a major design consideration and is briefly discussed in this chapter.

6.1 Design criteria

6.1.1 Engineering design criteria

General

Route option designs have been developed in accordance with the RTA's Upgrading the Pacific Highway, Draft Design Guidelines March 2005. In accordance with the draft guidelines, options have been designed to meet the standards of RTA and AUSTROADS publications and Australian Standards applicable to other elements of the design. Where there is discrepancy between design standards, the following order of precedence has been adopted:

- The RTA's Upgrading the Pacific Highway, Draft Design Guidelines March 2005.
- RTA publications.
- AUSTROADS design guidelines
- Australian Standards.
- Standards Australia handbooks.
- Other reference documents and standards.

This project is being designed to 'M Class' standard, which requires the following:

- 110 km/h motorway standard.
- Alternative routes to be made available for local traffic through the provision of service roads or local arterial road networks.

6.1.2 Design life

The development of route options has considered the design life of various highway assets to ensure that a viable engineering solution can be achieved for those options short listed. These design life requirements will continue to be incorporated throughout the route selection and preliminary highway design phase.

6.1.3 Flood immunity

The preferred option design must ensure that the appropriate level of flood immunity, in accordance with the Pacific Highway Route Strategy, is provided. The guidelines require that the pavement wearing surface of at least one carriageway remains above the water level during the design flood event. The guidelines target immunity from a one per cent AEP flood event with a minimum requirement for immunity against a five per cent AEP flood event. Design elevations for a range of flood frequency events were investigated and it was found that levels required to provide immunity against design floods greater than a five per cent AEP flood event, were impractical from a buildability and hydraulic perspective. Consequently five per cent AEP flood events have been adopted and achieved in all route options developed to date.

The incorporation of long term embankment settlements is an important consideration in ensuring that flood immunity is maintained over the projects operation.

In addition, option development has also considered the potential impact on changes to the local water environment, including:

- Existing flooding regime.
- Water levels upstream (afflux).
- Erosion and deposition of debris due to flood events.
- Time and frequency of flood inundation.
- Existing local drainage patterns.
- Velocities.

Engineering treatments would be implemented to mitigate the above impacts to acceptable levels in the refinement of feasible route options and selection of a preferred route.

6.1.4 Noise criteria

Road traffic noise criteria in NSW are based on guidance in the DEC's *Environmental Criteria for Road Traffic Noise (ECRTN 1999)*. The *ECRTN* recommends noise level criteria for various road categories. These noise criteria are 'non-mandatory targets'. The *ECRTN* provides criteria for average noise levels (L_{Aeq}) at residential receivers and other noise sensitive receivers and also addresses maximum noise levels at residences.

The DEC is currently reviewing traffic noise criteria but have indicated that there will be no substantial changes.

Those residents who currently experience little or no road traffic noise are likely to be more affected by traffic noise from traffic on a new road alignment than those residents who currently experience some road traffic noise, and for whom, noise from traffic on a redeveloped road may result in little or no change.

Key noise criteria from the ECRTN guidelines are presented in **Table 6.1**.

Table 6.1 – Noise criteria from ECRTN guidelines

Area	Measurement	Maximum average noise levels (dBA)
Residential		
New Freeway or Arterial Road Corridor	$L_{Aeq,15hr}$ (7.00am-10.00pm)	55
	$L_{Aeq,9hr}$ (10.00pm-7.00am)	50
Redevelopment of Existing Freeway or Arterial Road	$L_{Aeq,15hr}$ (7.00am-10.00pm)	60
	$L_{Aeq,9hr}$ (10.00pm-7.00am)	55
Schools		
Inside Classrooms	$L_{Aeq,1hr}$	45
Playgrounds	$L_{Aeq,1hr}$	55
Parks and Recreational Areas		
Passive recreational areas	$L_{Aeq,15hr}$	55

Area	Measurement	Maximum average noise levels (dBA)
Commercial Premises		
Internal noise level in offices	L_{Aeq}	45

Source; NSW Department of Environment and Conservation (May, 1999)

At those residences where noise levels increase significantly above the *ECRTN* guidelines, noise mitigation would be provided subject to technical practicality, visual considerations, cost effectiveness, previous compensation relating to noise and community support.

The RTA Environmental Noise Management Manual (ENMM) was developed by the RTA in consultation with DEC (the former EPA) and provides detailed procedures for determining whether roads are to be classified as 'new' or as 'upgrade to existing' and whether noise mitigation is reasonable and feasible.

Under ENMM 'acute' operational noise levels are described as those equal to or greater than 65 dB(A) L_{Aeq} (15 hours) (daytime) and 60 dB(A) L_{Aeq} (9 hours) (night-time).

These noise criteria would be considered as part of the investigations undertaken for the development of the preferred route.

6.1.5 Urban design criteria

The Pacific Highway Urban Design Framework (RTA 2005) contains six urban design objectives to assist in the planning and delivery of an urban design vision of this project. These objectives are:

- Provision of a flowing road alignment that is responsive and integrated with the landscape.
- Provision of a well vegetated natural road reserve.
- Provision of an enjoyable interesting highway with varied views and vistas of the landscape and pleasant 'restful' places to stop.
- Value the communities and towns along the road.
- Provision of consistency with variety in road elements.
- Provision of a simplified unobtrusive road design.

These objectives will be incorporated into the development of a road design for the preferred route.

6.2 Road alignment

6.2.1 Vertical alignment

The RTA requirement for flood immunity on the Pacific Highway is, as a minimum, that one carriageway of the project must provide immunity against a five per cent AEP flood event. This requirement sets the minimum design elevation for the project.

As a large proportion of the study area is located on floodplain, any new alignment would need to be raised to achieve minium design levels. Options for raising the alignment include the use of an earth embankment, an elevated structural solution or a combination of the two. A structural solution is only likely to be considered where ground and / or hydrological conditions dictate, however the final solution would be dependant on engineering, environmental, social and economic aspects.

Upper limit design levels are based primarily on minimising the height of embankment which would form a new hydrological flow control across the floodplain. Long elevated structural solutions are limited primarily by economic and aesthetic aspects.

To aid in balancing the fill deficit in earthworks arising from construction across floodplain, the generation of material from a deep cutting through Black Hill is desirable. A cut through this area would also facilitate a smooth vertical transition from the elevated topography of Black Hill onto the floodplain with minimum embankment height. Other benefits of an alignment in cutting at this location would include improved acoustic and urban design/visual impact outcomes.

East of Black Hill, minimum design levels are controlled by the flood immunity criterion discussed above. Due to the floodplain topography, drainage of the highway is likely to be achieved by independently grading drainage works, as opposed to the vertical road alignment.

Approaching the Hunter River, the vertical profile would need to be raised to cross key items of infrastructure including the New England Highway / Main Northern Railway line / Woodlands Close corridor and the above ground north-south section of the CTGWM. Design elevations in these areas would be based on the provision of sufficient vertical clearance, maintenance accessibility and structural member depths. Clearance requirements for key items of interest are summarised in **Table 6.2**.

Table 6.2 – Clearance requirements for key items of interest

Asset	Vertical clearance	Horizontal clearance
CTGWM	Allow for maintenance or provide new section of pipeline	Allow for maintenance or provide new section of pipeline
New England Highway	5.3 metres	-
Main Northern Railway	7.1 metres	-
Woodlands Close	4.6 metres	-
Hunter River	10.0 metres above RL 0.48 metres AHD	30 metre free span
Structure over existing highway	5.3 metres	-

Clearances shown above for the Hunter River crossing are the minimum requirement for navigation. In addition, the vertical profile of the project within proximity of the Hunter River would be determined by the length and elevations required to meet waterway area requirements during design flood events. These specific requirements are discussed in **Chapter 6.3**.

Heatherbrae, Motto Farm and the vegetated area to the south of these settlements are situated well above the five per cent AEP flood event levels. Consequently options utilising the existing Pacific Highway or passing to the south of these settlements could be constructed near existing surface levels.

Options within a corridor north of Heatherbrae would be constructed on floodplain and would require elevating by construction on an earth embankment or bridge structure. Minimum design levels would be controlled by the flood immunity criterion.

6.3 Hydrology and hydraulics

Hydrological and hydraulic investigations have been carried out by WBM Oceanics in two key stages. Stage 1 (**Chapter 7.2**) has been completed and involved a review of flood existing modelling and historical studies of the Hunter River floodplain to develop and understanding of

historical flood patterns and the potential impact of the project. Stage 2 is in progress (refer to **Chapter 7.2**) and involves the construction and application of a two dimensional Tuflow model to simulate key flood event scenarios (i.e. one per cent AEP and five per cent AEP) between Green Rocks and the mouth of the Hunter River.

6.3.1 Flood level considerations

The Lower Hunter River Flood Study - Green Rocks to Newcastle (PWD, 1994) identified that during design flood events in excess of the 20 per cent AEP, a significant proportion of the flood flow within the study area would be conveyed along the eastern floodplain of the Hunter River. It was estimated that the proportion of the flow conveyed within the eastern floodplain would vary between approximately 28 per cent for the 10 per cent AEP design event to 60 per cent for the one per cent AEP design event (PWD, 1994).

While the construction of the project across the floodplain has the potential to act as a significant flow control for flooding the provision of structures in place of embankment will ensure upstream water levels (afflux) are mitigated to acceptable levels (no increase in inundation).

Route options that minimise the proportion of impeded flood flows would assist in minimising the impact on upstream flood levels.

In addition to afflux considerations, the designs address the changes in flow velocities resulting from the redistribution of flood waters. The critical areas for changes in flood velocities are in the vicinity of culverts/bridges where flow is rapidly contracting and expanding (high velocities requiring scour protection or velocities reduced to acceptable levels through design) and between bridges (low velocity) where sediment and debris conveyed by the flood waters may be deposited.

6.3.2 Positioning culverts and bridges

The spacing of the major bridges/culverts would also consider maximum velocity criteria to minimise the potential for scouring of the floodplain adjacent to the lateral crossings.

The location of short listed route options minimises the impact on the existing local drainage network within the floodplain. Transverse drainage flows across the road alignment will be facilitated via appropriately sized culvert/bridge structures to minimise potential impacts on the local water environment. Due to the relative flatness of the floodplain, construction of any re-aligned/regraded drains will be carefully undertaken to ensure the maintenance of the current drainage regime. Any change to drainage functions could potentially impact land use activities and properties on the floodplain.

Major bridge/culvert structures have been positioned where possible to address flooding and drainage.

6.3.3 River geomorphology

Continued development within the Hunter River catchment may impact existing flow regimes and river geomorphology through the introduction of greater areas of impervious surfaces and increased run off velocities entering the local water environment. For example the levee banks along the river upstream of Hexham Bridges are believed to have led to increased flow velocities during flood events and scouring on the outer edges of the river banks.

The location of the new Hunter River crossings, consider the dynamic behaviour of the river and potential for changes in the river alignment.

6.3.4 Water quality

The principle hazard posed to water quality during major flooding arises from soil disturbance activities and the influx of suspended sediments into the local water environment by surface water run off. Increased flow velocities within some sections of the floodplain and the river may potentially increase soil erosion and deposition rates, contributing to increased levels of total suspended solids and other related water quality parameters in the local water environment. Reduced velocities in some areas may result in increased deposition of sediment and debris within the floodplain upstream of the highway during major flood events.

During more frequent storm events, highway run off may also potentially convey stormwater pollutants including Total Suspended Sediment (TSS), nutrients, hydrocarbons, litter, organic debris, sediment, oils and greases, heavy metals and other common pollutants into the local water environment. Installing appropriate stormwater treatment controls along the highway using grass filtering systems would assist with minimising the potential impacts from the project on water quality within the Hunter River and other waterways during these frequent events.

6.4 Geotechnical considerations

To provide an appropriate level of flood immunity, a length of any alignment constructed across the low lying Hunter River floodplain would require elevating. Normally this is achieved through construction of an earth embankment which, when constructed on the deep and soft alluvial deposits of the floodplain, leads to a number of key engineering issues:

- Large time dependent embankment settlements resulting in unacceptable deformation of the road surface during the operational phase of the project. This is particularly an issue with differential settlements at the interface of embankment and bridge structures and also for ensuring that flood immunity is maintained.
- Low bearing capacities, restricting the steepness of embankment batter slopes and height unless stabilization measures are introduced. This issue also impacts the viability of preloading or surcharging soft ground prior to formation of the permanent earthworks.

6.4.1 Geotechnical conditions

Key geotechnical issues considered in the elevated terrain of the Black Hill area (Domain A) include the presence of expansive residual clays which may require stabilisation before reuse elsewhere in the project as fill material, or insitu stabilisation if a pavement were to be constructed upon this material.

The batter slopes of a cut formation (to lower the road below existing surface levels) are likely to be formed at shallow angles (2:1 or 3:1 horizontal to vertical slope) within this domain, due to the presence of a deep weathered bedrock profile.

Ground subsidence arising from movement or collapse of disused underground mines is a potential issue for highway development through Domain A. The potential for mine shafts has been identified in this area and further investigation to quantify the extent and potential remediation that may be required to stabilise these voids, if present, is underway.

East of Black Hill and north of the existing Pacific Highway, the soft alluvial/estuarine soils of the Hunter River floodplain vary in depth and consistency. These areas include Domains B1, B2 and C and are summarised below.

Between Black Hill and Woodlands Close (Domain B1) soft alluvial/estuarine soft soils generally vary between five to ten metres in depth and directly overlie bedrock. East of Woodlands Close (Domain B2) soft alluvial soils up to 35 metres deep have been encountered during recent investigations and generally, also directly overlie bedrock.

East from approximately one to 1.5 km west of where the Hunter River crosses the northern part of the study area, and north of the existing Pacific Highway, sands and gravels underlie soft soils (Domain C) and depths to bedrock of up to 60 metres have been recorded. While the presence of sands and gravels will aid in the consolidation of the soft clays above, through the provision of a drainage layer, the depth of soft soil presents a significant engineering constraint.

While the degree of constraint to project development through Domains B1, B2 and C varies, the constraint is common and relates to construction of embankment on deep soft soils. The issues primarily relate to time dependent settlement and bearing capacity. Ground treatment options, summarised in **Table 6.3** have been considered in the development of route options traversing these domains.

Any Hunter River crossing within the study area is likely to be located within an area of deep soft soil of estuarine origin. The use of deep foundations and a structural approach span in place of an approach embankment would provide a viable engineering solution to excessive and time dependent settlement issues.

Within the immediate vicinity and to the south of Heatherbrae (Domain D) Aeolian (wind deposited) sand deposits are present and extend to depths of approximately 20 to 40 metres and potentially overly soft clays with total soil depths to 80 metres. The sand stratum is generally loosely deposited, and settlements resulting from highway construction, will occur immediately. Highway construction would be unlikely to impose stresses of sufficient magnitude to result in settlement from the underlying deep clay deposits. Domain D does not present a significant engineering constraint to route option development.

Near the eastern extent of the study area soft ground associated with Windeyers Creek east of the Masonite Road roundabout creates a significant constraint for route options passing to the east or west of Heatherbrae. Options passing to the south of Heatherbrae can avoid the poor ground conditions by connecting with Raymond Terrace Bypass west of the creek. An option through Heatherbrae would utilise the Raymond Terrace Bypass and avoid this soft ground.

6.4.2 Ground treatment options

All route options passing over the floodplain on embankment would require varying degrees of ground treatment and/or utilisation of lightweight fills, to ensure that settlement criteria are achieved and an acceptable factor of safety against embankment failure is achieved during the operational phase of the project.

A number of potential treatments for construction of embankments on soft soils are available as shown in **Table 6.3**.

Table 6.3 – Potential treatments on soft soils

Treatment	Method	Advantages	Disadvantages
Preloading	Early placement of embankment material to induce settlements prior to operational phase.	• Reduces settlements during operation phase. • Inexpensive if fill material is readily available.	• Planning and duration required (years). • Material required early. • Limited strength gain in foundation material without other treatment.
Vertical Drainage (wick drains)	Placement of vertical drainage reduces pore water drainage path and consolidation times.	• Accelerates consolidation settlements. • Increased rate of strength gain	• Potential impact upon hydrogeology. • High material and installation costs.

Treatment	Method	Advantages	Disadvantages
		(relative to preload alone).	
Lightweight Fills	Utilisation of a lightweight embankment material reduces ground contact stress and resulting settlements.	• Reduces total settlement. • Reduces instability. • Rapid construction.	• High cost. • Potential buoyancy and environmental impact.
Piled raft	Partial structural solution transferring vertical loads to lower levels through a combination of a raft foundation and the use of piles.	• Reduces settlement. • Significantly reduces instability issues. • Limited footprint leading to a possible reduction in land requirements. • Overall time reduction.	• High cost. • Availability of low cost (timber) piles may be an issue.
Piled Viaduct	Full structural solution transferring vertical loads to competent material at depth.	• Negligible settlement. • No stability impact. • Minimal surface drainage impact. • Possible reduction in land requirements. • Overall time reduction.	• Very high cost. • Deep foundations difficulties.
Flattening Batters	Flatter batter angle of embankment improves stability.	• Reduces stability impact. • Inexpensive.	• Larger footprint. • Increased fill quantities.
Geotextile reinforcement	Synthetic material providing tensile reinforcement against horizontal strains in the lower part of an embankment.	• Improve stability. • Inexpensive (relative to piled solutions). • Possible reduction in land requirements.	• Greater control over fill material required. • Limited reduction in overall settlement.

Each of above treatments has been considered in the development of route options.

6.5 Property and landuse impacts

Property impacts can be classified under two categories as follows:

- Direct impact where acquisition would be required.
- Indirect impact where acquisition would not be required, but amenity (noise, visual and accessibility/connectivity considerations) would be affected.

A description of land use and property types, within the study area is provided in **Chapter 5.2.3.**

Floodplain within the study area is utilised for agricultural purposes and land parcels are typically large. In considering alignments that sever properties, the potential impact on land uses and maintenance of connectivity between land parcels has been considered.

Within the floodplain, the elevation of the highway alignment required to achieve flood immunity is unlikely to be sufficient to satisfy the vertical clearance requirements for an underpass. Subsequently, consideration has been given to raising the highway alignment where underpasses are required.

An important consideration in route options development was therefore the number of parcels of land severed, the type of land use affected and the number and viability of overpass/underpass structures required. This is particularly evident to the north of Heatherbrae where stud farms and equestrian facilities are located. Land parcels in this area are typically narrow and stretch from the northern side of Heatherbrae to the Hunter River. The provision of under or overpasses within the floodplain is complicated by soft ground conditions.

In addition to severance and connectivity issues, visual amenity and noise impacts are also an important consideration in route options development. The residential areas on the northern side of Heatherbrae and at Black Hill enjoy expansive views from their elevated locations across the floodplain.

The existing highway passes through Motto Farm and Heatherbrae and provides the opportunity to investigate upgrading to M Class standard. The majority of property impacts would be indirect (i.e. noise and vehicular emissions), although some direct impact (i.e. land acquisition) could result from the requirement to meet the M Class design standard, and to provide sufficient width for an option through this area.

Where the ECRTN is exceeded, indirect impacts could be mitigated through the use of architectural treatments to treat noise and the provision of an overpass structure to maintain connectivity between the already divided northern residential area and the primarily commercial southern area. Local access would be maintained on either side of the existing highway through the provision of service roads.

Other major community land uses within the study area include the Hunter Region Botanic Gardens and Hunter River High School. Both these land uses have been considered a constraint in option development. Connectivity between the high school and its population catchment at Raymond Terrace is however a consideration, particularly for options that pass to the north of Heatherbrae

6.6 Existing major infrastructure and utilities

6.6.1 Main Northern Railway, New England Highway and Woodlands Close

All route options would cross Woodlands Close (sealed or unsealed sections), the Main Northern Railway line and the New England Highway. It is likely that the crossing of this infrastructure would be achieved using one structure due to their close proximity. A crossing of this infrastructure in the southern half of the study area would present the narrowest corridor and could be integrated with a new structure required over the Hunter River.

6.6.2 Chichester Trunk Gravitation Water Main (CTGWM)

All route options would cross a north south section of the CTGWM, which is currently above ground at this location. Hunter Water Corporation plans to re-route this section of the pipeline underground and to install an additional trunk water main between Tomago and Tarro. These developments will need to be undertaken in conjunction with project planning, design and construction.

As the finished surface level of the road will be above the CTGWM, a culvert structure may be needed to protect the pipeline and provide adequate access for maintenance purposes. Alternatively a maintenance free and/or second capped pipeline may be installed within the preferred route corridor.

Three parallel 500 millimetre trunk water mains transverse the eastern section of the study area, running south from the Masonite Road roundabout. Treatment will be subject to the depth of burial of the pipeline, maintenance and minimum cover requirements.

6.6.3 High voltage overhead transmission lines (330 kV)

All route options would pass under a set of existing 330 kV TransGrid overhead transmission lines.

Options that pass under these overhead transmission lines close to the F3 Freeway take off point will meet vertical clearance requirements already in place for the F3 Freeway crossing. Route options that depart the F3 Freeway within the southern half of the study area would be required to pass under the overhead transmission lines at Black Hill or at locations on the Hunter River floodplain.

Any crossing of these overhead on the floodplain will incur clearance difficulties as the road elevation must achieve the minimum design levels for flood immunity. In addition, embankment construction on soft ground has potential to result in unacceptable vertical and lateral movement of soils supporting the transmission towers. Passing underneath the transmission lines near the Hunter River will also constrain the vertical alignment on the approach to the river crossing.

Route options that cross the overhead transmission lines in the Black Hill area will be in shallow cut or at grade, and will present the greatest opportunity to achieve the minimum 12 metres vertical clearance required by TransGrid between the project and the overhead transmission lines. Route options in this area benefit from more favourable ground conditions than those encountered on the Hunter River floodplain where potential lateral and vertical deformation of the towers is greater. Road construction in this area would be within close proximity of the transmission towers.

Raising transmission line towers to achieve the required clearance will be avoided where possible, to minimise cost and the potential temporary loss of service.

6.6.4 High voltage overhead transmission lines (132 kV)

Similar issues to the 330 kV TransGrid transmission lines are anticipated for the 132 kV Energy Australia transmission line which crosses the study area in an east west direction passing the Hunter Region Botanic Gardens. These issues relate to obtaining adequate vertical clearance while meeting the minimum road design levels to satisfy the design flood immunity and the disturbance of transmission tower foundations as a result of adjacent project earthworks on anticipated soft soils.

Route options that pass near the southern boundary of the study area in the vicinity of this transmission line (near the Hunter Region Botanic Gardens) will be on higher ground and not be subject to the potential overhead clearance constraints associated with achieving flood immunity.

6.6.5 Low voltage overhead transmission lines

A route option through Heatherbrae would require relocation and/or burial of the low voltage overhead transmission lines located adjacent to the existing Pacific Highway.

Transmission lines are located on both sides of Woodlands Close would require burial or realignment and protection within the project corridor. Specific treatment options would depend on the type of structure adopted to cross the road.

The substation located to the south east of the Masonite Road roundabout would be avoided through geometric design. A route option to the east of Heatherbrae would require under passing or burial of the overhead transmission lines that cross the study area between Windeyers Creek and the substation.

6.6.6 High voltage underground electricity cables

Underground electricity cables that may be affected by the project are located within Heatherbrae adjacent to the existing Pacific Highway, along Masonite Road and Woodlands Close in the central part of the study area. Appropriate treatments as agreed with the requirements of the utility provider would be implemented where the project would cross these cables.

6.6.7 Gas

Although all route options within the study area would pass over the buried Tarro to Hexham high pressure buried secondary gas main which runs parallel to Woodlands Close, it is unlikely to generate significant issues and treatment would be addressed based on the elevation of the pipe and cover requirements.

The network of low pressure polyethylene gas mains located in the Heatherbrae area along Masonite Road and the existing Pacific Highway would be treated, if affected by a route option in accordance with the utility provider.

6.6.8 Telecommunications

The Visionstream, Telstra and Optus fibre optic cables would be overpassed with the structure over the Woodlands Close/Main Northern Railway/New England Highway infrastructure corridor.

Telstra fibre optic cables are also located in the Heatherbrae and Motto Farm areas adjacent to the existing Pacific Highway and Masonite Road. Where an alignment must cross, or be constructed over major fibre optic cables, appropriate road construction techniques, protective measures and design treatments would be implemented.

6.7 Construction issues

6.7.1 Highway construction staging

Route options that utilise the existing Pacific Highway, such as an option through Heatherbrae will require detailed consideration during construction staging. This is likely to result in traffic delays during construction.

Route options that duplicate the existing highway may also require construction staging and result in temporary traffic disruption.

Ground treatment would be required for sections of highway constructed on embankment traversing soft soil deposits on the floodplain to accelerate ground movements. Treatment options being considered include the early placement of embankment material which may be several years prior to the main construction works. A temporary embankment, with an elevation higher than the finished height of the permanent embankment (surcharge) would also be considered.

While these procedures will not affect traffic, they will require consideration of the material source for the embankment and also, the potential impacts of hydraulic flow control,

particularly if a surcharged embankment is utilised. Measures that may be deployed to mitigate these effects include a moving surcharge, to aid reducing the amount of fill material required while also minimising the extent of the temporary hydraulic flow control.

Any potential construction activities carried out during prawn trawling season (October to May), would avoid obstructing the passage of trawlers and recreational fishing craft on the Hunter River.

6.7.2 Construction materials

The construction of route options across the Hunter River floodplain involving sections of embankment would require a substantial volume of material. To minimise potential ground disturbances embankment sections across part of the floodplain could be constructed on the existing ground surface, with minimal topsoil stripping.

Elevated terrain at Black Hill provides an opportunity to construct the project in cutting and preliminary estimates indicate that this could yield sufficient volume to approximately balance earthworks. Preliminary geotechnical investigations indicate that this material is likely to be suitable for the lower portion of the embankment formation.

Alternative sources of fill material include overburden from various open cut mines within the Hunter Region, or dredging activities within the Hunter River. Select material, required within the upper zones of the embankment formation and for the pavement sub grade would need to be imported from quarries within the region.

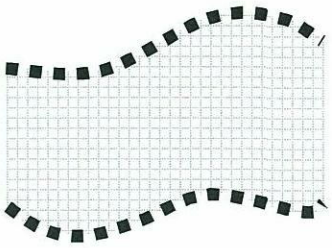
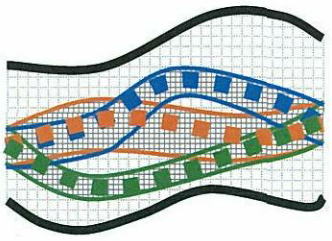
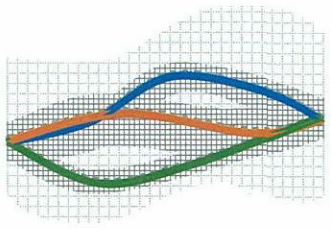
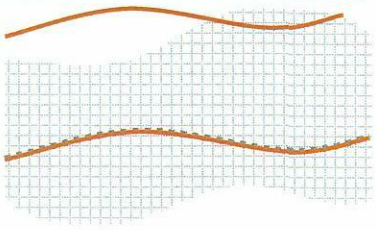
7 Development of route options

This chapter provides an overview of the route options development and evaluation process, from the development of an initial long list of route options through to the selection of feasible route options for public exhibition. A brief description of the route options is also provided and supplemented by accompanying figures.

7.1 Route options development process

The route option development process is presented in **Figure 7.1**.

Figure 7.1 – Overview of route option development process

Study Process Stage 1	*Multi Criteria Assessment Phase 1*	***1. Study Area Familiarisation*** • Project and study area familiarisation. • Data collection and constraint mapping. • Identification of key constraints.	
Study Process Stage 2	*Multi Criteria Assessment Phase 1*	***2. Preliminary Route Option Development - Corridor Identification*** • Establish preliminary routes (long list) and alignment corridors. • Conduct Phase 1 MCA broad assessment on options. • Eliminate unfeasible options. • Refine number and scope of shortlisted options resulting in the identification of feasible routes.	
	Multi Criteria Assessment Phase 2	***3. Feasible Route Option Development*** • Further investigation of feasible routes. • Quantify the inputs for detailed Phase 2 MCA on feasible routes.	
		4. Selection of a Preferred Route • Value Management studies. • Undertake detailed Phase 2 MCA.	

(Source: Maunsell 2004)

7.2 Assessment criteria

Route options identified for the project are being assessed through a Multi Criteria Assessment (MCA) framework which comprises an agreed set of evaluation criteria and performance measures developed specifically for this project.

MCA is a systematic process that facilitates the development and comparison of route options and will ultimately assist with the selection of the preferred route. This type of comparative analysis reflects the conformance of each route option against the stated objectives, in this case, the Pacific Highway Upgrading Program and Project specific objectives.

The MCA process is being implemented in two phases as follows:

7.2.1 Phase 1 broad assessment

This involves the utilisation of broad evaluation criteria and performance measures to coarsely sieve options and eliminate options with 'fundamental flaws' or those that do not meet the criteria and stated objectives.

The Phase 1 assessment, has been undertaken to short list and determine feasible route options that will be proceeding to the preferred route selection stage and is presented in this report.

7.2.2 Phase 2 detailed assessment

Further evaluation will be conducted against a more comprehensive set of criteria on a limited number of options. This provides the opportunity for a more robust assessment to be conducted on those options short-listed as potentially viable and feasible alternatives. The Phase 2 assessment will result in the recommendation of a preferred route for consideration by the Minister for Roads.

This comparative approach enables greater focus to be given to the feasible route options identified and saves complex assessment processes to quantify the significance of impacts.

The evaluation criteria developed for this project include both qualitative factors such as potential environmental and social impacts and qualitative factors such as project costs for route lengths. Primarily these criteria are based on:

- The Pacific Highway Upgrading Program and project specific objectives.
- Issues raised in the community involvement process to date (i.e. June 2005).
- Consideration of relevant statutory requirements and policy guidelines in relation to environmental issues

The baseline environmental studies carried out in Phase 1 and initial results from some Phase 2 specialist studies have been used to provide preliminary input for the MCA and are presented in Appendix B. At this stage no conclusions about the preferred route option have been made.

7.3 Study area familiarisation

7.3.1 Information collation and review

Since the announcement of the upgrade in October 2004, identification and documentation of constraints within the study area has been ongoing. Prior to the initiation of the preliminary specialist field investigations listed in **Chapter 1.3**, a desk top analysis was conducted collating information from key government agencies, local councils and other stakeholders on landuse, flora and fauna, waterways and flooding, ground conditions and cultural heritage. This information was reviewed and presented using geographical information software to identify broad route option corridors within the study area.

7.3.2 Constraints identification and mapping

Constraint mapping has been updated and incorporated into the route option development process as Phase 1 specialist field investigations have been completed. Key data sets that were reviewed and utilised during the identification of constraints included:

- 1:25,000 scale topographical maps
- Aerial photography that was flown in March 2004.
- Records held by the Department of Environment and Conservation in relation to flora and fauna, heritage.
- Records held by the Department of Planning and Department of Natural Resources for soils, SEPP 14 wetlands, SEPP 44 Koala habitat.
- Records held by the Department of Primary Industries for geology.
- LEPs for Newcastle, Maitland and Port Stephens.
- Other relevant reports and mapping held by local councils.

An overview of identified constraints within the study area is provided in **Figure 7.2**.

Within the western section of the study area, route options are physically bounded to the north by the settlements of Tarro and Beresfield, and to the south by the development within Black Hill. The resulting corridor and minimum desirable road design horizontal radius (750 metres) provide for a limited number of options through this area.

7.3.3 Context

Between Black Hill and the Hunter River, a number of route options are geometrically possible. The horizontal alignment of potential options within this area is driven primarily by avoidance of the Glenrowan homestead, the northern extents of Hexham Swamp, isolated areas of SEPP 14 wetlands and the approach to cross the Hunter River in desirable locations. An alignment in this area also needs to be sufficiently offset from the high voltage overhead transmission lines to ensure adequate safety for road users and to avoid deformation of the towers from ground movements induced by highway construction.

The Hunter River is located within the central part of the study area, meandering in an 'S' configuration with a significant proportion of the river aligned parallel with the existing Pacific Highway. Near the northern and southern boundaries of the study area, the river is approximately orthogonal to the existing highway, presenting opportunities for a more optimal crossing of the waterway. A perpendicular river crossing would minimise the number of piers in the water, length through adjacent wetland and length of construction over water. It is noted that a number of other significant factors influence the optimal Hunter River crossing locations and include hydrological, environmental, urban design, social and economic consideration. These issues are discussed under the relevant sections of this report.

East of the Hunter River, the study area forms a 'bulb' around the settlements of Motto Farm and Heatherbrae, facilitating three broad corridors for options located north, south or through these settlements.

South of Motto Farm and Heatherbrae, the Hunter Region Botanic Gardens, freshwater wetlands and Koala habitat would be key considerations for an option through this area. Severance and fragmentation of native vegetation would also be an important consideration.

North of Heatherbrae, an eastern option would connect into the existing Raymond Terrace Bypass at Masonite Road. Highway service related business interests at Motto Farm / Heatherbrae and the capacity of the Masonite Road roundabout to accommodate projected traffic volumes would be key factors.

7.4 Corridor identification

The project team held a route options workshop in December 2004, to enable the team's various specialist consultants to present their findings from Phase 1 studies and to present newly identified project constraints. During the workshop, these findings were integrated with the preliminary constraint analysis and a long-list of initial route options were generated within the study area. Following the workshop, the options were reviewed to ensure that minimum design criteria, such as horizontal radii, were achieved.

In conjunction with the study team generating options, the clg participated in a workshop during January 2005 to also identify potential routes as discussed in **Chapter 3**. The routes identified during this workshop are shown in **Figure 7.2**.

The set of route options produced during the project team workshop in December 2004 was augmented by those produced by the clg workshop in February 2005. This resulted in 14 route options being considered that represented geometrically viable options within the study area. Every attempt was made to avoid direct or minimise contact with environmentally sensitive areas such as SEPP 14 wetlands, where practicable.

These options formed the basis for identification of broad corridors which are shown in **Figure 7.3**. Through the central section routes could pass either to the north or south of the Hunter River and in the eastern section, corridors include to the north, south and through the centre of Heatherbrae.

Figure 7.2 – CLG route options

Figure 7.3 – Preliminary route corridors

7.4.1 Expanded study area

A combination of community feedback, clg generated options to the south of the study area and investigations conducted as part of the route options development process led to the expansion of the study area which was announced in April 2005. The study area expansion allowed the consideration of options within a corridor to the south of the Hunter River.

7.4.2 Eliminated routes

Route options passing through Hexham Swamp, either utilising the abandoned railway corridor, or passing through the wetland itself were rejected on sensitive environmental grounds through consultation with the relevant government agencies and stakeholders. However, a route option utilising the existing Pacific Highway immediately to the east of the Hunter River crossing was considered potentially viable and one that would be subject to further assessment.

A further study area expansion to incorporate a route option passing further to the east of Heatherbrae was also considered. A route option through this region would pass through the central area of the Tomago GMA, which is discussed in **Chapter 5.1.3**. A preliminary investigation into the viability of this option, including discussions with Hunter Water Corporation indicated that the option would not be feasible due to groundwater management, native vegetation and flora and fauna issues.

7.5 Route identification

A Phase 1 assessment was performed on the long list of 14 route options. The outcome of this assessment was three short listed route options as shown in **Figure 7.4**. Preliminary vertical alignments for these three options were generated to enable further assessment.

7.5.1 Refinement of options

Further information from specialist investigations arising from the Phase 2 specialist studies, together with ongoing discussions and site visits with key stakeholders and government agencies instigated a revised application of the Phase 1 MCA on the short listed options.

A key aspect of the Phase 2 specialist studies was the quantification of the potential impacts on flooding, and the waterway areas required to mitigate upstream effects on Options A, B and C. The investigation indicated that a significant proportion of an alignment traversing the central section of the floodplain, north of the Hunter River and/or to north of Heatherbrae, would be required to allow for the passage of floodwaters.

The construction of route options across the Hunter River floodplain on embankment would require a substantial volume of material. Preliminary investigations indicate that an alignment similar to Option C would require approximately 1.2 million cubic metres of fill material to cross the floodplain along the northern study area boundary.

Further, preliminary results from geotechnical ground investigations were also reviewed, indicating the nature and extent of soft soils through the central part of the floodplain and in the area around Windeyers Creek, north of the existing highway. Land use, severance and amenity issues were also incorporated in the revised Phase 1 assessment.

After further assessment, Option C was abandoned due to the length of bridging required for flood management, the amount of imported fill material required and the high cost of construction over extensive lengths of floodplain. Option C performed at a level below that of options already abandoned.

This further assessment confirmed options A and B as the only options suitable for further development. The refined options are shown in **Figure 7.5**. These two options have been shortlisted to proceed to public exhibition.

Figure 7.4 – Shortlisted route options

Figure 7.5 – Feasible route options

8 Comparison of feasible options

A comparison between the two feasible options is provided below. **Appendix A** details the preliminary inputs for the Stage 2 MCA.

8.1 Engineering considerations

8.1.1 Major structures

Option A would involve a 1.2 km crossing at the CTGWM, Woodlands Close, New England Highway, Main Northern Railway line and Purgatory Creek within a 1.2 km stretch. A single structure would be used to span the Main Northern Railway line and New England Highway, while culverts would be utilised to cross the CTGWM and Purgatory Creek.

The Woodlands Close crossing may be integrated with the bridge structure, over the New England Highway and the Main Northern Railway line, or a culvert structure may be used.

Option A would cross the Hunter River near the existing 330 kV overhead transmission line crossing. Within Heatherbrae an overpass structure would be required to connect the service roads on the north and south side of the settlement.

A structure spanning SEPP 14 wetland No. 832 will be required for Option A, which could also provide for fauna movements and transverse drainage flows.

Option B presents the opportunity to cross the Main Northern Railway line, New England Highway and the Hunter River with one long structure approximately 800 metres long.

A structure over Masonite Road for Option B would be integrated with an interchange and is discussed below.

8.1.2 Overpass and interchanges

Both Options A and B would require structures over the existing highway at the southern and northern tie in points, i.e. at the F3 Freeway and near Masonite Road roundabout.

An interchange at Black Hill would enable northbound traffic on the F3 Freeway to exit the motorway prior to the upgrade carriageway, via the remaining length of the F3 Freeway to the John Renshaw Drive roundabout. Provision for traffic travelling south from the John Renshaw Drive roundabout via the F3 Freeway would also be provided with a structure over or under the upgrade carriageways.

For Option A an opportunity exists to provide a partial interchange at the F3 Freeway and a complementary partial interchange at the New England Highway / Option A intersection between the Main Northern Railway line and the Hunter River. This interchange would enable traffic on the New England Highway to enter the northbound carriageway of Option A, and also to enable traffic travelling on the southbound carriageway to exit onto the New England Highway. A full interchange may be provided at Black Hill instead of the partial New England Highway interchange. The additional interchange arms would include a northbound onload ramp and a southbound offload ramp. The final interchange arrangement has not yet been determined and is subject to further studies.

For Option A, access to the existing Tomago Road intersection would be via the existing local road network. Local traffic on the existing Pacific Highway would merge with the upgrade north of the Hunter Region Botanic Gardens.

A partial interchange option at Tomago Road would be considered for Option B, to accommodate traffic movements to Newcastle Airport and Newcastle Port. A structure would be provided to enable the upgrade carriageways to pass over/under the existing highway.

Option A would require a structure over the existing Masonite Road roundabout and would be integrated with a full interchange providing north and southbound on and offload ramps.

Option B would require a structure over Masonite Road, south of the existing roundabout. This structure would be integrated with a full interchange providing north and southbound on and offload ramps. The existing highway between the Masonite Road roundabout and the upgrade connection into the Raymond Terrace Bypass would become redundant.

8.1.3 Hydrology

For Option A, preliminary modelling indicates that an opening of two to three km will be required to limit afflux to acceptable levels (50 millimetres) during a five per cent AEP flood event. This length of opening is likely to be achieved through a combination of an extension to the proposed bridge structure over the Hunter River to the west through the central open floodplain and the use of culverts to provide openings further to the west.

For Option A the structure over the Main Northern Railway line, New England Highway and Woodlands Close could not be utilised in accounting for the waterway area required as the elevation of this existing infrastructure is at or above the five per cent AEP level in this area.

Option B crosses the Hunter River near the existing constriction at the Hexham bridges. Preliminary modelling indicates that an opening of 1.5 to 2.5 km will be required to achieve an acceptable afflux (50 millimetres) during a five per cent AEP flood event. This length of opening will be achieved by extension to the proposed bridge structure over the New England Highway/Main Northern Railway/Hunter River crossing to also span part of the floodplain west of Hexham and culverts/bridges to the west.

The structure utilised for Option B, spanning both the infrastructure corridor and the Hunter River would also provide for the majority of waterway area required. This is due to the low elevation of the infrastructure at this location and the presence of an existing hydraulic construction.

All culverts required for both options will be designed to provide adequate waterway areas for drainage flows and would also for fauna movements.

8.1.4 Ground conditions

Option A traverses approximately 6.2 km of soft soil. While the need to satisfy waterway requirements, a long structure, avoiding embankments, a significant proportion of the route options would be constructed in the vicinity of Purgatory creek, where some of the deepest soft soils have been encountered during Phase 2 geotechnical investigations.

Ground conditions on the existing highway through Motto Farm and Heatherbrae will present little constraint to the project.

Option B traverses approximately 5.3 km of soft soils, which are predominately located west of the Hunter River. Part of this section will be spanned in structure to meet waterway requirements discussed above. East of the Hunter River, Option B would be constructed on the geological boundary of soft alluvial soils and the Aeolian sand deposit of the Tomago Sand Beds. The constraint to the project along this section of the route will depend on the nature of the transition and precise location of these two soil units. It is likely that the construction of a new embankment adjacent to the existing highway embankment will present a moderate constraint.

South of Heatherbrae, Option B will traverse the western edge of Tomago Sand Beds and no significant constraints related to ground conditions are anticipated.

8.2 Environmental considerations

8.2.1 Terrestrial ecology

Vegetation communities

Option A crosses a number of vegetation communities including four EECs:

- Lower Hunter Spotted Gum Ironbark Forest within Black Hill
- Freshwater Wetland Complex east of Black Hill.
- Swamp Oak Floodplain Forest through the central part of the study area.
- Coastal Saltmarsh along the banks of the Hunter River.

Option B passes across two EECs:

- Lower Hunter Spotted Gum Ironbark Forest in the Black Hill area,
- Swamp Oak Floodplain Forest through the central part of the study area.

Option B also traverses Coastal Sand Apple Blackbutt Forest and plantation/exotic dominated forest in the eastern section of the study area to the south of Motto Farm and Heatherbrae. This option also passes directly north of the Hunter Region Botanic Gardens and adjacent Swamp Sclerophyll Forest and freshwater wetland.

Threatened species

Flora

One threatened flora species, *Callistemon linearifolius*, potentially would be potentially affected by both Options A and B in the Lower Hunter Spotted Gum Ironbark Forest at Black Hill. Seeds and cutting of *Callistemon linearifolius* can be easily collected to assist with mitigating treatments. Potential habitat exists for a further four threatened plant species and these will be investigated during targeted surveys once a preferred route is selected.

Fauna

Potential habitat for 59 threatened and migratory fauna species is potentially affected by both Options A and B (see **Appendix B**).

The potential habitat of an additional six threatened species habitats would be affected by Option B. These are potential habitats for the Green and Golden Bell Frog, Large-footed Myotis, Yellow-bellied Sheath-tailed Bat, Powerful Owl, Black Bittern and Australian Bittern.

Additional species potentially affected by Option A are the threatened Osprey and the migratory Whimbrel and Eastern Curlew.

Wetlands

While the development of route options has avoided direct contact with SEPP 14 wetlands as far as practicable, both Options A and B traverse a portion of at least one SEPP 14 wetland.

Figure 5.7 shows the location of SEPP 14 wetlands within and surrounding the study area.

Option A traverses SEPP 14 wetland no. 832 in the western part of the study area. This would be crossed with a structure and integrated with a fauna underpass. The structure over the Hunter River would also span the edge of SEPP 14 wetland no. 826a.

Option B would pass to the north of Hexham Swamp (SEPP 14 wetland no. 840), but would pass through part of SEPP 14 wetland no 830 located on the eastern bank of the Hunter River. The Option B crossing of SEPP 14 wetland no. 830 would be confined to its eastern edge immediately adjacent to the existing Pacific Highway corridor.

SEPP 14 wetland no. 830 is weed infested, however significant stands of mangroves adjacent to the Hunter River and areas of saltmarsh are present within this wetland complex. The mangroves would be crossed utilising the structure over the Hunter River, within the remainder of this section of Option B crossing SEPP 14 wetland no. 830, on an elevated structure to achieve waterway requirements.

For Options A and B, the impact of an elevated structure shading mangroves and other habitats within these wetlands will be investigated in further studies.

Koala habitat

An area of 'potential' Koala habitat is located to the south of the existing 330 kV overhead electricity transmission corridor at Black Hill (refer to **Figure 5.6**). This habitat area will not be impacted by either option.

Both Options A and B skirt 'core' Koala habitat in the eastern section of the study area (within the Port Stephens LGA) potentially resulting in habitat loss for this species. This area of 'core' Koala habitat is located immediately adjacent to the eastern side of the Pacific Highway. Option B also passes through vegetation that could be considered 'potential' Koala habitat to the east of Heatherbrae. Koalas have been recorded previously on the Tomago Sand Beds and along the Windeyers Creek corridor. Port Stephens Council's *Comprehensive Koala Plan of Management* (June 2002) has been adopted by the DoP and the DoNR (then DIPNR) and supersedes the requirements of SEPP 44 Koala habitat within this LGA. The RTA implements and conforms with best practice management for Koalas.

Connectivity issues

The nature of connectivity issues associated with each of the route options will be assessed to determine the role of culverts/underpasses and other appropriate mitigation measures.

Western section

Both route options would fragment bushland areas in the western section of the study area. Utilities easements, transport corridors and cleared farmland already fragment this block of native vegetation. However, the bushland in this area is potential habitat for threatened flora and fauna species. Consideration of fauna movements in this area would need to be given during refinement and selection of a preferred route.

Route Option B would pass between SEPP 14 wetland nos. 832 and 840, however, a structure in the form of a bridge or culvert is likely to be required to satisfy waterway requirements during flood events. This structure will maintain connectivity between the wetlands and provide for fauna movement.

Central section

The route options would not result in fragmentation of any large areas of bushland in this area.

Eastern section

Route Option B will result in the disturbance of a native vegetation area situated on the edge of Tomago Sand Beds. Loss of vegetation through highway construction could result in additional impacts such as edge effects, including potential weed invasion.

Koala Habitat and EECs including Freshwater Wetland Complexes and Swamp Sclerophyll Forest are located to the immediate south of Option B. It is possible that these habitats could be impacted by edge effects. Consideration to fauna movements in this area would need to be given during refinement and selection of a preferred route.

8.2.2 Aquatic ecology

Option A would cross a small section of Freshwater Wetland Complex of moderate ecological value in the western section of the study area. The wetland could be crossed using standard recommended methods with little effect on its ecology.

Option A would traverse narrow stands of mangroves on each side of the main channel of the Hunter River. Mangroves on both banks of the river (SEPP 14 wetland no. 826a) reach heights of up to seven metres. The mangroves on the western bank are heavily grazed. The route also crosses a narrow belt of Coastal Saltmarsh (a listed ECC under the TSC Act) on the eastern bank of the Hunter River. There is opportunity to compensate for potential habitat disturbance by rehabilitating degraded saltmarsh communities in nearby areas.

The potential also exists for riparian vegetation on the banks of Purgatory Creek to be cleared during construction of Option A.

Option B would traverse a thick stand of mangroves (SEPP 14 wetland no. 830) on the eastern bank of the Hunter River.

Option B passes close to designated Freshwater Wetland Complexes (listed under the TSC Act) which form part of the northern extent of Hexham Swamp in the western section of the study area and in the vicinity of the Hunter Region Botanic Gardens in the eastern part of the study area. It is possible that these habitats could be impacted by edge effects. Appropriate measures to minimise potential edge effects issues will be considered further as part of the development of the preferred route.

For both Options A and B, linkages between the aquatic habitat areas within the study area will need to be considered so that fauna movements are not restricted between feeding and habitat areas.

8.2.3 Urban design, landscape and visual amenity

A proposed urban and landscape design framework for both options is presented in **Figure 8.1**.

Option A traverses a significant area of open floodplain and parallels a set of 330 kV overhead transmission lines.

The proposed Hunter River crossing for Option A is suitable for a landmark bridge structure with low horizontal alignment and abutment structures. A high quality symmetrical bridge with transparent safety barriers allowing views of the Hunter River and floodplain would be desirable.

For the through town section of Option A, significant urban design investigation will be required to ensure that a visually acceptable design can be achieved for the community and road users.

The crossing of the Hunter River for Option B near the existing Hexham Bridges will be highly visible and will require careful consideration.

As Option B parallels the existing highway along the northern edge of the Tomago Sand Beds, east of Heatherbrae, the landscape design will incorporate an appropriate native vegetation schedule to assist in the integration of the project into the local visual setting. Noise mounding and plant screening at the Hunter Region Botanic Gardens could be also considered.

The noise environment of Heatherbrae would be improved with less traffic movements within the town. Reduced traffic through Heatherbrae provides the opportunity for improved connectivity, visual amenity and streetscapes of Heatherbrae.

8.2.4 Water quality

Mechanisms for preventing the influx of contaminants from highway runoff or an accidental chemical or product spillage into the local waterways and wetlands within the study area will be a important issue for consideration in any option traversing the floodplain.

Construction activities may generate increased levels of nutrient-enriched and sediment-laden runoff with the potential to directly enter local waterways. This may result in increased levels of turbidity and disturbance of potentially contaminated sediments that may adversely impact local water quality and aquatic biota. A range of appropriate erosion and sediment control measures will need to be installed during both the construction and operation of the project to minimise the potential of surface water runoff generated during construction and operation of the project on the local water environment.

The potential impact of Options A and B on water quality can be directly correlated to the number, proximity to and sensitivity of the waterways and wetlands each route crosses.

Option B traversing the western edge of the Tomago GMA requires further investigation to determine the measures required to mitigate against any potential accidental spillage incident on the highway. Appropriate control measures implemented on the existing Raymond Terrace to Karuah project would be considered.

Figure 8.1 – Urban design and landscape strategy

8.3 Cultural heritage

8.3.1 Indigenous heritage

Option A crosses an area of high archaeological sensitivity at Black Hill for approximately 2.8 km. This area is known to contain high concentrations of archaeological deposits. Data from the DEC Aboriginal Heritage Information Management System (AHIMS) indicates that Option A would directly impact upon three archaeological sites (two open camp sites, and one isolated find). There is likely to be a potential impact on more sites that are not listed on the AHIMS.

Option A crosses the Hunter Floodplain for 9.2 km, which is considered to be of low archaeological potential to the modified and disturbed state of the land. The connection point with the Pacific Highway north of Heatherbrae is considered to be an area of moderate to high archaeological potential in the vicinity of the Tomago Sand Beds (for 0.8 km).

Option B crosses the area of high archaeological sensitivity at Black Hill, for 2.1 km. As mentioned above, AHIMS data indicates a relatively high presence of archaeological material in this area. Two recorded sites would be directly impacted by Option B (an isolated find and a site newly identified during this study). Option B traverses within the low archaeological potential Hunter Floodplain for 8.4 km, and traverses the moderate-high archaeological potential Tomago Sand Beds area for 3.8 km.

Further studies will be undertaken to identify the areas within Black Hill that contain the highest concentrations of artefacts, enabling options in this area to be refined to minimise impacts.

8.3.2 Non-indigenous heritage

Although there are a number of items of non-indigenous (European) heritage surrounding the study area, there are only a limited number within the study area.

Option A may impact on the Moreton Bay Fig Trees (*Ficus macrophylla*), which are significant features of the landscape character of the area. The trees are located on the edge of the exiting Pacific Highway, north of Hank Street.

Option B does not directly impact upon any items of non-indigenous heritage, however it does skirt the northern boundary of the Hunter Estuary Wetlands, which are 'Registered' on the Register of National Estate. It should be noted that Option B passes near the Oak Factory, approximately 120 metres from the existing Hexham Bridges.

8.4 Land use and property impacts

Option A passes immediately to the south of Glenrowan homestead before continuing east across open floodplain in the central study area. This area is characterised by large parcels of rural land utilised for grazing and limited cropping and the number of properties affected would be small. Generally the option parallels a set of existing 330 kV overhead transmission lines to provide more opportunity for larger land parcels to be located on one side of the route. The exception is lot 2/803276 (property ID 76) where the alignment attempts to parallel the property boundary.

One dwelling, the main house on lot 2/873320 (property ID 10 refer to **Figure 8.2b**) would be located approximately 90 metres from the road reserve of Option A.

Figure 8.2a – Property ID plan

Figure 8.3b – Property ID plan

East of the Hunter River Option A would join the existing Pacific Highway south of the existing equestrian facility before passing through the centre of Motto Farm and Heatherbrae.

Option A passes through Motto Farm and Heatherbrae it will have a direct impact on properties on the northern side of the existing highway with acquisition required. In most cases, dwellings would not be directly affected and changes to visual setting and noise pollution would be mitigated through appropriate design treatments.

To enable the highway to achieve the required design standard for speed (i.e. 110 km/h), acquisition approximately five properties would be required on the southern side of exiting highway. In addition, isolated acquisition of property may be required to facilitate a potential overpass providing connectivity between the northern and southern sides of Heatherbrae.

As direct highway access would not be provided for properties at Motto Farm and Heatherbrae, the impact on existing commercial premises would require careful consideration. Service roads to maintain local traffic access would be provided along property frontage.

Option B also passes through a limited number of large properties in the western section of the study area. These properties would generally be the same as Option A. However, the main house (property ID 10, refer to **Figure 8.2b**) would be a greater distance from the alignment (approximately 175 metres).

Where the options diverge, Option B passes through a small strip of residential dwellings situated between the Main Northern Railway and the New England Highway. These dwellings are typically detached, single storey, weatherboard buildings. This land corridor is zoned '4(b) Urban Services' under the NLEP 2003. The strip of residential properties, are bounded to the east by the New England Highway.

The large parcel of land (Lot 1 in Deposited Plan 748716) adjacent to the Pacific Highway and surrounding the Hunter Region Botanic Gardens is owned by Hunter Water Corporation and leased to the Hunter Region Botanic Gardens for preservation of natural bushland which is open for public viewing. Option B crosses the north western corner of this lot, some properties situated along the Pacific Highway in this locality may need to be acquired.

East of the Hunter Region Botanic Gardens, Option B passes across the northern edge of the Tomago Sand Beds and within 70 metres of an operational bore line. Initial discussions with Hunter Water Corporation have indicated that this alignment is feasible. This alignment also presents an opportunity to define the extent of future industrial development to the south of Heatherbrae and Motto Farm.

Option B would pass through land zoned for industrial purposes but currently remaining as high quality bushland immediately west of Masonite Road. East of Masonite Road, Option B passes through land upon which a commercial shed has recently been constructed, and land which contains the Weathertex Factory. Option B rejoins the Pacific Highway on land zoned industrial adjacent to Windeyer's Creek bridge.

Table 8.1 – Land use impacts

Issue/Impact	Option A – Yellow through town	Option B – Pink eastern
Socio-economic issues		
Number of lots potentially severed or requiring full or partial acquisition	56	32
Number of residential dwellings within 400 metres of option	119 dwellings, Hunter Region Botanic Gardens, Newcastle equestrian, Pacific Gardens Mobile Home (Caravan park), and 1 Farm Homestead (Motel) and Heatherbrae Caravan Park	25 dwellings, Hunter Region Botanic Gardens, Pacific Gardens Mobile Home (Caravan park)
Number of properties within 150 metres of option	144	41
Number of dwellings directly affected	6	2
Number of existing commercial buildings directly affected	None	Large shed intended for commercial purposes. Located in property ID 169
Extent and nature of impacts on existing highway related business	Existing business at the Beresfield Service centre; the Oak Factory and service stations at Hexham are likely to experience loss of passing trade. Existing businesses at Motto Farm and Heatherbrae are likely to experience some loss of trade as a result of limited access required to accommodate the proposed highway. Also potential for restricted visibility to businesses, possibly cause by noise walls	Existing business at the Beresfield Service centre; Motto Farm and Heatherbrae are likely to experience loss of passing trade.

8.4.1 Statutory planning approvals

Options A and B traverse various zonings under the *Newcastle Local Environmental Plan 2003* (NLEP 2003), the *Maitland Local Environmental Plan 1993* (MLEP 1993) and the *Port Stephens Local Environmental Plan 2000* (PS LEP 2000). Actual zonings crossed and their relevant permissibility's in relation to development of a road, have been listed in **Table 8.2** and **Table 8.3.**

Table 8.2 – Option A LEP zonings impacted

LGA	Zones	Notable Prohibitions/ Permissibility's
Newcastle	5(a) Special Uses (Transport)	Under Clause 13 of the NLEP 2003, road construction is **permissible without development consent.**
	7(c) Environmental Investigation Zone	
	7(b) Environmental Protection Zone	
	5(b) Special Uses (Arterial Road)	
Maitland	1(a) Prime Rural Land	Under the MLEP 1993, development of a 'road' is **permissible only with development consent.**
Port Stephens	1(a) Rural Agricultural "A"	Under the PSLEP 2000, the Proposal is **permissible only with development consent.**

Source: Information from Newcastle Local Environmental Plan 2003, the Maitland Local Environmental Plan 1993 and the Port Stephens Local Environmental Plan 2000, analysis by MAPL 2005.

Table 8.3 – Option B – LEP zonings impacted

LGA	Zones	Notable Prohibitions/ Permissibility's
Newcastle	5(a) Special Uses (Transport)	Under Clause 13 of the NLEP 2003, road construction is permissible **without development consent.**
	7(c) Environmental Investigation Zone	
	7(b) Environmental Protection Zone	
	5(b) Special Uses (Arterial Road)	
	4(b) Port and Industry Zone	
Maitland	1(a) Prime Rural Land	Under the MLEP 1993, development of a 'road' is **permissible only with development consent.**
Port Stephens	1(a) Rural Agricultural "A"	Under the PSLEP 2000, the Proposal is **permissible only with development consent.**
	7(a) Environment Protection "A"	
	7(c) Environment Protection "C" (Water Catchment)	
	4(a) Industrial General "A"	

Source: Information from Newcastle Local Environmental Plan 2003, the Maitland Local Environmental Plan 1993 and the Port Stephens Local Environmental Plan 2000, analysis by MAPL 2005.

Where consent is not required under LEP zonings

Development for the purpose of a road is permissible without consent under certain zonings as listed above. Where the route options cross these zones, development is permissible under Part 5 of the EP&A Act.

Where consent is required under LEP zonings

Development for the purpose of a road is permissible only with consent under certain zonings listed above. Clause 35 of the *Environmental Planning & Assessment Model Provisions 1980* provides that:

> *'Nothing in the local environmental plan shall be construed as restricting or prohibiting or enabling the consent authority to restrict or prohibit…the carrying out of development of any description specified in Schedule 1,*

Schedule 1 describes '*any development required in connection with the construction, reconstruction, improvement, maintenance or repair of any road,'* The Newcastle, Maitland and Port Stephens Council have all adopted the Model Provisions or a similar savings provision, however further clarification will be sought on their applicability as part of the preferred route investigations.

Under the provisions of *State Environmental Planning Policy No 4 – Development Without Consent and Miscellaneous Exempt and Complying Development* (SEPP 4) (which applies to classified roads[1] such as the Project) an Environmental Impact Assessment for roads in zones where development of a road is permissible only with development consent would also be covered under the provisions of Part 5 of the EP&A Act.

The planning approvals process under Part 5 of EP&A Act is applicable to both options.

8.4.2 Noise and vibration

The overall impacts of both Options A and B are similar in the area between the F3 Freeway and the New England Highway. It would be unlikely that any additional noise barriers would be required in the Beresfield area but low level noise barriers may be required in the Tarro area. Additionally it would be unlikely that noise barriers would be required to meet new freeway noise criteria at Black Hill due to the buffer distance from the route option alignments. However, at least one isolated residence would require architectural noise treatments for both Options A and B.

It is unlikely that noise mitigation would be required for either of the route options between the New England Highway and the township of Motto Farm, with the exception of individual treatment to isolated residences and the Hunter Region Botanic Gardens.

Between Motto Farm and the Masonite Road roundabout, it is likely that noise barriers would be required for Option B on the western side of Heatherbrae where it branches off the existing alignment. Option A follows the existing road alignment through Heatherbrae and Motto Farm where less stringent noise criteria would apply, however, architectural treatments would be necessary for properties within these settlements if Option A was constructed. It is likely that noise barriers would be required on the northern side of the proposed freeway road at the eastern end of Heatherbrae to protect residential dwellings and the Hunter River High School from noise burden. Some individual residences impacted by noise on the western end of the upgrade may also require individual architectural treatments.

[1] As defined under the Roads Act 1993; 'a main road, a State highway, a freeway, a controlled access road, a secondary road, a tourist road, a tollway, a transitway, a State work.'

Option B has the potential to impact on commercial/ light industrial premises, however, it would be unlikely that mitigation would be required for these premises.

8.5 Construction issues

8.5.1 Highway construction staging

Option A will require considerable staging of construction, particularly through Heatherbrae where it utilises the existing Pacific Highway. This is likely to result in traffic delays during construction. Option B where it parallels the existing highway may also require construction staging and may also result in temporary traffic disruption.

8.5.2 Occupational health and safety in construction

Key Occupational Health and Safety (OH and S) issues for consideration in the construction of Options A and B are as follows:

- Construction at height (all bridges).
- Construction over water (Hunter River, Purgatory Creek).
- Construction over operational railway lines and roads (Main Northern Railway line, F3 Freeway, New England Highway, existing Pacific Highway, Woodlands Close, Masonite road).
- Construction adjacent to existing highways (existing Pacific Highway through Heatherbrae, existing Pacific Highway between Hexham Bridge and the Hunter Region Botanic Gardens).
- Construction within proximity of overhead transmission lines (TransGrid 330 kV and 132 kV Energy Australia lines).
- Construction within proximity of buried power lines (Woodlands close and Heatherbrae/ Motto Farm).
- Construction within proximity of high pressure gas mains (Woodlands Close).

Both Options A and B will require the construction of bridges over existing major infrastructure items including the Main Northern Railway line and the New England Highway. These transport corridors will remain operational during construction of the project. Consideration of construction methodologies and integration of OH and S procedures will be required to promote both the safe construction of the project and operation of the existing highway and railway line.

The Hunter River crossing proposed for Option A will be achieved using a second major structure which will also span part of the floodplain, while the crossing for Option B will be integrated with the structure spanning the Main Northern Railway line and the New England Highway.

Both Options A and B will be constructed within close proximity of underground and overhead utilities. The most evident of these utilities is the TransGrid 330 kV overhead transmission lines which lie in close proximity to Option A for approximately four km and 1.5 km for Option B. The project is offset from these overhead transmission lines at a distance that would allow the transmission line towers to topple and remain clear of the project. Maintaining adequate lateral and overhead clearance during construction is a critical consideration.

In addition to the 330 kV overhead transmission lines, Options A and B will also cross the Energy Australia 132 kV overhead transmission lines near the Hunter Region Botanic Gardens, buried high voltage power and buried high pressure buried gas pipelines. A number of local overhead transmission lines within Heatherbrae and Motto Farm will need to be relocated for

Option A. Appropriate precautions and OH and S procedures will need to be implemented during construction to ensure that utility adjustments and contact is undertaken in a safe manner.

Construction adjacent to the existing highway presents OH and S challenges for Option A through the township of Heatherbrae and Motto Farm, and for Option B, between Hexham Bridge and the Hunter Region Botanic Gardens. Safe egress of construction machinery and workforce will be an important consideration in addressing this issue.

Construction of interchanges for Options A and B at Black Hill, the Masonite Road roundabout and Masonite Road, will also require construction over the operating F3 Freeway, Masonite Road and the Pacific Highway, respectively. An interchange at Tomago Road for Option B would require a structure over the existing Pacific Highway.

9 Project cost and economic analysis

An important aspect of any development is the consideration of project costs. This chapter provides an overview of the economic analysis, undertaken in compliance to relevant NSW and RTA economic appraisal and analysis guidelines (see **Section 9.2**).

9.1 Route options cost estimate

Results acquired from the preliminary specialist investigations conducted in the fields of hydrology, geotechnics, traffic and transportation, and noise and vibration have been integrated with the quantities determined from the route option MX models to generate preliminary strategic cost estimates. These have enabled a relative comparison of the economic viability of Options A and B.

The cost estimates were prepared based on the recommendations and approach for Strategic Estimates outlined in "Project Estimating" prepared by the Project Management Office of the RTA (Document No. RTA-CSD-PMS-PR-M-02). These initial estimates indicate that Option B could be constructed for the lowest cost out of the two options considered.

Table 9.1 – Summary of key project elements

Project Elements	Option A	Option B
Length of Upgrade	12.8 km	13.5 km
Embankment	Generally three metres high with a 4:1 batter	Generally three metres high with a 4:1 batter
Pavement	250 millimetres thick CRCP	250 millimetres thick CRCP
Interchange	Southern interchange at the F3 Freeway (Black Hill) Northern interchange at Masonite Road roundabout	Southern interchange the F3 Freeway (Black Hill) Northern interchange at Masonite Road
Key Structures	Combined crossing of Woodlands Close, the Main Northern Railway line, and the New England Highway Purgatory Creek Bridge Hunter River Bridge	Combined crossing of Woodlands Close, the Main Northern Railway line and the New England Highway, the Hunter River, near the existing Hexham Bridges
New service roads	25 lane km of new local road	8 lane km of new local road

9.2 Economic evaluation

9.2.1 Approach

To ensure that a project delivers value for money to the community, economic appraisals are undertaken to determine the magnitude of benefits generated for a given level of expenditure.

Modelling for the economic appraisal has initially been carried out following cost benefit analysis guidelines outlined in the *RTA Economic Analysis Manual*, Version 2, 1999. This economic appraisal will also be developed to ensure consistency with the NSW Government's *Guidelines for Economic Appraisals (TPP 97-2)* for the processing of items not explicitly covered by the *RTA Economic Analysis Manual*.

The NSW Government's *Guidelines for Economic Appraisals* suggest that the following structure be used:

- Identification of objectives.
- Scope of project.
- Identification of options.
- Identification of quantifiable costs.
- Identification of quantifiable benefits.
- Calculation of net benefits at a real rate of seven per cent.
- Identification of qualitative factors.
- Summary of results.

The economic appraisal will assess whether the development of one of the alignment options would be more beneficial for the community and road users against a base case of allowing traffic to continue using the existing road network.

9.2.2 Scope

The scope of this economic appraisal extends to consider the effects of the project on the community. However, as an initial stage to a wider appraisal of economic benefits and costs, this economic appraisal focuses on road user benefits and costs, which are expected to account for a significant proportion of total benefits and costs from a potential highway upgrade.

9.2.3 Quantitative assessment

The following key assumptions were made:

- All costs and benefits are expressed in December $2004.
- A three year construction period, beginning in 2006 (for the purpose of assessment only).
- A 33-year evaluation period, commencing in 2006 (benefits to be accrued from 2009).
- A real discount rate of seven per cent.
- No real increases in vehicle operating costs (VOCs), vehicle operating time (VOT) or accident costs.

The latest version of the *RTA Economic Analysis Manual* presents parameters in December 2003 dollars. These parameters, where required, have been inflated by 2.6 per cent to index them to December 2004 dollars. The inflation rate of 2.6 per cent represents the increase in the

Consumer Price Index between December 2003 and December 2004 (estimate based on ABS Consumer Price Index data Cat. No. 6401.0).

9.2.4 AADT assumptions

The development and construction of any of the alignment options can be expected to have significant impact on the existing distribution of traffic on the road network within the vicinity. Modelling undertaken for the F3 Freeway to Branxton Project has been considered as has forecast development within the catchment area.

AADT projections take into account general annual growth in traffic as well as the impacts of changes to the existing network (for example, the F3 Freeway to Branxton Project) or land use changes (industrial and residential development in Thornton and Raymond Terrace).

The AADT projections were then used to calculate vehicle km travelled and vehicle hours travelled for the base case and each of the options.

9.2.5 Benefits and costs

Annual user benefits have been estimated as the sum of:

- Vehicle operating cost savings.
- Travel time savings.
- Accident cost savings.

The three user benefits have been estimated, based on estimations made of the travel time and vehicle kilometres for travel under the base case and the two alignment options. The various parameter values used to value vehicle operating costs, travel time savings and accidents are consistent with those presented within Appendix B of the *RTA Economic Analysis Manual.*

Vehicle operating cost savings

Assumptions:

- Naasra Roughness Measure (NRM) count of between 0 and 49 (reflecting very good road conditions on sealed roads).
- Road-volume capacity of 0.5.
- Average speed of 60 km/h along the existing alignment, 110 km/h along new road alignments.

Vehicle operation costs (VOC) estimates prepared for this economic appraisal include:

- Fuel and oil.
- Depreciation.
- Maintenance.
- Wear on tyres and brakes.

The VOC parameters used in this economic appraisal are based on rural road parameters (estimate based on ABS Consumer Price Index data (Cat. No. 6401.0), which account for the following attributes:

- Vehicle class.
- Average vehicle speed.
- Road surface and pavement conditions.
- Horizontal alignment.

- Grading.
- Road-volume capacity.

The origin-destination survey undertaken for this study indicated an average travel speed during the peak periods of 44 to 66 km/h. For the purpose of this assessment a 60 km/h average speed has been assumed.

After accounting for horizontal alignment, grading, average speeds and road-volume capacity the appropriate VOC parameters have been incorporated into the economic appraisal.

VOC, based on estimated AADT and trip lengths, were estimated for each case, with vehicle operating cost savings estimated for each option by taking the difference between the VOC of an option and the VOC of the base case.

Travel time savings

Rural values of time (VOT) parameters were used for the economic appraisal. VOT are based on the following factors:

- Trip type.
- Occupancy.
- Presence of freight.

The *RTA Economic Analysis Manual* recommends an appropriate value of time parameter in dollars per vehicle hour. With a higher proportion of heavy vehicle traffic (14 per cent) than used in the manual, project specific VOT parameters have been developed and used.

The VOT parameter is based on the VOT of five groups, namely private car users, business car users, light commercial truck users, heavy commercial truck users and road train users.

To calculate an estimate of VOT for light and heavy vehicles, users were disaggregated by vehicle class (light and heavy), with the proportion of each type of user within each vehicle class estimated. From these proportions, a weighted VOT parameter was calculated for light and heavy vehicle users.

Travel time savings for each of the road alignment options were calculated by taking the difference between travel time costs for each option and the base case.

Accident cost savings

Assumptions:

A crash rate of 0.10 crashes per MVKT for all proposed road alignment options.

A review of accident rates between 2001 and 2003 reveals that there were 182 accidents on the following roads:

- John Renshaw Drive (between the F3 Freeway and the New England Highway).
- New England Highway (between John Renshaw Drive and the Pacific Highway).
- Pacific Highway (between the New England Highway and Raymond Terrace).

Considered together, these roads form the existing alignment between the end of the F3 Freeway and the Pacific Highway at the Hexham Bridges. Based on a review of historic crash statistics, a crash rate per MVKT has been estimated.

Accident rates published in the *RTA Economic Analysis Manual* were used to estimate the cost of future road accidents. The accident rates include costs for:

- Human costs including ambulance, hospital and medical costs.

- Vehicle costs including repairs and towing.
- General costs including travel delays, police and property.

According to the *RTA Economic Analysis Manual*, the average cost of a rural accident is $139,000 (in 2003 dollar terms). This was inflated by 2.6 per cent to estimate an accident cost in December 2004 dollars ($142,600).

Accident cost savings for each of the road alignment options was estimated by taking the difference between the accident costs under the base case and under each of the road alignment options.

9.2.6 Costs

Construction costs

Assumptions:

Payment of construction costs over three year construction period in three equal instalments, in nominal terms.

Concept costs for the options have been estimated and included in the economic appraisal. For planning purposes, it has been assumed that the nominal construction cost is spread across a three-year period between 2006 and 2008 with the instalment payable annually.

A contingency premium of 30 per cent has been incorporated into the concept cost estimate.

9.2.7 Results

The appraisal models all cash flows over a 33-year period, including the three years of construction between 2006 and 2008, at a (real) discount rate of seven per cent per annum. All cash flows have been discounted to 2005. The discounted cash flows are subsequently used in the calculation of economic indicators. Four economic indicators were calculated as outputs of the economic appraisal to evaluate the relative attractiveness for each of the development options against the base case. A brief description of each indicator is provided as follows:

Net Present Value (NPV): measures the difference between benefits and costs, whilst accounting for the timing of benefits and costs. Net cash flows are discounted at the prescribed discount rate of seven per cent, reflecting the notion that future benefits and costs have less value compared to current benefits and costs. A project with a NPV greater than zero would be considered desirable, with the project having the highest modelled NPV being the most desirable.

Net Present Value Per Dollar of Investment (NPVI): measures the return on a dollar of investment. The NPVI is calculated by dividing the net present value by the present value of investment (construction costs have been used as the proxy for investment). A project with a NPVI greater than zero would be considered desirable, with the project having the highest modelled NPV being most desirable.

Benefit Cost Ratio (BCR): measures the return received per dollar of costs. The BCR is calculated by dividing the present value of all benefits by the present value of all costs. A project with a BCR greater than one would be considered desirable, with the project having the highest BCR being most desirable.

The NPVI and BCR provide a scale in which to compare the relative attractiveness of different projects where the level of expenditure varies between projects.

Internal Rate of Return (IRR): the discount rate required to ensure that NPV is equal to zero. A project with an IRR greater than seven per cent would be considered desirable, with the project with the largest IRR being most desirable.

It is important to note that the above economic indicators, individually, have various weaknesses in assessing the optimum project. Hence, the Guidelines suggest a range of economic indicators to ensure the best project is selected.

The results show, based on the assumptions used, that Options A and B generate net benefits for road users. Both these options have BCR's above 1.0.

It should be noted that the analysis is based on assumptions regarding traffic flows on the proposed road link. Furthermore, the economic appraisal is limited in considering road user costs and benefits. An analysis of other attributes to include wider community effects and impacts have not been included in the appraisal at this stage. A more detailed discussion of these attributes follow in **Chapter 9.2.9**.

9.2.8 Sensitivity analysis

Sensitivity analysis was conducted on key parameters used to underpin the model to test the robustness of inferences made in the previous section. Sensitivity tests were conducted on the following parameters:

- Level of traffic (± 20 per cent).
- Average speed on the existing link (± 10 kmh^{-1}).
- Construction costs (± 20 per cent).
- Discount rates (± 3 per cent).

For simplicity, only the NPV and BCR results were generated.

The results suggest that the economic appraisal results are sensitive to variables including the discount rate, AADT and base speeds although less so for construction costs. Nonetheless, the degree of sensitivity is not to the extent that the conclusions from the economic appraisal would be greatly affected.

9.2.9 Qualitative assessment

A range of factors have been identified that, at this stage, have not, or are not able to be quantified. The *NSW Guidelines for Economic Appraisals* and the *RTA Economic Analysis Manual* allow scope for the detailing of attributes that may impacts on the economic desirability qualitatively. These attributes include:

- Amenity.
- Economic development.
- Property values.
- Environmental.
- Safety.
- Construction dis-benefits.

The possible impact of the abovementioned attributes on the economic desirability of a road link is described briefly as follows:

Economic development

A new highway upgrade has the potential to promote economic development through the provision of greater accessibility and mobility. The reduction in travel time savings combined with better connectivity of industrial areas to high-speed freeway links provides the opportunity to consolidate and develop these areas to take advantage of improved access to key markets. For instance, the road freight business, which accounts for approximately 80 per cent of freight

movements between Brisbane and Sydney (BTRE Information Sheet 22), would be expected to be a major beneficiary from reduced travel times and vehicle operating costs.

The project will also assist in reducing travel times for visitors to the region and to popular holiday destinations located on the mid and far north coast regions of NSW. The reduction in travel times and improved safety conditions through the upgrade will assist the development and further growth of the tourism industry along the NSW North Coast.

Finally, construction spending on the development of a new road link has potential to generate long term growth in employment within the region. Whilst construction positions will be created, the economic multiplier effects from expenditure on construction generally have longer term impacts.

Existing businesses in Motto Farm and Heatherbrae with direct access to the existing Pacific Highway are likely to experience changes in trade levels if the project is relocated to another alignment or if access arrangements on the existing highway are changed substantially. The extent of these impacts is likely to vary in response to factors such as:

- The nature of the business.
- Its reliance on highway-related trade.
- Its ability to develop new/different markets.
- Ameliorative measures incorporated in the design and implementation of the project such as access arrangements and systems to provide advance information to highway users.

Through Heatherbrae there are a range of business types. A number of highway service related businesses exist, such as fast food outlets and service stations, as well as destination based trade such as car dealerships. In any case the local road network or new service roads carrying higher traffic volumes than the project, will continue to provide passing trade opportunities.

An alignment may also have the potential to reduce productivity and density for a given piece of land. This may occur through decreased access and/or a reduction in scale allowed on the land. This effect will potentially have an impact on the productivity of the land and in turn, the economic output that may be produced from the given land.

Property values

Road developments potentially have ambiguous effects on property values. On one hand, a reduction of traffic has the ability to improve amenity, providing a positive effect on residential property values. Residential, commercial and industry land values can be further enhanced by greater accessibility and mobility provided by the development of a new road.

On the other hand, commercial property values may be adversely affected by a diversion. Reduced throughput on a road decreases the potential for passing trade and in turn, decreases the economic rent that landowners are able to extract from tenants. If economic activity is significantly impacted, this may have longer term flow on effects on general land values. Severance caused by a new road link may also reduce property values through reduced access and productivity.

Safety

A key imperative for highway developments such as the F3 Freeway to Raymond Terrace Project is the achievement of road safety improvements principally for highway users but also for local vehicular and pedestrian traffic where this access currently occurs on sections of the highway or intersects with it. These safety benefits are likely to accrue across the wide 'community' of existing and future highway users as well as local communities such as Motto Farm and

Heatherbrae where residents currently have to access or cross the highway for a variety of day-to-day activities.

In the case of this project, safety benefits will be derived by the removal of through traffic from the existing road network. It also provides the community with an alternative route during and incident.

Construction impacts

The construction of a road link will bring about negative externalities from the construction activities. These impacts include the possible reduction of travel speeds, increasing the time required to travel between trip ends. Construction of road links also bring about the possibility of accidents with construction workers, noise, water quality and dust issues.

7.3.2 Constraints identification and mapping

Constraint mapping has been updated and incorporated into the route option development process as Phase 1 specialist field investigations have been completed. Key data sets that were reviewed and utilised during the identification of constraints included:

- 1:25,000 scale topographical maps
- Aerial photography that was flown in March 2004.
- Records held by the Department of Environment and Conservation in relation to flora and fauna, heritage.
- Records held by the Department of Planning and Department of Natural Resources for soils, SEPP 14 wetlands, SEPP 44 Koala habitat.
- Records held by the Department of Primary Industries for geology.
- LEPs for Newcastle, Maitland and Port Stephens.
- Other relevant reports and mapping held by local councils.

An overview of identified constraints within the study area is provided in **Figure 7.2**.

Within the western section of the study area, route options are physically bounded to the north by the settlements of Tarro and Beresfield, and to the south by the development within Black Hill. The resulting corridor and minimum desirable road design horizontal radius (750 metres) provide for a limited number of options through this area.

7.3.3 Context

Between Black Hill and the Hunter River, a number of route options are geometrically possible. The horizontal alignment of potential options within this area is driven primarily by avoidance of the Glenrowan homestead, the northern extents of Hexham Swamp, isolated areas of SEPP 14 wetlands and the approach to cross the Hunter River in desirable locations. An alignment in this area also needs to be sufficiently offset from the high voltage overhead transmission lines to ensure adequate safety for road users and to avoid deformation of the towers from ground movements induced by highway construction.

The Hunter River is located within the central part of the study area, meandering in an 'S' configuration with a significant proportion of the river aligned parallel with the existing Pacific Highway. Near the northern and southern boundaries of the study area, the river is approximately orthogonal to the existing highway, presenting opportunities for a more optimal crossing of the waterway. A perpendicular river crossing would minimise the number of piers in the water, length through adjacent wetland and length of construction over water. It is noted that a number of other significant factors influence the optimal Hunter River crossing locations and include hydrological, environmental, urban design, social and economic consideration. These issues are discussed under the relevant sections of this report.

East of the Hunter River, the study area forms a 'bulb' around the settlements of Motto Farm and Heatherbrae, facilitating three broad corridors for options located north, south or through these settlements.

South of Motto Farm and Heatherbrae, the Hunter Region Botanic Gardens, freshwater wetlands and Koala habitat would be key considerations for an option through this area. Severance and fragmentation of native vegetation would also be an important consideration.

North of Heatherbrae, an eastern option would connect into the existing Raymond Terrace Bypass at Masonite Road. Highway service related business interests at Motto Farm / Heatherbrae and the capacity of the Masonite Road roundabout to accommodate projected traffic volumes would be key factors.

7.4 Corridor identification

The project team held a route options workshop in December 2004, to enable the team's various specialist consultants to present their findings from Phase 1 studies and to present newly identified project constraints. During the workshop, these findings were integrated with the preliminary constraint analysis and a long-list of initial route options were generated within the study area. Following the workshop, the options were reviewed to ensure that minimum design criteria, such as horizontal radii, were achieved.

In conjunction with the study team generating options, the clg participated in a workshop during January 2005 to also identify potential routes as discussed in **Chapter 3**. The routes identified during this workshop are shown in **Figure 7.2**.

The set of route options produced during the project team workshop in December 2004 was augmented by those produced by the clg workshop in February 2005. This resulted in 14 route options being considered that represented geometrically viable options within the study area. Every attempt was made to avoid direct or minimise contact with environmentally sensitive areas such as SEPP 14 wetlands, where practicable.

These options formed the basis for identification of broad corridors which are shown in **Figure 7.3**. Through the central section routes could pass either to the north or south of the Hunter River and in the eastern section, corridors include to the north, south and through the centre of Heatherbrae.

Figure 7.2 – CLG route options

Figure 7.3 – Preliminary route corridors

7.4.1 Expanded study area

A combination of community feedback, clg generated options to the south of the study area and investigations conducted as part of the route options development process led to the expansion of the study area which was announced in April 2005. The study area expansion allowed the consideration of options within a corridor to the south of the Hunter River.

7.4.2 Eliminated routes

Route options passing through Hexham Swamp, either utilising the abandoned railway corridor, or passing through the wetland itself were rejected on sensitive environmental grounds through consultation with the relevant government agencies and stakeholders. However, a route option utilising the existing Pacific Highway immediately to the east of the Hunter River crossing was considered potentially viable and one that would be subject to further assessment.

A further study area expansion to incorporate a route option passing further to the east of Heatherbrae was also considered. A route option through this region would pass through the central area of the Tomago GMA, which is discussed in **Chapter 5.1.3**. A preliminary investigation into the viability of this option, including discussions with Hunter Water Corporation indicated that the option would not be feasible due to groundwater management, native vegetation and flora and fauna issues.

7.5 Route identification

A Phase 1 assessment was performed on the long list of 14 route options. The outcome of this assessment was three short listed route options as shown in **Figure 7.4**. Preliminary vertical alignments for these three options were generated to enable further assessment.

7.5.1 Refinement of options

Further information from specialist investigations arising from the Phase 2 specialist studies, together with ongoing discussions and site visits with key stakeholders and government agencies instigated a revised application of the Phase 1 MCA on the short listed options.

A key aspect of the Phase 2 specialist studies was the quantification of the potential impacts on flooding, and the waterway areas required to mitigate upstream effects on Options A, B and C. The investigation indicated that a significant proportion of an alignment traversing the central section of the floodplain, north of the Hunter River and/or to north of Heatherbrae, would be required to allow for the passage of floodwaters.

The construction of route options across the Hunter River floodplain on embankment would require a substantial volume of material. Preliminary investigations indicate that an alignment similar to Option C would require approximately 1.2 million cubic metres of fill material to cross the floodplain along the northern study area boundary.

Further, preliminary results from geotechnical ground investigations were also reviewed, indicating the nature and extent of soft soils through the central part of the floodplain and in the area around Windeyers Creek, north of the existing highway. Land use, severance and amenity issues were also incorporated in the revised Phase 1 assessment.

After further assessment, Option C was abandoned due to the length of bridging required for flood management, the amount of imported fill material required and the high cost of construction over extensive lengths of floodplain. Option C performed at a level below that of options already abandoned.

This further assessment confirmed options A and B as the only options suitable for further development. The refined options are shown in **Figure 7.5**. These two options have been shortlisted to proceed to public exhibition.

Figure 7.4 – Shortlisted route options

Figure 7.5 – Feasible route options

8 Comparison of feasible options

A comparison between the two feasible options is provided below. **Appendix A** details the preliminary inputs for the Stage 2 MCA.

8.1 Engineering considerations

8.1.1 Major structures

Option A would involve a 1.2 km crossing at the CTGWM, Woodlands Close, New England Highway, Main Northern Railway line and Purgatory Creek within a 1.2 km stretch. A single structure would be used to span the Main Northern Railway line and New England Highway, while culverts would be utilised to cross the CTGWM and Purgatory Creek.

The Woodlands Close crossing may be integrated with the bridge structure, over the New England Highway and the Main Northern Railway line, or a culvert structure may be used.

Option A would cross the Hunter River near the existing 330 kV overhead transmission line crossing. Within Heatherbrae an overpass structure would be required to connect the service roads on the north and south side of the settlement.

A structure spanning SEPP 14 wetland No. 832 will be required for Option A, which could also provide for fauna movements and transverse drainage flows.

Option B presents the opportunity to cross the Main Northern Railway line, New England Highway and the Hunter River with one long structure approximately 800 metres long.

A structure over Masonite Road for Option B would be integrated with an interchange and is discussed below.

8.1.2 Overpass and interchanges

Both Options A and B would require structures over the existing highway at the southern and northern tie in points, i.e. at the F3 Freeway and near Masonite Road roundabout.

An interchange at Black Hill would enable northbound traffic on the F3 Freeway to exit the motorway prior to the upgrade carriageway, via the remaining length of the F3 Freeway to the John Renshaw Drive roundabout. Provision for traffic travelling south from the John Renshaw Drive roundabout via the F3 Freeway would also be provided with a structure over or under the upgrade carriageways.

For Option A an opportunity exists to provide a partial interchange at the F3 Freeway and a complementary partial interchange at the New England Highway / Option A intersection between the Main Northern Railway line and the Hunter River. This interchange would enable traffic on the New England Highway to enter the northbound carriageway of Option A, and also to enable traffic travelling on the southbound carriageway to exit onto the New England Highway. A full interchange may be provided at Black Hill instead of the partial New England Highway interchange. The additional interchange arms would include a northbound onload ramp and a southbound offload ramp. The final interchange arrangement has not yet been determined and is subject to further studies.

For Option A, access to the existing Tomago Road intersection would be via the existing local road network. Local traffic on the existing Pacific Highway would merge with the upgrade north of the Hunter Region Botanic Gardens.

A partial interchange option at Tomago Road would be considered for Option B, to accommodate traffic movements to Newcastle Airport and Newcastle Port. A structure would be provided to enable the upgrade carriageways to pass over/under the existing highway.

Option A would require a structure over the existing Masonite Road roundabout and would be integrated with a full interchange providing north and southbound on and offload ramps.

Option B would require a structure over Masonite Road, south of the existing roundabout. This structure would be integrated with a full interchange providing north and southbound on and offload ramps. The existing highway between the Masonite Road roundabout and the upgrade connection into the Raymond Terrace Bypass would become redundant.

8.1.3 Hydrology

For Option A, preliminary modelling indicates that an opening of two to three km will be required to limit afflux to acceptable levels (50 millimetres) during a five per cent AEP flood event. This length of opening is likely to be achieved through a combination of an extension to the proposed bridge structure over the Hunter River to the west through the central open floodplain and the use of culverts to provide openings further to the west.

For Option A the structure over the Main Northern Railway line, New England Highway and Woodlands Close could not be utilised in accounting for the waterway area required as the elevation of this existing infrastructure is at or above the five per cent AEP level in this area.

Option B crosses the Hunter River near the existing constriction at the Hexham bridges. Preliminary modelling indicates that an opening of 1.5 to 2.5 km will be required to achieve an acceptable afflux (50 millimetres) during a five per cent AEP flood event. This length of opening will be achieved by extension to the proposed bridge structure over the New England Highway/Main Northern Railway/Hunter River crossing to also span part of the floodplain west of Hexham and culverts/bridges to the west.

The structure utilised for Option B, spanning both the infrastructure corridor and the Hunter River would also provide for the majority of waterway area required. This is due to the low elevation of the infrastructure at this location and the presence of an existing hydraulic construction.

All culverts required for both options will be designed to provide adequate waterway areas for drainage flows and would also for fauna movements.

8.1.4 Ground conditions

Option A traverses approximately 6.2 km of soft soil. While the need to satisfy waterway requirements, a long structure, avoiding embankments, a significant proportion of the route options would be constructed in the vicinity of Purgatory creek, where some of the deepest soft soils have been encountered during Phase 2 geotechnical investigations.

Ground conditions on the existing highway through Motto Farm and Heatherbrae will present little constraint to the project.

Option B traverses approximately 5.3 km of soft soils, which are predominately located west of the Hunter River. Part of this section will be spanned in structure to meet waterway requirements discussed above. East of the Hunter River, Option B would be constructed on the geological boundary of soft alluvial soils and the Aeolian sand deposit of the Tomago Sand Beds. The constraint to the project along this section of the route will depend on the nature of the transition and precise location of these two soil units. It is likely that the construction of a new embankment adjacent to the existing highway embankment will present a moderate constraint.

South of Heatherbrae, Option B will traverse the western edge of Tomago Sand Beds and no significant constraints related to ground conditions are anticipated.

8.2 Environmental considerations

8.2.1 Terrestrial ecology

Vegetation communities

Option A crosses a number of vegetation communities including four EECs:

- Lower Hunter Spotted Gum Ironbark Forest within Black Hill
- Freshwater Wetland Complex east of Black Hill.
- Swamp Oak Floodplain Forest through the central part of the study area.
- Coastal Saltmarsh along the banks of the Hunter River.

Option B passes across two EECs:

- Lower Hunter Spotted Gum Ironbark Forest in the Black Hill area,
- Swamp Oak Floodplain Forest through the central part of the study area.

Option B also traverses Coastal Sand Apple Blackbutt Forest and plantation/exotic dominated forest in the eastern section of the study area to the south of Motto Farm and Heatherbrae. This option also passes directly north of the Hunter Region Botanic Gardens and adjacent Swamp Sclerophyll Forest and freshwater wetland.

Threatened species

Flora

One threatened flora species, *Callistemon linearifolius*, potentially would be potentially affected by both Options A and B in the Lower Hunter Spotted Gum Ironbark Forest at Black Hill. Seeds and cutting of *Callistemon linearifolius* can be easily collected to assist with mitigating treatments. Potential habitat exists for a further four threatened plant species and these will be investigated during targeted surveys once a preferred route is selected.

Fauna

Potential habitat for 59 threatened and migratory fauna species is potentially affected by both Options A and B (see **Appendix B**).

The potential habitat of an additional six threatened species habitats would be affected by Option B. These are potential habitats for the Green and Golden Bell Frog, Large-footed Myotis, Yellow-bellied Sheath-tailed Bat, Powerful Owl, Black Bittern and Australian Bittern.

Additional species potentially affected by Option A are the threatened Osprey and the migratory Whimbrel and Eastern Curlew.

Wetlands

While the development of route options has avoided direct contact with SEPP 14 wetlands as far as practicable, both Options A and B traverse a portion of at least one SEPP 14 wetland.

Figure 5.7 shows the location of SEPP 14 wetlands within and surrounding the study area.

Option A traverses SEPP 14 wetland no. 832 in the western part of the study area. This would be crossed with a structure and integrated with a fauna underpass. The structure over the Hunter River would also span the edge of SEPP 14 wetland no. 826a.

Option B would pass to the north of Hexham Swamp (SEPP 14 wetland no. 840), but would pass through part of SEPP 14 wetland no 830 located on the eastern bank of the Hunter River. The Option B crossing of SEPP 14 wetland no. 830 would be confined to its eastern edge immediately adjacent to the existing Pacific Highway corridor.

SEPP 14 wetland no. 830 is weed infested, however significant stands of mangroves adjacent to the Hunter River and areas of saltmarsh are present within this wetland complex. The mangroves would be crossed utilising the structure over the Hunter River, within the remainder of this section of Option B crossing SEPP 14 wetland no. 830, on an elevated structure to achieve waterway requirements.

For Options A and B, the impact of an elevated structure shading mangroves and other habitats within these wetlands will be investigated in further studies.

Koala habitat

An area of 'potential' Koala habitat is located to the south of the existing 330 kV overhead electricity transmission corridor at Black Hill (refer to **Figure 5.6**). This habitat area will not be impacted by either option.

Both Options A and B skirt 'core' Koala habitat in the eastern section of the study area (within the Port Stephens LGA) potentially resulting in habitat loss for this species. This area of 'core' Koala habitat is located immediately adjacent to the eastern side of the Pacific Highway. Option B also passes through vegetation that could be considered 'potential' Koala habitat to the east of Heatherbrae. Koalas have been recorded previously on the Tomago Sand Beds and along the Windeyers Creek corridor. Port Stephens Council's *Comprehensive Koala Plan of Management* (June 2002) has been adopted by the DoP and the DoNR (then DIPNR) and supersedes the requirements of SEPP 44 Koala habitat within this LGA. The RTA implements and conforms with best practice management for Koalas.

Connectivity issues

The nature of connectivity issues associated with each of the route options will be assessed to determine the role of culverts/underpasses and other appropriate mitigation measures.

Western section

Both route options would fragment bushland areas in the western section of the study area. Utilities easements, transport corridors and cleared farmland already fragment this block of native vegetation. However, the bushland in this area is potential habitat for threatened flora and fauna species. Consideration of fauna movements in this area would need to be given during refinement and selection of a preferred route.

Route Option B would pass between SEPP 14 wetland nos. 832 and 840, however, a structure in the form of a bridge or culvert is likely to be required to satisfy waterway requirements during flood events. This structure will maintain connectivity between the wetlands and provide for fauna movement.

Central section

The route options would not result in fragmentation of any large areas of bushland in this area.

Eastern section

Route Option B will result in the disturbance of a native vegetation area situated on the edge of Tomago Sand Beds. Loss of vegetation through highway construction could result in additional impacts such as edge effects, including potential weed invasion.

Koala Habitat and EECs including Freshwater Wetland Complexes and Swamp Sclerophyll Forest are located to the immediate south of Option B. It is possible that these habitats could be impacted by edge effects. Consideration to fauna movements in this area would need to be given during refinement and selection of a preferred route.

8.2.2 Aquatic ecology

Option A would cross a small section of Freshwater Wetland Complex of moderate ecological value in the western section of the study area. The wetland could be crossed using standard recommended methods with little effect on its ecology.

Option A would traverse narrow stands of mangroves on each side of the main channel of the Hunter River. Mangroves on both banks of the river (SEPP 14 wetland no. 826a) reach heights of up to seven metres. The mangroves on the western bank are heavily grazed. The route also crosses a narrow belt of Coastal Saltmarsh (a listed ECC under the TSC Act) on the eastern bank of the Hunter River. There is opportunity to compensate for potential habitat disturbance by rehabilitating degraded saltmarsh communities in nearby areas.

The potential also exists for riparian vegetation on the banks of Purgatory Creek to be cleared during construction of Option A.

Option B would traverse a thick stand of mangroves (SEPP 14 wetland no. 830) on the eastern bank of the Hunter River.

Option B passes close to designated Freshwater Wetland Complexes (listed under the TSC Act) which form part of the northern extent of Hexham Swamp in the western section of the study area and in the vicinity of the Hunter Region Botanic Gardens in the eastern part of the study area. It is possible that these habitats could be impacted by edge effects. Appropriate measures to minimise potential edge effects issues will be considered further as part of the development of the preferred route.

For both Options A and B, linkages between the aquatic habitat areas within the study area will need to be considered so that fauna movements are not restricted between feeding and habitat areas.

8.2.3 Urban design, landscape and visual amenity

A proposed urban and landscape design framework for both options is presented in **Figure 8.1**.

Option A traverses a significant area of open floodplain and parallels a set of 330 kV overhead transmission lines.

The proposed Hunter River crossing for Option A is suitable for a landmark bridge structure with low horizontal alignment and abutment structures. A high quality symmetrical bridge with transparent safety barriers allowing views of the Hunter River and floodplain would be desirable.

For the through town section of Option A, significant urban design investigation will be required to ensure that a visually acceptable design can be achieved for the community and road users.

The crossing of the Hunter River for Option B near the existing Hexham Bridges will be highly visible and will require careful consideration.

As Option B parallels the existing highway along the northern edge of the Tomago Sand Beds, east of Heatherbrae, the landscape design will incorporate an appropriate native vegetation schedule to assist in the integration of the project into the local visual setting. Noise mounding and plant screening at the Hunter Region Botanic Gardens could be also considered.

The noise environment of Heatherbrae would be improved with less traffic movements within the town. Reduced traffic through Heatherbrae provides the opportunity for improved connectivity, visual amenity and streetscapes of Heatherbrae.

8.2.4 Water quality

Mechanisms for preventing the influx of contaminants from highway runoff or an accidental chemical or product spillage into the local waterways and wetlands within the study area will be a important issue for consideration in any option traversing the floodplain.

Construction activities may generate increased levels of nutrient-enriched and sediment-laden runoff with the potential to directly enter local waterways. This may result in increased levels of turbidity and disturbance of potentially contaminated sediments that may adversely impact local water quality and aquatic biota. A range of appropriate erosion and sediment control measures will need to be installed during both the construction and operation of the project to minimise the potential of surface water runoff generated during construction and operation of the project on the local water environment.

The potential impact of Options A and B on water quality can be directly correlated to the number, proximity to and sensitivity of the waterways and wetlands each route crosses.

Option B traversing the western edge of the Tomago GMA requires further investigation to determine the measures required to mitigate against any potential accidental spillage incident on the highway. Appropriate control measures implemented on the existing Raymond Terrace to Karuah project would be considered.

Figure 8.1 – Urban design and landscape strategy

8.3 Cultural heritage

8.3.1 Indigenous heritage

Option A crosses an area of high archaeological sensitivity at Black Hill for approximately 2.8 km. This area is known to contain high concentrations of archaeological deposits. Data from the DEC Aboriginal Heritage Information Management System (AHIMS) indicates that Option A would directly impact upon three archaeological sites (two open camp sites, and one isolated find). There is likely to be a potential impact on more sites that are not listed on the AHIMS.

Option A crosses the Hunter Floodplain for 9.2 km, which is considered to be of low archaeological potential to the modified and disturbed state of the land. The connection point with the Pacific Highway north of Heatherbrae is considered to be an area of moderate to high archaeological potential in the vicinity of the Tomago Sand Beds (for 0.8 km).

Option B crosses the area of high archaeological sensitivity at Black Hill, for 2.1 km. As mentioned above, AHIMS data indicates a relatively high presence of archaeological material in this area. Two recorded sites would be directly impacted by Option B (an isolated find and a site newly identified during this study). Option B traverses within the low archaeological potential Hunter Floodplain for 8.4 km, and traverses the moderate-high archaeological potential Tomago Sand Beds area for 3.8 km.

Further studies will be undertaken to identify the areas within Black Hill that contain the highest concentrations of artefacts, enabling options in this area to be refined to minimise impacts.

8.3.2 Non-indigenous heritage

Although there are a number of items of non-indigenous (European) heritage surrounding the study area, there are only a limited number within the study area.

Option A may impact on the Moreton Bay Fig Trees (*Ficus macrophylla*), which are significant features of the landscape character of the area. The trees are located on the edge of the exiting Pacific Highway, north of Hank Street.

Option B does not directly impact upon any items of non-indigenous heritage, however it does skirt the northern boundary of the Hunter Estuary Wetlands, which are 'Registered' on the Register of National Estate. It should be noted that Option B passes near the Oak Factory, approximately 120 metres from the existing Hexham Bridges.

8.4 Land use and property impacts

Option A passes immediately to the south of Glenrowan homestead before continuing east across open floodplain in the central study area. This area is characterised by large parcels of rural land utilised for grazing and limited cropping and the number of properties affected would be small. Generally the option parallels a set of existing 330 kV overhead transmission lines to provide more opportunity for larger land parcels to be located on one side of the route. The exception is lot 2/803276 (property ID 76) where the alignment attempts to parallel the property boundary.

One dwelling, the main house on lot 2/873320 (property ID 10 refer to **Figure 8.2b**) would be located approximately 90 metres from the road reserve of Option A.

Figure 8.2a – Property ID plan

Figure 8.3b – Property ID plan

East of the Hunter River Option A would join the existing Pacific Highway south of the existing equestrian facility before passing through the centre of Motto Farm and Heatherbrae.

Option A passes through Motto Farm and Heatherbrae it will have a direct impact on properties on the northern side of the existing highway with acquisition required. In most cases, dwellings would not be directly affected and changes to visual setting and noise pollution would be mitigated through appropriate design treatments.

To enable the highway to achieve the required design standard for speed (i.e. 110 km/h), acquisition approximately five properties would be required on the southern side of exiting highway. In addition, isolated acquisition of property may be required to facilitate a potential overpass providing connectivity between the northern and southern sides of Heatherbrae.

As direct highway access would not be provided for properties at Motto Farm and Heatherbrae, the impact on existing commercial premises would require careful consideration. Service roads to maintain local traffic access would be provided along property frontage.

Option B also passes through a limited number of large properties in the western section of the study area. These properties would generally be the same as Option A. However, the main house (property ID 10, refer to **Figure 8.2b**) would be a greater distance from the alignment (approximately 175 metres).

Where the options diverge, Option B passes through a small strip of residential dwellings situated between the Main Northern Railway and the New England Highway. These dwellings are typically detached, single storey, weatherboard buildings. This land corridor is zoned '4(b) Urban Services' under the NLEP 2003. The strip of residential properties, are bounded to the east by the New England Highway.

The large parcel of land (Lot 1 in Deposited Plan 748716) adjacent to the Pacific Highway and surrounding the Hunter Region Botanic Gardens is owned by Hunter Water Corporation and leased to the Hunter Region Botanic Gardens for preservation of natural bushland which is open for public viewing. Option B crosses the north western corner of this lot, some properties situated along the Pacific Highway in this locality may need to be acquired.

East of the Hunter Region Botanic Gardens, Option B passes across the northern edge of the Tomago Sand Beds and within 70 metres of an operational bore line. Initial discussions with Hunter Water Corporation have indicated that this alignment is feasible. This alignment also presents an opportunity to define the extent of future industrial development to the south of Heatherbrae and Motto Farm.

Option B would pass through land zoned for industrial purposes but currently remaining as high quality bushland immediately west of Masonite Road. East of Masonite Road, Option B passes through land upon which a commercial shed has recently been constructed, and land which contains the Weathertex Factory. Option B rejoins the Pacific Highway on land zoned industrial adjacent to Windeyer's Creek bridge.

Table 8.1 – Land use impacts

Issue/Impact	Option A – Yellow through town	Option B – Pink eastern
Socio-economic issues		
Number of lots potentially severed or requiring full or partial acquisition	56	32
Number of residential dwellings within 400 metres of option	119 dwellings, Hunter Region Botanic Gardens, Newcastle equestrian, Pacific Gardens Mobile Home (Caravan park), and 1 Farm Homestead (Motel) and Heatherbrae Caravan Park	25 dwellings, Hunter Region Botanic Gardens, Pacific Gardens Mobile Home (Caravan park)
Number of properties within 150 metres of option	144	41
Number of dwellings directly affected	6	2
Number of existing commercial buildings directly affected	None	Large shed intended for commercial purposes. Located in property ID 169
Extent and nature of impacts on existing highway related business	Existing business at the Beresfield Service centre; the Oak Factory and service stations at Hexham are likely to experience loss of passing trade. Existing businesses at Motto Farm and Heatherbrae are likely to experience some loss of trade as a result of limited access required to accommodate the proposed highway. Also potential for restricted visibility to businesses, possibly cause by noise walls	Existing business at the Beresfield Service centre; Motto Farm and Heatherbrae are likely to experience loss of passing trade.

8.4.1 Statutory planning approvals

Options A and B traverse various zonings under the *Newcastle Local Environmental Plan 2003* (NLEP 2003), the *Maitland Local Environmental Plan 1993* (MLEP 1993) and the *Port Stephens Local Environmental Plan 2000* (PS LEP 2000). Actual zonings crossed and their relevant permissibility's in relation to development of a road, have been listed in **Table 8.2** and **Table 8.3.**

Table 8.2 – Option A LEP zonings impacted

LGA	Zones	Notable Prohibitions/ Permissibility's
Newcastle	5(a) Special Uses (Transport)	Under Clause 13 of the NLEP 2003, road construction is **permissible without development consent.**
	7(c) Environmental Investigation Zone	
	7(b) Environmental Protection Zone	
	5(b) Special Uses (Arterial Road)	
Maitland	1(a) Prime Rural Land	Under the MLEP 1993, development of a 'road' is **permissible only with development consent.**
Port Stephens	1(a) Rural Agricultural "A"	Under the PSLEP 2000, the Proposal is **permissible only with development consent.**

Source: Information from Newcastle Local Environmental Plan 2003, the Maitland Local Environmental Plan 1993 and the Port Stephens Local Environmental Plan 2000, analysis by MAPL 2005.

Table 8.3 – Option B – LEP zonings impacted

LGA	Zones	Notable Prohibitions/ Permissibility's
Newcastle	5(a) Special Uses (Transport)	Under Clause 13 of the NLEP 2003, road construction is permissible **without development consent.**
	7(c) Environmental Investigation Zone	
	7(b) Environmental Protection Zone	
	5(b) Special Uses (Arterial Road)	
	4(b) Port and Industry Zone	
Maitland	1(a) Prime Rural Land	Under the MLEP 1993, development of a 'road' is **permissible only with development consent.**
Port Stephens	1(a) Rural Agricultural "A"	Under the PSLEP 2000, the Proposal is **permissible only with development consent.**
	7(a) Environment Protection "A"	
	7(c) Environment Protection "C" (Water Catchment)	
	4(a) Industrial General "A"	

Source: Information from Newcastle Local Environmental Plan 2003, the Maitland Local Environmental Plan 1993 and the Port Stephens Local Environmental Plan 2000, analysis by MAPL 2005.

Where consent is not required under LEP zonings

Development for the purpose of a road is permissible without consent under certain zonings as listed above. Where the route options cross these zones, development is permissible under Part 5 of the EP&A Act.

Where consent is required under LEP zonings

Development for the purpose of a road is permissible only with consent under certain zonings listed above. Clause 35 of the *Environmental Planning & Assessment Model Provisions 1980* provides that:

> *'Nothing in the local environmental plan shall be construed as restricting or prohibiting or enabling the consent authority to restrict or prohibit…the carrying out of development of any description specified in Schedule 1,*

Schedule 1 describes '*any development required in connection with the construction, reconstruction, improvement, maintenance or repair of any road,'* The Newcastle, Maitland and Port Stephens Council have all adopted the Model Provisions or a similar savings provision, however further clarification will be sought on their applicability as part of the preferred route investigations.

Under the provisions of *State Environmental Planning Policy No 4 – Development Without Consent and Miscellaneous Exempt and Complying Development* (SEPP 4) (which applies to classified roads[1] such as the Project) an Environmental Impact Assessment for roads in zones where development of a road is permissible only with development consent would also be covered under the provisions of Part 5 of the EP&A Act.

The planning approvals process under Part 5 of EP&A Act is applicable to both options.

8.4.2 Noise and vibration

The overall impacts of both Options A and B are similar in the area between the F3 Freeway and the New England Highway. It would be unlikely that any additional noise barriers would be required in the Beresfield area but low level noise barriers may be required in the Tarro area. Additionally it would be unlikely that noise barriers would be required to meet new freeway noise criteria at Black Hill due to the buffer distance from the route option alignments. However, at least one isolated residence would require architectural noise treatments for both Options A and B.

It is unlikely that noise mitigation would be required for either of the route options between the New England Highway and the township of Motto Farm, with the exception of individual treatment to isolated residences and the Hunter Region Botanic Gardens.

Between Motto Farm and the Masonite Road roundabout, it is likely that noise barriers would be required for Option B on the western side of Heatherbrae where it branches off the existing alignment. Option A follows the existing road alignment through Heatherbrae and Motto Farm where less stringent noise criteria would apply, however, architectural treatments would be necessary for properties within these settlements if Option A was constructed. It is likely that noise barriers would be required on the northern side of the proposed freeway road at the eastern end of Heatherbrae to protect residential dwellings and the Hunter River High School from noise burden. Some individual residences impacted by noise on the western end of the upgrade may also require individual architectural treatments.

[1] As defined under the Roads Act 1993; 'a main road, a State highway, a freeway, a controlled access road, a secondary road, a tourist road, a tollway, a transitway, a State work.'

Option B has the potential to impact on commercial/ light industrial premises, however, it would be unlikely that mitigation would be required for these premises.

8.5 Construction issues

8.5.1 Highway construction staging

Option A will require considerable staging of construction, particularly through Heatherbrae where it utilises the existing Pacific Highway. This is likely to result in traffic delays during construction. Option B where it parallels the existing highway may also require construction staging and may also result in temporary traffic disruption.

8.5.2 Occupational health and safety in construction

Key Occupational Health and Safety (OH and S) issues for consideration in the construction of Options A and B are as follows:

- Construction at height (all bridges).
- Construction over water (Hunter River, Purgatory Creek).
- Construction over operational railway lines and roads (Main Northern Railway line, F3 Freeway, New England Highway, existing Pacific Highway, Woodlands Close, Masonite road).
- Construction adjacent to existing highways (existing Pacific Highway through Heatherbrae, existing Pacific Highway between Hexham Bridge and the Hunter Region Botanic Gardens).
- Construction within proximity of overhead transmission lines (TransGrid 330 kV and 132 kV Energy Australia lines).
- Construction within proximity of buried power lines (Woodlands close and Heatherbrae/ Motto Farm).
- Construction within proximity of high pressure gas mains (Woodlands Close).

Both Options A and B will require the construction of bridges over existing major infrastructure items including the Main Northern Railway line and the New England Highway. These transport corridors will remain operational during construction of the project. Consideration of construction methodologies and integration of OH and S procedures will be required to promote both the safe construction of the project and operation of the existing highway and railway line.

The Hunter River crossing proposed for Option A will be achieved using a second major structure which will also span part of the floodplain, while the crossing for Option B will be integrated with the structure spanning the Main Northern Railway line and the New England Highway.

Both Options A and B will be constructed within close proximity of underground and overhead utilities. The most evident of these utilities is the TransGrid 330 kV overhead transmission lines which lie in close proximity to Option A for approximately four km and 1.5 km for Option B. The project is offset from these overhead transmission lines at a distance that would allow the transmission line towers to topple and remain clear of the project. Maintaining adequate lateral and overhead clearance during construction is a critical consideration.

In addition to the 330 kV overhead transmission lines, Options A and B will also cross the Energy Australia 132 kV overhead transmission lines near the Hunter Region Botanic Gardens, buried high voltage power and buried high pressure buried gas pipelines. A number of local overhead transmission lines within Heatherbrae and Motto Farm will need to be relocated for

Option A. Appropriate precautions and OH and S procedures will need to be implemented during construction to ensure that utility adjustments and contact is undertaken in a safe manner.

Construction adjacent to the existing highway presents OH and S challenges for Option A through the township of Heatherbrae and Motto Farm, and for Option B, between Hexham Bridge and the Hunter Region Botanic Gardens. Safe egress of construction machinery and workforce will be an important consideration in addressing this issue.

Construction of interchanges for Options A and B at Black Hill, the Masonite Road roundabout and Masonite Road, will also require construction over the operating F3 Freeway, Masonite Road and the Pacific Highway, respectively. An interchange at Tomago Road for Option B would require a structure over the existing Pacific Highway.

9 Project cost and economic analysis

An important aspect of any development is the consideration of project costs. This chapter provides an overview of the economic analysis, undertaken in compliance to relevant NSW and RTA economic appraisal and analysis guidelines (see **Section 9.2**).

9.1 Route options cost estimate

Results acquired from the preliminary specialist investigations conducted in the fields of hydrology, geotechnics, traffic and transportation, and noise and vibration have been integrated with the quantities determined from the route option MX models to generate preliminary strategic cost estimates. These have enabled a relative comparison of the economic viability of Options A and B.

The cost estimates were prepared based on the recommendations and approach for Strategic Estimates outlined in "Project Estimating" prepared by the Project Management Office of the RTA (Document No. RTA-CSD-PMS-PR-M-02). These initial estimates indicate that Option B could be constructed for the lowest cost out of the two options considered.

Table 9.1 – Summary of key project elements

Project Elements	Option A	Option B
Length of Upgrade	12.8 km	13.5 km
Embankment	Generally three metres high with a 4:1 batter	Generally three metres high with a 4:1 batter
Pavement	250 millimetres thick CRCP	250 millimetres thick CRCP
Interchange	Southern interchange at the F3 Freeway (Black Hill) Northern interchange at Masonite Road roundabout	Southern interchange the F3 Freeway (Black Hill) Northern interchange at Masonite Road
Key Structures	Combined crossing of Woodlands Close, the Main Northern Railway line, and the New England Highway Purgatory Creek Bridge Hunter River Bridge	Combined crossing of Woodlands Close, the Main Northern Railway line and the New England Highway, the Hunter River, near the existing Hexham Bridges
New service roads	25 lane km of new local road	8 lane km of new local road

9.2 Economic evaluation

9.2.1 Approach

To ensure that a project delivers value for money to the community, economic appraisals are undertaken to determine the magnitude of benefits generated for a given level of expenditure.

Modelling for the economic appraisal has initially been carried out following cost benefit analysis guidelines outlined in the *RTA Economic Analysis Manual*, Version 2, 1999. This economic appraisal will also be developed to ensure consistency with the NSW Government's *Guidelines for Economic Appraisals (TPP 97-2)* for the processing of items not explicitly covered by the *RTA Economic Analysis Manual*.

The NSW Government's *Guidelines for Economic Appraisals* suggest that the following structure be used:

- Identification of objectives.
- Scope of project.
- Identification of options.
- Identification of quantifiable costs.
- Identification of quantifiable benefits.
- Calculation of net benefits at a real rate of seven per cent.
- Identification of qualitative factors.
- Summary of results.

The economic appraisal will assess whether the development of one of the alignment options would be more beneficial for the community and road users against a base case of allowing traffic to continue using the existing road network.

9.2.2 Scope

The scope of this economic appraisal extends to consider the effects of the project on the community. However, as an initial stage to a wider appraisal of economic benefits and costs, this economic appraisal focuses on road user benefits and costs, which are expected to account for a significant proportion of total benefits and costs from a potential highway upgrade.

9.2.3 Quantitative assessment

The following key assumptions were made:

- All costs and benefits are expressed in December $2004.
- A three year construction period, beginning in 2006 (for the purpose of assessment only).
- A 33-year evaluation period, commencing in 2006 (benefits to be accrued from 2009).
- A real discount rate of seven per cent.
- No real increases in vehicle operating costs (VOCs), vehicle operating time (VOT) or accident costs.

The latest version of the *RTA Economic Analysis Manual* presents parameters in December 2003 dollars. These parameters, where required, have been inflated by 2.6 per cent to index them to December 2004 dollars. The inflation rate of 2.6 per cent represents the increase in the

Consumer Price Index between December 2003 and December 2004 (estimate based on ABS Consumer Price Index data Cat. No. 6401.0).

9.2.4 AADT assumptions

The development and construction of any of the alignment options can be expected to have significant impact on the existing distribution of traffic on the road network within the vicinity. Modelling undertaken for the F3 Freeway to Branxton Project has been considered as has forecast development within the catchment area.

AADT projections take into account general annual growth in traffic as well as the impacts of changes to the existing network (for example, the F3 Freeway to Branxton Project) or land use changes (industrial and residential development in Thornton and Raymond Terrace).

The AADT projections were then used to calculate vehicle km travelled and vehicle hours travelled for the base case and each of the options.

9.2.5 Benefits and costs

Annual user benefits have been estimated as the sum of:

- Vehicle operating cost savings.
- Travel time savings.
- Accident cost savings.

The three user benefits have been estimated, based on estimations made of the travel time and vehicle kilometres for travel under the base case and the two alignment options. The various parameter values used to value vehicle operating costs, travel time savings and accidents are consistent with those presented within Appendix B of the *RTA Economic Analysis Manual.*

Vehicle operating cost savings

Assumptions:

- Naasra Roughness Measure (NRM) count of between 0 and 49 (reflecting very good road conditions on sealed roads).
- Road-volume capacity of 0.5.
- Average speed of 60 km/h along the existing alignment, 110 km/h along new road alignments.

Vehicle operation costs (VOC) estimates prepared for this economic appraisal include:

- Fuel and oil.
- Depreciation.
- Maintenance.
- Wear on tyres and brakes.

The VOC parameters used in this economic appraisal are based on rural road parameters (estimate based on ABS Consumer Price Index data (Cat. No. 6401.0), which account for the following attributes:

- Vehicle class.
- Average vehicle speed.
- Road surface and pavement conditions.
- Horizontal alignment.

- Grading.
- Road-volume capacity.

The origin-destination survey undertaken for this study indicated an average travel speed during the peak periods of 44 to 66 km/h. For the purpose of this assessment a 60 km/h average speed has been assumed.

After accounting for horizontal alignment, grading, average speeds and road-volume capacity the appropriate VOC parameters have been incorporated into the economic appraisal.

VOC, based on estimated AADT and trip lengths, were estimated for each case, with vehicle operating cost savings estimated for each option by taking the difference between the VOC of an option and the VOC of the base case.

Travel time savings

Rural values of time (VOT) parameters were used for the economic appraisal. VOT are based on the following factors:

- Trip type.
- Occupancy.
- Presence of freight.

The *RTA Economic Analysis Manual* recommends an appropriate value of time parameter in dollars per vehicle hour. With a higher proportion of heavy vehicle traffic (14 per cent) than used in the manual, project specific VOT parameters have been developed and used.

The VOT parameter is based on the VOT of five groups, namely private car users, business car users, light commercial truck users, heavy commercial truck users and road train users.

To calculate an estimate of VOT for light and heavy vehicles, users were disaggregated by vehicle class (light and heavy), with the proportion of each type of user within each vehicle class estimated. From these proportions, a weighted VOT parameter was calculated for light and heavy vehicle users.

Travel time savings for each of the road alignment options were calculated by taking the difference between travel time costs for each option and the base case.

Accident cost savings

Assumptions:

A crash rate of 0.10 crashes per MVKT for all proposed road alignment options.

A review of accident rates between 2001 and 2003 reveals that there were 182 accidents on the following roads:

- John Renshaw Drive (between the F3 Freeway and the New England Highway).
- New England Highway (between John Renshaw Drive and the Pacific Highway).
- Pacific Highway (between the New England Highway and Raymond Terrace).

Considered together, these roads form the existing alignment between the end of the F3 Freeway and the Pacific Highway at the Hexham Bridges. Based on a review of historic crash statistics, a crash rate per MVKT has been estimated.

Accident rates published in the *RTA Economic Analysis Manual* were used to estimate the cost of future road accidents. The accident rates include costs for:

- Human costs including ambulance, hospital and medical costs.

- Vehicle costs including repairs and towing.
- General costs including travel delays, police and property.

According to the *RTA Economic Analysis Manual*, the average cost of a rural accident is $139,000 (in 2003 dollar terms). This was inflated by 2.6 per cent to estimate an accident cost in December 2004 dollars ($142,600).

Accident cost savings for each of the road alignment options was estimated by taking the difference between the accident costs under the base case and under each of the road alignment options.

9.2.6 Costs

Construction costs

Assumptions:

Payment of construction costs over three year construction period in three equal instalments, in nominal terms.

Concept costs for the options have been estimated and included in the economic appraisal. For planning purposes, it has been assumed that the nominal construction cost is spread across a three-year period between 2006 and 2008 with the instalment payable annually.

A contingency premium of 30 per cent has been incorporated into the concept cost estimate.

9.2.7 Results

The appraisal models all cash flows over a 33-year period, including the three years of construction between 2006 and 2008, at a (real) discount rate of seven per cent per annum. All cash flows have been discounted to 2005. The discounted cash flows are subsequently used in the calculation of economic indicators. Four economic indicators were calculated as outputs of the economic appraisal to evaluate the relative attractiveness for each of the development options against the base case. A brief description of each indicator is provided as follows:

Net Present Value (NPV): measures the difference between benefits and costs, whilst accounting for the timing of benefits and costs. Net cash flows are discounted at the prescribed discount rate of seven per cent, reflecting the notion that future benefits and costs have less value compared to current benefits and costs. A project with a NPV greater than zero would be considered desirable, with the project having the highest modelled NPV being the most desirable.

Net Present Value Per Dollar of Investment (NPVI): measures the return on a dollar of investment. The NPVI is calculated by dividing the net present value by the present value of investment (construction costs have been used as the proxy for investment). A project with a NPVI greater than zero would be considered desirable, with the project having the highest modelled NPV being most desirable.

Benefit Cost Ratio (BCR): measures the return received per dollar of costs. The BCR is calculated by dividing the present value of all benefits by the present value of all costs. A project with a BCR greater than one would be considered desirable, with the project having the highest BCR being most desirable.

The NPVI and BCR provide a scale in which to compare the relative attractiveness of different projects where the level of expenditure varies between projects.

Internal Rate of Return (IRR): the discount rate required to ensure that NPV is equal to zero. A project with an IRR greater than seven per cent would be considered desirable, with the project with the largest IRR being most desirable.

It is important to note that the above economic indicators, individually, have various weaknesses in assessing the optimum project. Hence, the Guidelines suggest a range of economic indicators to ensure the best project is selected.

The results show, based on the assumptions used, that Options A and B generate net benefits for road users. Both these options have BCR's above 1.0.

It should be noted that the analysis is based on assumptions regarding traffic flows on the proposed road link. Furthermore, the economic appraisal is limited in considering road user costs and benefits. An analysis of other attributes to include wider community effects and impacts have not been included in the appraisal at this stage. A more detailed discussion of these attributes follow in **Chapter 9.2.9**.

9.2.8 Sensitivity analysis

Sensitivity analysis was conducted on key parameters used to underpin the model to test the robustness of inferences made in the previous section. Sensitivity tests were conducted on the following parameters:

- Level of traffic (± 20 per cent).
- Average speed on the existing link (± 10 kmh^{-1}).
- Construction costs (± 20 per cent).
- Discount rates (± 3 per cent).

For simplicity, only the NPV and BCR results were generated.

The results suggest that the economic appraisal results are sensitive to variables including the discount rate, AADT and base speeds although less so for construction costs. Nonetheless, the degree of sensitivity is not to the extent that the conclusions from the economic appraisal would be greatly affected.

9.2.9 Qualitative assessment

A range of factors have been identified that, at this stage, have not, or are not able to be quantified. The *NSW Guidelines for Economic Appraisals* and the *RTA Economic Analysis Manual* allow scope for the detailing of attributes that may impacts on the economic desirability qualitatively. These attributes include:

- Amenity.
- Economic development.
- Property values.
- Environmental.
- Safety.
- Construction dis-benefits.

The possible impact of the abovementioned attributes on the economic desirability of a road link is described briefly as follows:

Economic development

A new highway upgrade has the potential to promote economic development through the provision of greater accessibility and mobility. The reduction in travel time savings combined with better connectivity of industrial areas to high-speed freeway links provides the opportunity to consolidate and develop these areas to take advantage of improved access to key markets. For instance, the road freight business, which accounts for approximately 80 per cent of freight

movements between Brisbane and Sydney (BTRE Information Sheet 22), would be expected to be a major beneficiary from reduced travel times and vehicle operating costs.

The project will also assist in reducing travel times for visitors to the region and to popular holiday destinations located on the mid and far north coast regions of NSW. The reduction in travel times and improved safety conditions through the upgrade will assist the development and further growth of the tourism industry along the NSW North Coast.

Finally, construction spending on the development of a new road link has potential to generate long term growth in employment within the region. Whilst construction positions will be created, the economic multiplier effects from expenditure on construction generally have longer term impacts.

Existing businesses in Motto Farm and Heatherbrae with direct access to the existing Pacific Highway are likely to experience changes in trade levels if the project is relocated to another alignment or if access arrangements on the existing highway are changed substantially. The extent of these impacts is likely to vary in response to factors such as:

- The nature of the business.
- Its reliance on highway-related trade.
- Its ability to develop new/different markets.
- Ameliorative measures incorporated in the design and implementation of the project such as access arrangements and systems to provide advance information to highway users.

Through Heatherbrae there are a range of business types. A number of highway service related businesses exist, such as fast food outlets and service stations, as well as destination based trade such as car dealerships. In any case the local road network or new service roads carrying higher traffic volumes than the project, will continue to provide passing trade opportunities.

An alignment may also have the potential to reduce productivity and density for a given piece of land. This may occur through decreased access and/or a reduction in scale allowed on the land. This effect will potentially have an impact on the productivity of the land and in turn, the economic output that may be produced from the given land.

Property values

Road developments potentially have ambiguous effects on property values. On one hand, a reduction of traffic has the ability to improve amenity, providing a positive effect on residential property values. Residential, commercial and industry land values can be further enhanced by greater accessibility and mobility provided by the development of a new road.

On the other hand, commercial property values may be adversely affected by a diversion. Reduced throughput on a road decreases the potential for passing trade and in turn, decreases the economic rent that landowners are able to extract from tenants. If economic activity is significantly impacted, this may have longer term flow on effects on general land values. Severance caused by a new road link may also reduce property values through reduced access and productivity.

Safety

A key imperative for highway developments such as the F3 Freeway to Raymond Terrace Project is the achievement of road safety improvements principally for highway users but also for local vehicular and pedestrian traffic where this access currently occurs on sections of the highway or intersects with it. These safety benefits are likely to accrue across the wide 'community' of existing and future highway users as well as local communities such as Motto Farm and

Heatherbrae where residents currently have to access or cross the highway for a variety of day-to-day activities.

In the case of this project, safety benefits will be derived by the removal of through traffic from the existing road network. It also provides the community with an alternative route during and incident.

Construction impacts

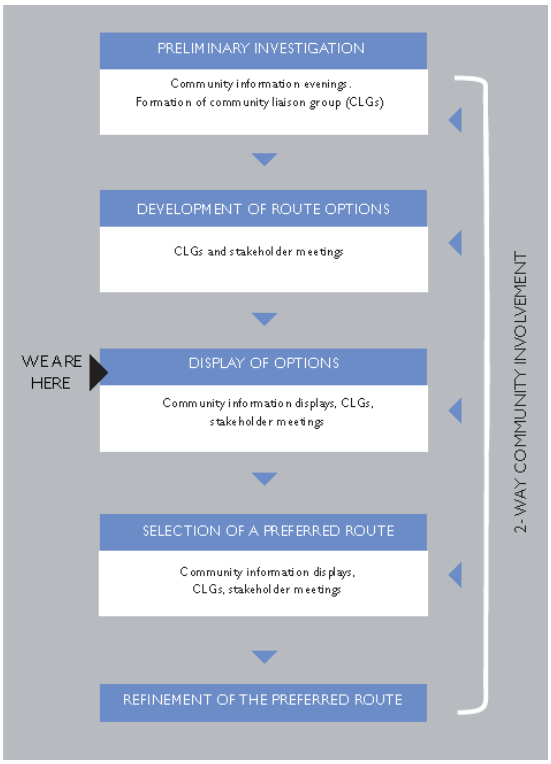
The construction of a road link will bring about negative externalities from the construction activities. These impacts include the possible reduction of travel speeds, increasing the time required to travel between trip ends. Construction of road links also bring about the possibility of accidents with construction workers, noise, water quality and dust issues.

10 Summary of next steps

10.1 Selection of a preferred route

The proposed upgrade of the Pacific Highway between the F3 Freeway and the Raymond Terrace bypass is being developed in a way that is both ecologically sustainable and achieves the best overall outcome for the whole community.

The RTA recognises the importance of achieving a balance between social, ecological, engineering and cost factors while continuing to provide for future transport needs. Most importantly, dual carriageway roads and fewer highway connections will result in a safer road environment.



A preferred route has not been selected at this stage

A preferred route will be selected by considering:

- The community's issues and comments on the route options.
- Information on the physical impact of each of these routes, in relation to economic, ecological, engineering and community issues.
- A value management process which will include a workshop. This workshop will be held with participants from the community, government and technical areas. The workshop will assess the performance of each of the route options against a range of agreed criteria.

10.2 Community comment on the options

Two feasible route options have been identified for further consideration and assessment (refer to **Figure 7.5**).

Community response to the two feasible options an important part of selecting a preferred route. The route options will be on display for approximately four weeks.

As the route options can be linked together in different ways, there are decisions to be made about a preferred route in the western, central and eastern parts of the study area. The community are being invited to consider each of the three sections and provide comments on the reply paid feedback form included with the community update (the feedback form is also available on-line). The community feedback will be integrated into the value management workshop.

10.3 Information on the physical impact of each of these routes

Investigation of the two feasible options will continue in preparation for the value management process.

While the analysis undertaken to date shows that Options A and B or a combination of the two, would provide the most feasible solution in terms of social, economic and environmental considerations, there are still issues to be addressed.

Option A would require detailed planning relating to integration with the Motto Farm and Heatherbrae urban areas. Access, noise, property and constructability issues would require further detailed investigations.

Option B crosses environmentally sensitive areas, passes through a greater area of protected wetlands than Option A and passes through the Tomago Sand Beds.

Both options impact on farmland through the central section of the study area and have varying impacts at Black Hill in terms of disturbance to native vegetation areas, visual and noise impacts across the floodplain and cultural heritage considerations.

A Paramics model is currently under construction to better define the travel time savings and vehicle operating costs. Further work is also underway to better define impacts to the commercial properties of Heatherbrae.

Investigations will continue so that stakeholders can be provided with further detail to allow either options (or combined options) to be fully evaluated using the MCA. The MCA allows comparison of options on a range of performance criteria based on the overall Pacific Highway Upgrading Program objectives and project specific objectives.

10.4 The value management process

The NSW Treasury Value Management Guide (September 2004) states that:

"Value Management may be described as a structured, analytical process for developing innovative, holistic solutions to complex problems".

A value management workshop (VMW) will be held as part of this process following specific methodology to guide key stakeholders in the selection of the preferred route. The workshop is to focus in achieving project objectives via the analysis of options and to suggest value added solutions as required.

A range of stakeholders will participate in the VMW, including representatives from:

- The RTA.
- Maunsell Australia Pty Ltd.
- Department of Planning (DoP) and Department of Natural Resources (DoNR).
- Department of Environment and Conservation (DEC).
- Department of Primary Industries (DPI).
- Newcastle, Port Stephens and Maitland Councils.
- Road User Groups including the NRMA.
- clg representatives.
- Mindaribba and Worimi Local Aboriginal Land Councils.
- Utility providers including Hunter Water Corporation and TransGrid.
- Hunter Central Rivers Catchment Authority.

The VMW will be held around two weeks after the end of the Route Options Display period.

10.5 Announcement of the preferred route

Extensive community consultation would continue.

- The announcement of the preferred route would be advertised in the local media.
- All affected property owners would be contacted by letter and offered meetings with RTA staff to discuss the affects of the preferred route.
- The preferred route would be placed on public display. The display material would provide detailed information on the route and how it was selected.
- A community update would be posted to residents within the study area.
- Details of the preferred route and the selection process would be provided on the project website.
- The clg would be briefed and briefings would be held with councils and stakeholders.

10.6 Refinement of the preferred route

Community comment on the preferred route will assist in its refinement to minimise impacts. In addition, further studies will be undertaken into:

- Urban design / landscape and visual amenity.
- Sources of construction material.
- Road user delay management and traffic impacts during construction.
- Traffic and transport analysis.
- Property impacts and adjustments.
- Temporary infrastructure.
- Stage 2 road safety audit.
- Utilities and services.
- Socio-economic effects.
- Flora and fauna.
- Indigenous and non-indigenous heritage.
- Noise and vibration.
- Air quality.
- Water quality.
- Planning and zoning.
- Land use.
- Hydrology and hydraulics.
- Geotechnical.
- Operational hazards and risks.

10.7 Continuing consultation

Following refinement of the preferred route the concept design and environmental assessment phases would commence.

Community consultation will continue. A clg, updates in the local media, newsletters, meetings with individuals and groups, and a project website will continue to keep the community informed and assist community input.

Appendix A – Route Options Comparison Tables

Assessment of route options

The Stage 2 Detailed Assessment, as described under **Chapter 7.2**, will be performed on Options A and B to determine a preferred route for consideration by the RTA. The draft evaluation criteria selected to assist in the justification of a preferred option for the proposed upgrading are presented in **Table A.1** below.

Table A.1 – Draft Evaluation Criteria

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
Traffic and transportation evaluation criteria				
Pacific Highway Upgrade Program objectives				
Significantly reduced road crashes and serious injuries	Reduces the number of conflict points along this stretch of the highway	(number)	42	42
Reduced travel times and delay	LoS achievable relative to forecast traffic volumes	(LoS) – 2009/2029 for mid-block	New link operates between LOS A and B in both 2009 and 2029 (mid block capacities based on Austroads Guide to Traffic Engineering Practice Part 2 1988).	New link operates between LOS A and B in 2009 and between LOS A and F in 2029 (mid block capacities based on Austroads Guide to Traffic Engineering Practice Part 2 1988).
	Total route length of construction	(km)	12.8	13.5
	Number of intersections/ merge movements	(number)	3	3
Reduced freight transport costs	Extent of travel time savings	(minutes)	To be confirmed following completion of Paramics microsimulation modelling.	

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
Project Specific Objectives				
Develop a dual carriageway road with a route target crash rate of a maximum of 15 crashes per 100 MVK over the project length	Comparison with road crash rate data from other sections of highway built to a similar standard	(statistical analysis)	Target crash rate 0.12	Target crash rate 0.12
Maximise the use of the existing road reserve, where possible	Area of additional land to be acquired beyond the existing road reserve boundaries	(hectares) - area based on a 100 m wide corridor, for comparison purposes only	110	128
Provide intersections designed to at least a Level of Service (LoS) C, 20 years after opening for the 100th Highest Hourly Volume	Level of service 2009 / 2029	LoS	LoS C or better	LoS C or better
Retain or replace existing rest areas within the study area	Extent of existing rest areas retained	(number)	F3 Freeway interchange maintains access to the Beresfield Highway Service Centre. There are no formal rest areas within the study area – signage to Heatherbrae will be provided at the nearest interchange.	F3 Freeway interchange maintains access to the Beresfield Highway Service Centre. There are no formal rest areas within the study area – signage to Heatherbrae will be provided at the nearest interchange.
	Extent and type of provision of new rest areas provided that meet the needs of the travelling public	(qualitative)	Rest areas could be developed at Heatherbrae.	Rest areas could be developed at Heatherbrae.

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
Develop a concept design for a 110 km/h design speed for the vertical alignment and 110 km/h design speed for the horizontal alignment.	Length of route alternative providing 110 km/h design speed for vertical alignment	(km)	Entire route.	Entire route.
	Length of route alternative providing 110 km/h design speed for horizontal alignment	(km)	Entire route.	Entire route.
	Length of road in high risk ASS areas	(km)	Option A crosses 7.2 km of land classified 'High Probability of ASS'	Option A crosses 5.4 km of land classified 'High Probability of ASS'
	Length of road in soft soils	(km)	6.2	5.3
	Length of road on embankment/structure	(km)	7.1	6.0
Economic Evaluation Criteria				
Pacific Highway Upgrade Program Objectives				
A route that supports economic development	Assessment of changes in local access provisions	(qualitative)	Access to community facilities provided via service roads parallel to highway. Improvement in safety and ease of access for Hunter River High School students from east side of highway at Heatherbrae with proposed pedestrian overpass.	Access to community facilities provided via service roads.
	Travel time savings	(minutes)	To be confirmed following completion of Paramics	

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
	compared with 'do minimum' base case		microsimulation modelling	
Maximum effectiveness of expenditure	Level of economic performance	(BCR)	Above 1.0	Above 1.0
Approach to the Integration of ESD Principals				
Pacific Highway Upgrade Program Objectives				
Reconstruction of the route managed in accordance with ESD Principles	Area of native vegetation loss	(hectares) area based on a 100 metres wide corridor, for comparative purposes only	23	38
	Area of SEPP 14 wetland loss	(hectares) area based on a 100 metres wide corridor for new alignments or a 50 metre corridor for duplication of existing Pacific Highway	3.5	4.5
	Number of Endangered Ecological Communities affected.	(number)	4	2
	Number of threatened species (terrestrial) potentially affected.	(number)	Option A has the potential to impact on 64 fauna and 1 flora species	Option B has the potential to impact on 70 fauna and 1 flora species
	Extent of sensitive cultural heritage sensitive areas affected.	(km)	2.8 km within the high sensitivity area at Black Hill	2.1 km within the high sensitivity area at Black Hill

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
			0.8 km within the moderate sensitivity Tomago Sand Beds.	3.8 km within the moderate sensitivity Tomago Sand Beds.
	Non indigenous heritage sites affected.	(number)	Direct impact upon one item: two Moreton Bay Fig Trees (Ficus macrophylla), which are of local significance.	No direct impact – although it does cross immediately north of Hexham Swamp, which is 'Registered' on the Register of National Estate.
	Extent of direct impact on waterways and potential for water quality impacts	(number of waterway crossings, length of bridges, qualitative assessment)	Crossings: 2 Overall length of structures: two to three km Water quality Impact: Moderate	Crossings: 1 Overall length of structures: 1.5 to 2.5 km Water Quality Impact: Moderate
	Length of route in Tomago GMA.	(km)	0 km	2.7 km
	Noise sensitive properties within 150 metres of highway	(number)	119 dwellings Hunter Region Botanic Gardens Newcastle Equestrian Centre Pacific Gardens Mobile Home Park; Motto Farm Homestead; Heatherbrae Caravan Park.	25 dwellings Hunter Region Botanic Gardens Pacific Gardens Mobile Home Park
	Air quality receivers within 150 metres of highway	(qualitative)	Option A would have a higher impact upon urban air quality as it runs through the	Option B would have a lower impact upon urban air quality as it is located away from the

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
			centre of the Motto Farm and Heatherbrae.	residential areas of Motto Farm and Heatherbrae.
Project Specific Objectives				
Provide a flood immunity on at least one carriageway between 1% AEP (target) and 20% AEP (absolute minimum)	Length and proportion of carriageway situated in one per cent AEP flood area	(km and per cent)	5.6 (43 per cent)	5.3 (39 per cent)
Land Use Evaluation Criteria				
Project Specific Objectives				
Provide transport developments which are complimentary with land use	Compatibility with existing and proposed land use zonings	(qualitative assessment)	Existing and future land use zonings have been considered in the development of route options.	
	Extent and nature of impacts on existing highway related businesses and other businesses.	(qualitative assessment)	Existing business at the Beresfield Highway Service Centre; the Oak Factory and service stations at Hexham are likely to experience loss of passing highway trade.	Existing business at the Beresfield Highway Service Centre; Motto Farm and Heatherbrae are likely to experience loss of passing highway trade.
			Existing businesses at Motto Farm and Heatherbrae are likely to experience some loss of highway trade access.	
	Length of road through visually sensitive areas	(km)	The alignment crosses six km of floodplain, much of which would be visible from	The alignment crosses four km of floodplain, much of which would be visible from

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
			surrounding elevated areas and at least one kilometre would be visible from Woods gully. The through-route would have significant visual impacts on Heatherbrae's urban environment.	surrounding elevated areas, and at least one kilometre from Woods Gully. Option B would not be visible from Heatherbrae due to the surrounding forested corridor.
	Length of road traversing Class 1-3 agricultural land	(km and hectares)	Data unavailable to assess impacts.	Data unavailable to assess impacts.
	Extent and nature of agricultural businesses affected	(number and qualitative assessment)	Option A affects seven major landowners utilising their land for the grazing of cattle except one which is a horse racing stud farm.	Option B affects three major landowners utilising their land for the grazing of cattle.
Community Evaluation Criteria				
Pacific Highway Upgrading Program Objectives				
A community satisfied with the physical development of the route	Area of land to be acquired from non government property owners.	(hectares) area based on a 100 metre wide corridor, for comparative purposes only	69	85
	Ability for key local movements to be maintained in a convenient direct manor. Local movements include: Woodberry/Beresfield to Heatherbrae/Raymond	(qualitative)	Connectivity of local movements would be maintained on existing highway and on service roads through Heatherbrae. The location of interchanges will	Local movements would all occur on the existing highway that will be maintained depending on location of interchanges, this option could also provide –

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
	Terrace Woodberry/Beresfield to Hexham Raymond Terrace/Heatherbrae to Hexham		impact on the volume of traffic using the service roads.	Woodberry-Beresfield to Heatherbrae/Raymond Terrace at the New England Highway.
	Ability for route to not obstruct major view corridors	(qualitative)	The alignment traverses six km of floodplain, of which at least one kilometre would be highly visible from Black Hill. Grade separated structures of high architectural quality, would be required to cross the Main Northern Railway line. The Hunter River Bridge would be dominant in the local landscape and visible from Heatherbrae and highly visible from the existing highway. It is unlikely to be visible from Tarro/ Woodberry.	The alignment traverses four km of floodplain, of which at least one kilometre would be highly visible from Black Hill. Design flexibility in the proportions and spanning arrangements of the new Hunter River Bridge would be complicated (to avoid existing infrastructure), and the structure would be dominant in the local landscape. It is unlikely to be visible from Tarro/ Woodberry

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
Project Specific Objectives				
Integrate input from the local communities into development of the project through the implementation of a comprehensive program of community consultation	Dwellings and commercial buildings potentially affected and / or displaced by acquisition.	(number of properties)	A residence within property ID 10 would be approximately 90 metres from road reserve. Strip acquisition of frontages along the existing Pacific Highway would affect property ID's 240 to 247, 249 and 250. Property ID's 222 to 230 would also be affected.	A residence within property ID 10 would be more than 175 metres from the option. Property ID's 246, 247 and 248 would be affected. A large shed located within property ID 169 would be affected. The Masonite Factory within property ID 168 would also be affected.
	Potential to sustain businesses reliant on highway through trade.	(qualitative)	May provide visual connection at Motto Farm and Heatherbrae to businesses but direct access will not be maintained.	Existing highway will continue to pass through Motto Farm and Heatherbrae. Depending on the location and arrangements of interchanges, advisory signage will be provided to inform road users of services at Motto Farm and Heatherbrae.
	Number of lots requiring partial of full acquisition	(number – excludes road and rail corridors)	56	32

Appendix B – Threatened species in the vicinity of Options A and B

Table B.2 – Terrestrial fauna that have been recorded or have potential habitat in the vicinity of route options A and B

Common Name	Route Options with Potential Habitat[1]
Green and Golden Bell Frog	Option B in the eastern section
Collared Sparrowhawk	Options A and B in the western section and Route Option B in the eastern section
Brown Goshawk	Options A and B in the western section, Option A in the central section and Route Option B in the eastern section
Clamorous Reed-Warbler	Options A and B in the western section and Route Option B in the eastern section
Chestnut Teal	Options A and B in the western and central sections and Option B in the eastern section
Grey Teal	Options A and B in the western and central sections and Option B in the eastern section
Australasian Shoveler	Options A and B in the western and central sections
Pacific Black Duck	Options A and B in the western and central sections, and Option B in the eastern section
Magpie Goose	Options A and B in the western section
Wedge-Tailed Eagle	Options A and B in the western section and Option B in the eastern section
Cattle Egret	Options A and B in the western and central sections and Option B in the eastern section
Hardhead	Options A and B in the western section and Option B in the eastern section
Australasian Bittern	Option B in the eastern section
Glossy Black-Cockatoo	Options A and B in the western section and Option B in the eastern section
Australian Wood Duck	Options A and B in the western and central sections and Option B in the eastern section
Speckled Warbler	Options A and B in the western section
Swamp Harrier	Options A and B in the western and central sections and Option B in the eastern section
Brown Treecreeper	Options A and B in the western section and Option B in the eastern section
Cicadabird	Options A and B in the western section and Option B in the eastern section
Black Swan	Options A and B in the western and central sections and Option B in the eastern section
Black-shouldered Kite	Options A and B in the western and central sections
Black-necked Stork	Options A and B in the western section and Option B in the central section
Brown Falcon	Options A and B in the western and central sections and Option B in the eastern section
Nankeen Kestrel	Options A and B in the western and central sections
Australian Hobby	Options A and B in the western section and Option A in the central section
Peregrine Falcon	Options A and B in the western and central sections and Option B in the eastern section
Latham's Snipe	Options A and B in the western and central sections
Pied Oystercatcher	Options A and B in the western section and Option A in the central section
White-bellied Sea-Eagle	Option A in the central section, and Option B in the eastern section
Black-breasted Buzzard	Options A and B in the western and central sections and Option B in the eastern section

Common Name	Route Options with Potential Habitat[1]
Black-winged Stilt	Options A and B in the western and central sections and Option B in the eastern section
White-throated Needletail	Options A and B in the western section and Option B in the eastern section
Comb-crested Jacana	Options A and B in the western section and Option B in the eastern section
Black Bittern	Option B in the eastern section
Swift Parrot	Options A and B in the western section and Option B in the eastern section
Square-tailed Kite	Options A and B in the western section and Option B in the eastern section
Tawny Grassbird	Options A and B in the western and central sections and Option B in the eastern section
Hooded Robin	Options A and B in the western section and Option B in the eastern section
Black-chinned Honeyeater	Options A and B in the western section
Black Kite	Options A and B in the western and central sections and Option B in the eastern section
Black-faced Monarch	Options A and B in the western section
Satin Flycatcher	Options A and B in the western section and Option B in the eastern section
Turquoise Parrot	Options A and B in the western section and Option B in the eastern section
Barking Owl	Options A and B in the western section and Option B in the eastern section
Powerful Owl	Option B in the eastern section
Eastern Curlew	Option A in the central and Option B in the central section
Whimbrel	Option A in the central and Option B in the central section
Osprey	Option A in the central and Option B in the central section
Grey-crowned Babbler	Options A and B in the western section and Option B in the eastern section
Rufous Fantail	Options A and B in the western section and Option B in the eastern section
Australian Painted Snipe	Options A and B in the western and central sections and Option B in the eastern section
Little Tern	Options A and B in the western and central sections
Common Greenshank	Options A and B in the western and central sections
Marsh Sandpiper	Options A and B in the western and central sections
Masked Owl	Options A and B in the western section and Option B in the eastern section
Masked Lapwing	Options A and B in the western and central sections and Option B in the eastern section
Regent Honeyeater	Options A and B in the western section and Option B in the eastern section
Large-eared Pied Bat	Options A and B in the western section and Option B in the eastern section
Eastern False Pipistrelle	Options A and B in the western section and Option B in the eastern section
Little Bent-wing-bat	Options A and B in the western section and Option B in the eastern section
Eastern Bent-wing Bat	Options A and B in the western section and Option B in the eastern section
Eastern Freetail-bat	Options A and B in the western section and Option B in the eastern section
Large-footed Myotis	Option A in the central and Option B in the eastern section
Squirrel Glider	Options A and B in the western section and Option B in the eastern section
Brush-tailed Phascogale	Options A and B in the western section and Option B in the eastern section
Koala	Option B in the eastern section

Common Name	Route Options with Potential Habitat[1]
Long-nosed Potoroo	Option B in the eastern section
Grey-headed Flying-fox	Options A and B in the western section and Option B in the eastern section
Yellow-bellied Sheathtail-bat	Option B in the eastern section
Greater Broad-nosed Bat	Options A and B in the western section and Option B in the eastern section

[1]The study area was divided into western, central and eastern sections for the purposes of the specialist investigation undertaken for terrestrial ecology. These divisions have been retained within this section for ease of discussion.

`

Appendix A – Route Options Comparison Tables

Assessment of route options

The Stage 2 Detailed Assessment, as described under **Chapter 7.2**, will be performed on Options A and B to determine a preferred route for consideration by the RTA. The draft evaluation criteria selected to assist in the justification of a preferred option for the proposed upgrading are presented in **Table A.1** below.

Table A.1 – Draft Evaluation Criteria

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
Traffic and transportation evaluation criteria				
Pacific Highway Upgrade Program objectives				
Significantly reduced road crashes and serious injuries	Reduces the number of conflict points along this stretch of the highway	(number)	42	42
Reduced travel times and delay	LoS achievable relative to forecast traffic volumes	(LoS) – 2009/2029 for mid-block	New link operates between LOS A and B in both 2009 and 2029 (mid block capacities based on Austroads Guide to Traffic Engineering Practice Part 2 1988).	New link operates between LOS A and B in 2009 and between LOS A and F in 2029 (mid block capacities based on Austroads Guide to Traffic Engineering Practice Part 2 1988).
	Total route length of construction	(km)	12.8	13.5
	Number of intersections/ merge movements	(number)	3	3
Reduced freight transport costs	Extent of travel time savings	(minutes)	To be confirmed following completion of Paramics microsimulation modelling.	

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
Project Specific Objectives				
Develop a dual carriageway road with a route target crash rate of a maximum of 15 crashes per 100 MVK over the project length	Comparison with road crash rate data from other sections of highway built to a similar standard	(statistical analysis)	Target crash rate 0.12	Target crash rate 0.12
Maximise the use of the existing road reserve, where possible	Area of additional land to be acquired beyond the existing road reserve boundaries	(hectares) - area based on a 100 m wide corridor, for comparison purposes only	110	128
Provide intersections designed to at least a Level of Service (LoS) C, 20 years after opening for the 100th Highest Hourly Volume	Level of service 2009 / 2029	LoS	LoS C or better	LoS C or better
Retain or replace existing rest areas within the study area	Extent of existing rest areas retained	(number)	F3 Freeway interchange maintains access to the Beresfield Highway Service Centre. There are no formal rest areas within the study area – signage to Heatherbrae will be provided at the nearest interchange.	F3 Freeway interchange maintains access to the Beresfield Highway Service Centre. There are no formal rest areas within the study area – signage to Heatherbrae will be provided at the nearest interchange.
	Extent and type of provision of new rest areas provided that meet the needs of the travelling public	(qualitative)	Rest areas could be developed at Heatherbrae.	Rest areas could be developed at Heatherbrae.

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
Develop a concept design for a 110 km/h design speed for the vertical alignment and 110 km/h design speed for the horizontal alignment.	Length of route alternative providing 110 km/h design speed for vertical alignment	(km)	Entire route.	Entire route.
	Length of route alternative providing 110 km/h design speed for horizontal alignment	(km)	Entire route.	Entire route.
	Length of road in high risk ASS areas	(km)	Option A crosses 7.2 km of land classified 'High Probability of ASS'	Option A crosses 5.4 km of land classified 'High Probability of ASS'
	Length of road in soft soils	(km)	6.2	5.3
	Length of road on embankment/structure	(km)	7.1	6.0
Economic Evaluation Criteria				
Pacific Highway Upgrade Program Objectives				
A route that supports economic development	Assessment of changes in local access provisions	(qualitative)	Access to community facilities provided via service roads parallel to highway. Improvement in safety and ease of access for Hunter River High School students from east side of highway at Heatherbrae with proposed pedestrian overpass.	Access to community facilities provided via service roads.
	Travel time savings	(minutes)	To be confirmed following completion of Paramics	

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
	compared with 'do minimum' base case		microsimulation modelling	
Maximum effectiveness of expenditure	Level of economic performance	(BCR)	Above 1.0	Above 1.0
Approach to the Integration of ESD Principals				
Pacific Highway Upgrade Program Objectives				
Reconstruction of the route managed in accordance with ESD Principles	Area of native vegetation loss	(hectares) area based on a 100 metres wide corridor, for comparative purposes only	23	38
	Area of SEPP 14 wetland loss	(hectares) area based on a 100 metres wide corridor for new alignments or a 50 metre corridor for duplication of existing Pacific Highway	3.5	4.5
	Number of Endangered Ecological Communities affected.	(number)	4	2
	Number of threatened species (terrestrial) potentially affected.	(number)	Option A has the potential to impact on 64 fauna and 1 flora species	Option B has the potential to impact on 70 fauna and 1 flora species
	Extent of sensitive cultural heritage sensitive areas affected.	(km)	2.8 km within the high sensitivity area at Black Hill	2.1 km within the high sensitivity area at Black Hill

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
			0.8 km within the moderate sensitivity Tomago Sand Beds.	3.8 km within the moderate sensitivity Tomago Sand Beds.
	Non indigenous heritage sites affected.	(number)	Direct impact upon one item: two Moreton Bay Fig Trees (Ficus macrophylla), which are of local significance.	No direct impact – although it does cross immediately north of Hexham Swamp, which is 'Registered' on the Register of National Estate.
	Extent of direct impact on waterways and potential for water quality impacts	(number of waterway crossings, length of bridges, qualitative assessment)	Crossings: 2 Overall length of structures: two to three km Water quality Impact: Moderate	Crossings: 1 Overall length of structures: 1.5 to 2.5 km Water Quality Impact: Moderate
	Length of route in Tomago GMA.	(km)	0 km	2.7 km
	Noise sensitive properties within 150 metres of highway	(number)	119 dwellings Hunter Region Botanic Gardens Newcastle Equestrian Centre Pacific Gardens Mobile Home Park; Motto Farm Homestead; Heatherbrae Caravan Park.	25 dwellings Hunter Region Botanic Gardens Pacific Gardens Mobile Home Park
	Air quality receivers within 150 metres of highway	(qualitative)	Option A would have a higher impact upon urban air quality as it runs through the	Option B would have a lower impact upon urban air quality as it is located away from the

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
			centre of the Motto Farm and Heatherbrae.	residential areas of Motto Farm and Heatherbrae.
Project Specific Objectives				
Provide a flood immunity on at least one carriageway between 1% AEP (target) and 20% AEP (absolute minimum)	Length and proportion of carriageway situated in one per cent AEP flood area	(km and per cent)	5.6 (43 per cent)	5.3 (39 per cent)
Land Use Evaluation Criteria				
Project Specific Objectives				
Provide transport developments which are complimentary with land use	Compatibility with existing and proposed land use zonings	(qualitative assessment)	Existing and future land use zonings have been considered in the development of route options.	
	Extent and nature of impacts on existing highway related businesses and other businesses.	(qualitative assessment)	Existing business at the Beresfield Highway Service Centre; the Oak Factory and service stations at Hexham are likely to experience loss of passing highway trade.	Existing business at the Beresfield Highway Service Centre; Motto Farm and Heatherbrae are likely to experience loss of passing highway trade.
			Existing businesses at Motto Farm and Heatherbrae are likely to experience some loss of highway trade access.	
	Length of road through visually sensitive areas	(km)	The alignment crosses six km of floodplain, much of which would be visible from	The alignment crosses four km of floodplain, much of which would be visible from

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
			surrounding elevated areas and at least one kilometre would be visible from Woods gully. The through-route would have significant visual impacts on Heatherbrae's urban environment.	surrounding elevated areas, and at least one kilometre from Woods Gully. Option B would not be visible from Heatherbrae due to the surrounding forested corridor.
	Length of road traversing Class 1-3 agricultural land	(km and hectares)	Data unavailable to assess impacts.	Data unavailable to assess impacts.
	Extent and nature of agricultural businesses affected	(number and qualitative assessment)	Option A affects seven major landowners utilising their land for the grazing of cattle except one which is a horse racing stud farm.	Option B affects three major landowners utilising their land for the grazing of cattle.
Community Evaluation Criteria				
Pacific Highway Upgrading Program Objectives				
A community satisfied with the physical development of the route	Area of land to be acquired from non government property owners.	(hectares) area based on a 100 metre wide corridor, for comparative purposes only	69	85
	Ability for key local movements to be maintained in a convenient direct manor. Local movements include: Woodberry/Beresfield to Heatherbrae/Raymond	(qualitative)	Connectivity of local movements would be maintained on existing highway and on service roads through Heatherbrae. The location of interchanges will	Local movements would all occur on the existing highway that will be maintained depending on location of interchanges, this option could also provide –

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
	Terrace Woodberry/Beresfield to Hexham Raymond Terrace/Heatherbrae to Hexham		impact on the volume of traffic using the service roads.	Woodberry-Beresfield to Heatherbrae/Raymond Terrace at the New England Highway.
	Ability for route to not obstruct major view corridors	(qualitative)	The alignment traverses six km of floodplain, of which at least one kilometre would be highly visible from Black Hill. Grade separated structures of high architectural quality, would be required to cross the Main Northern Railway line. The Hunter River Bridge would be dominant in the local landscape and visible from Heatherbrae and highly visible from the existing highway. It is unlikely to be visible from Tarro/ Woodberry.	The alignment traverses four km of floodplain, of which at least one kilometre would be highly visible from Black Hill. Design flexibility in the proportions and spanning arrangements of the new Hunter River Bridge would be complicated (to avoid existing infrastructure), and the structure would be dominant in the local landscape. It is unlikely to be visible from Tarro/ Woodberry

Pacific Highway Upgrade Program and project objectives	Evaluation criteria	Units of measurements	Option A yellow	Option B pink
Project Specific Objectives				
Integrate input from the local communities into development of the project through the implementation of a comprehensive program of community consultation	Dwellings and commercial buildings potentially affected and / or displaced by acquisition.	(number of properties)	A residence within property ID 10 would be approximately 90 metres from road reserve. Strip acquisition of frontages along the existing Pacific Highway would affect property ID's 240 to 247, 249 and 250. Property ID's 222 to 230 would also be affected.	A residence within property ID 10 would be more than 175 metres from the option. Property ID's 246, 247 and 248 would be affected. A large shed located within property ID 169 would be affected. The Masonite Factory within property ID 168 would also be affected.
	Potential to sustain businesses reliant on highway through trade.	(qualitative)	May provide visual connection at Motto Farm and Heatherbrae to businesses but direct access will not be maintained.	Existing highway will continue to pass through Motto Farm and Heatherbrae. Depending on the location and arrangements of interchanges, advisory signage will be provided to inform road users of services at Motto Farm and Heatherbrae.
	Number of lots requiring partial of full acquisition	(number – excludes road and rail corridors)	56	32

Appendix B – Threatened species in the vicinity of Options A and B

Table B.2 – Terrestrial fauna that have been recorded or have potential habitat in the vicinity of route options A and B

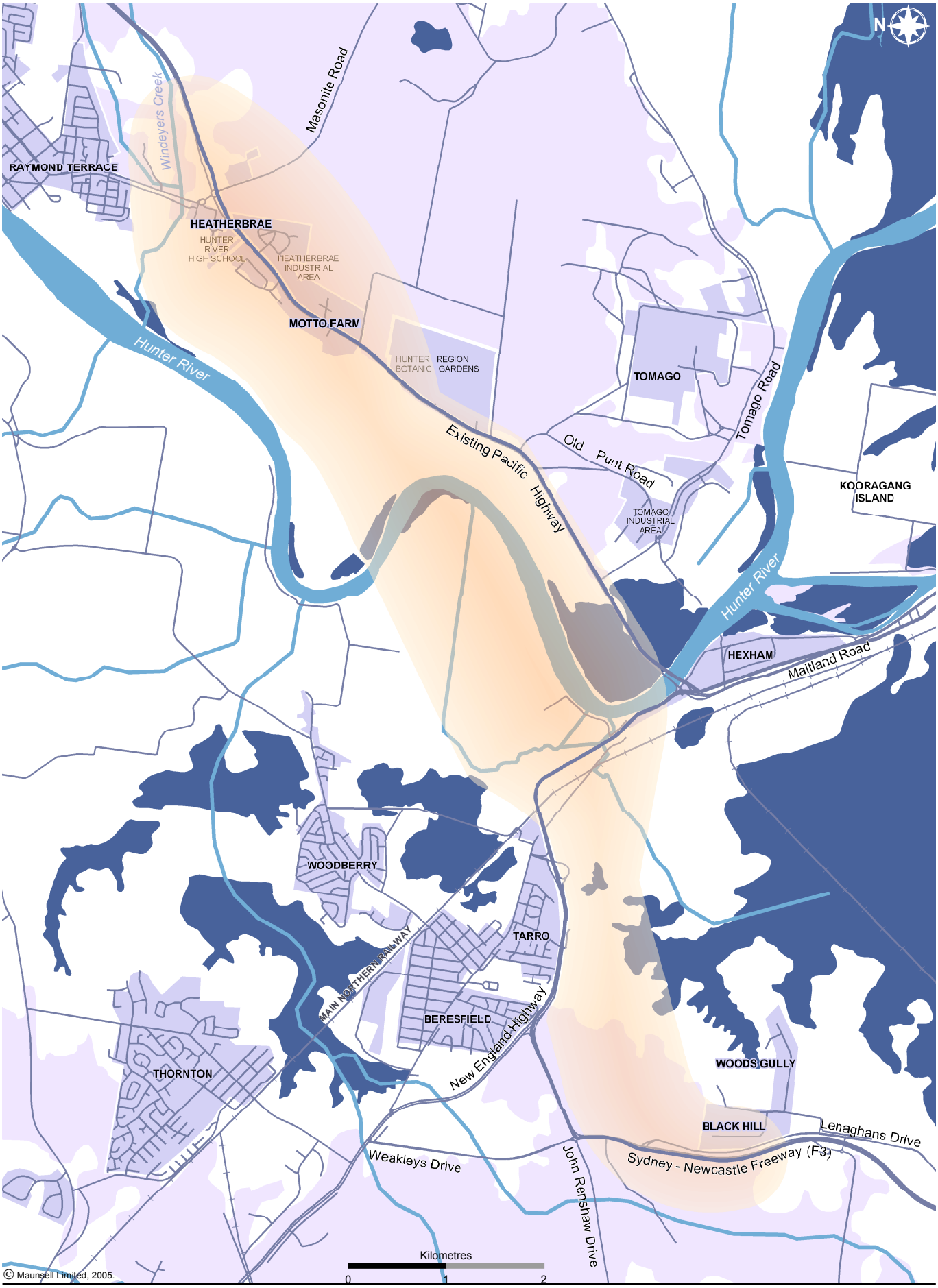
Common Name	Route Options with Potential Habitat[1]
Green and Golden Bell Frog	Option B in the eastern section
Collared Sparrowhawk	Options A and B in the western section and Route Option B in the eastern section
Brown Goshawk	Options A and B in the western section, Option A in the central section and Route Option B in the eastern section
Clamorous Reed-Warbler	Options A and B in the western section and Route Option B in the eastern section
Chestnut Teal	Options A and B in the western and central sections and Option B in the eastern section
Grey Teal	Options A and B in the western and central sections and Option B in the eastern section
Australasian Shoveler	Options A and B in the western and central sections
Pacific Black Duck	Options A and B in the western and central sections, and Option B in the eastern section
Magpie Goose	Options A and B in the western section
Wedge-Tailed Eagle	Options A and B in the western section and Option B in the eastern section
Cattle Egret	Options A and B in the western and central sections and Option B in the eastern section
Hardhead	Options A and B in the western section and Option B in the eastern section
Australasian Bittern	Option B in the eastern section
Glossy Black-Cockatoo	Options A and B in the western section and Option B in the eastern section
Australian Wood Duck	Options A and B in the western and central sections and Option B in the eastern section
Speckled Warbler	Options A and B in the western section
Swamp Harrier	Options A and B in the western and central sections and Option B in the eastern section
Brown Treecreeper	Options A and B in the western section and Option B in the eastern section
Cicadabird	Options A and B in the western section and Option B in the eastern section
Black Swan	Options A and B in the western and central sections and Option B in the eastern section
Black-shouldered Kite	Options A and B in the western and central sections
Black-necked Stork	Options A and B in the western section and Option B in the central section
Brown Falcon	Options A and B in the western and central sections and Option B in the eastern section
Nankeen Kestrel	Options A and B in the western and central sections
Australian Hobby	Options A and B in the western section and Option A in the central section
Peregrine Falcon	Options A and B in the western and central sections and Option B in the eastern section
Latham's Snipe	Options A and B in the western and central sections
Pied Oystercatcher	Options A and B in the western section and Option A in the central section
White-bellied Sea-Eagle	Option A in the central section, and Option B in the eastern section
Black-breasted Buzzard	Options A and B in the western and central sections and Option B in the eastern section

Common Name	Route Options with Potential Habitat[1]
Black-winged Stilt	Options A and B in the western and central sections and Option B in the eastern section
White-throated Needletail	Options A and B in the western section and Option B in the eastern section
Comb-crested Jacana	Options A and B in the western section and Option B in the eastern section
Black Bittern	Option B in the eastern section
Swift Parrot	Options A and B in the western section and Option B in the eastern section
Square-tailed Kite	Options A and B in the western section and Option B in the eastern section
Tawny Grassbird	Options A and B in the western and central sections and Option B in the eastern section
Hooded Robin	Options A and B in the western section and Option B in the eastern section
Black-chinned Honeyeater	Options A and B in the western section
Black Kite	Options A and B in the western and central sections and Option B in the eastern section
Black-faced Monarch	Options A and B in the western section
Satin Flycatcher	Options A and B in the western section and Option B in the eastern section
Turquoise Parrot	Options A and B in the western section and Option B in the eastern section
Barking Owl	Options A and B in the western section and Option B in the eastern section
Powerful Owl	Option B in the eastern section
Eastern Curlew	Option A in the central and Option B in the central section
Whimbrel	Option A in the central and Option B in the central section
Osprey	Option A in the central and Option B in the central section
Grey-crowned Babbler	Options A and B in the western section and Option B in the eastern section
Rufous Fantail	Options A and B in the western section and Option B in the eastern section
Australian Painted Snipe	Options A and B in the western and central sections and Option B in the eastern section
Little Tern	Options A and B in the western and central sections
Common Greenshank	Options A and B in the western and central sections
Marsh Sandpiper	Options A and B in the western and central sections
Masked Owl	Options A and B in the western section and Option B in the eastern section
Masked Lapwing	Options A and B in the western and central sections and Option B in the eastern section
Regent Honeyeater	Options A and B in the western section and Option B in the eastern section
Large-eared Pied Bat	Options A and B in the western section and Option B in the eastern section
Eastern False Pipistrelle	Options A and B in the western section and Option B in the eastern section
Little Bent-wing-bat	Options A and B in the western section and Option B in the eastern section
Eastern Bent-wing Bat	Options A and B in the western section and Option B in the eastern section
Eastern Freetail-bat	Options A and B in the western section and Option B in the eastern section
Large-footed Myotis	Option A in the central and Option B in the eastern section
Squirrel Glider	Options A and B in the western section and Option B in the eastern section
Brush-tailed Phascogale	Options A and B in the western section and Option B in the eastern section
Koala	Option B in the eastern section

Common Name	Route Options with Potential Habitat[1]
Long-nosed Potoroo	Option B in the eastern section
Grey-headed Flying-fox	Options A and B in the western section and Option B in the eastern section
Yellow-bellied Sheathtail-bat	Option B in the eastern section
Greater Broad-nosed Bat	Options A and B in the western section and Option B in the eastern section

[1]The study area was divided into western, central and eastern sections for the purposes of the specialist investigation undertaken for terrestrial ecology. These divisions have been retained within this section for ease of discussion.

`

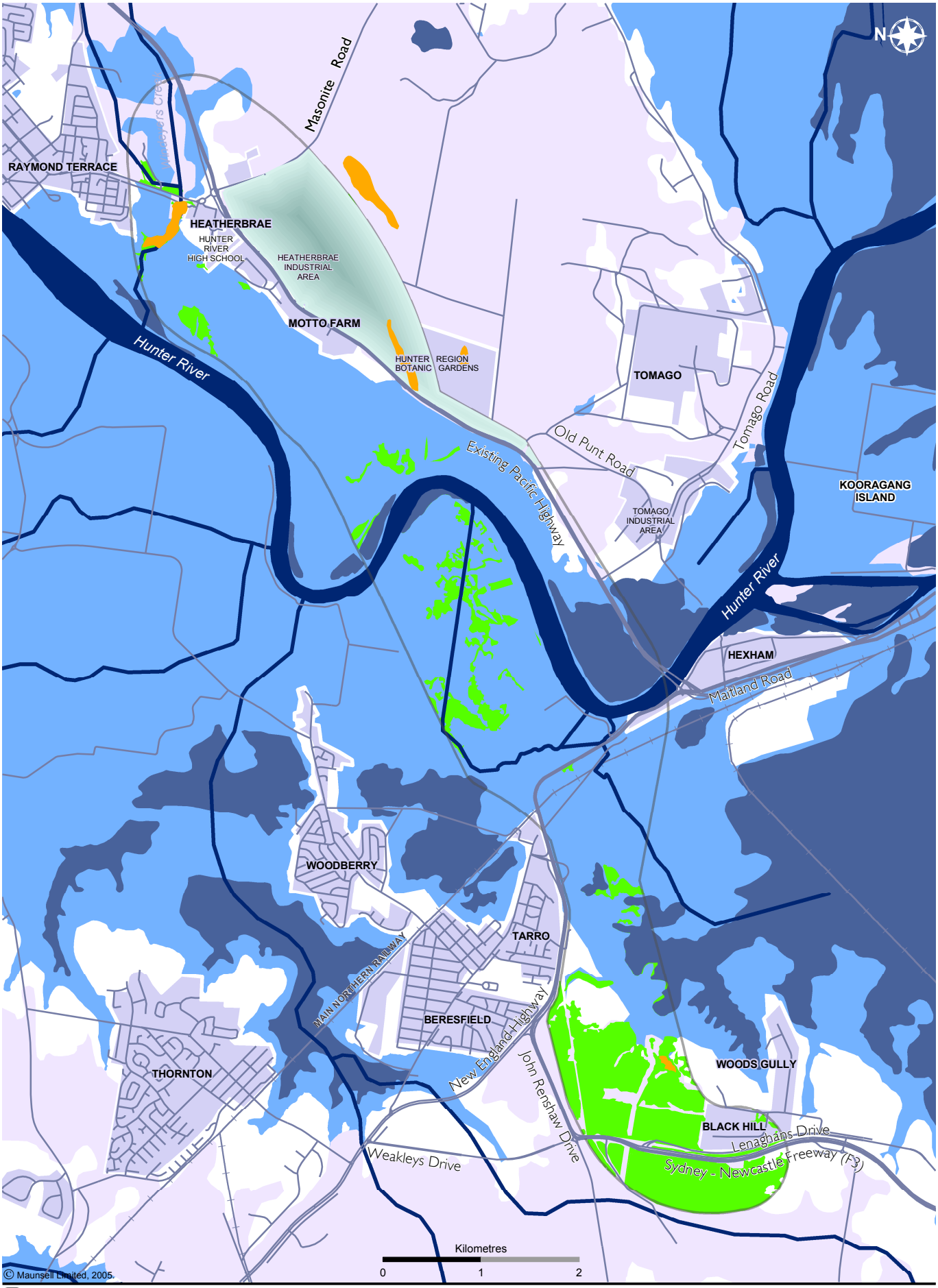


Data Sources: RTA (2004), Maunsell (2005), DIPNR (2004), LPI (2004)

Date: 2 June, 2005 5:41:43 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig1_2_StudyArea.mxd

- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE ES.1.2: STUDY AREA



Study area
Main Northern Railway line
Existing traffic route
Local road
Waterway
SEPP 14 wetlands
Vegetated area
Built-up area
Core and potential koala habitat
Endangered Ecological Community
1% Annual Exceedance Probability level
Tomago Groundwater Management Area

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE ES.1.3: ENVIRONMENTAL CONTEXT PLAN

Date: 2 June, 2005 5:34:37 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_FigES_2_EnvContext.mxd Data Sources: RTA (2004), Maunsell (2005), DIPNR (2004), LPI (2004), Biosis (2005)

Project Location

Karuah Bypass Completed

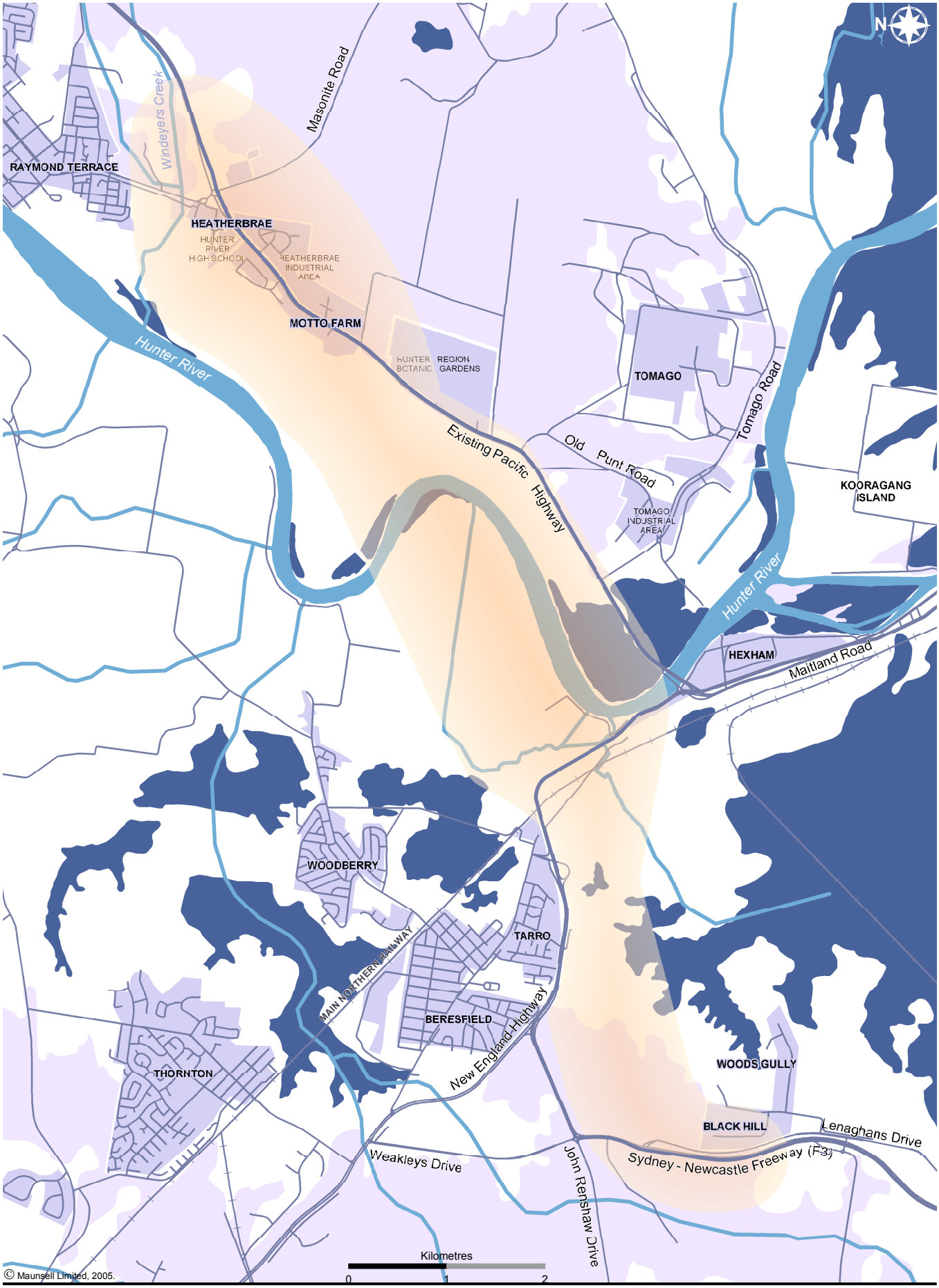
Tugun Bypass To be Completed

NSW Border

NSW ROADS AND TRAFFIC AUTHORITY

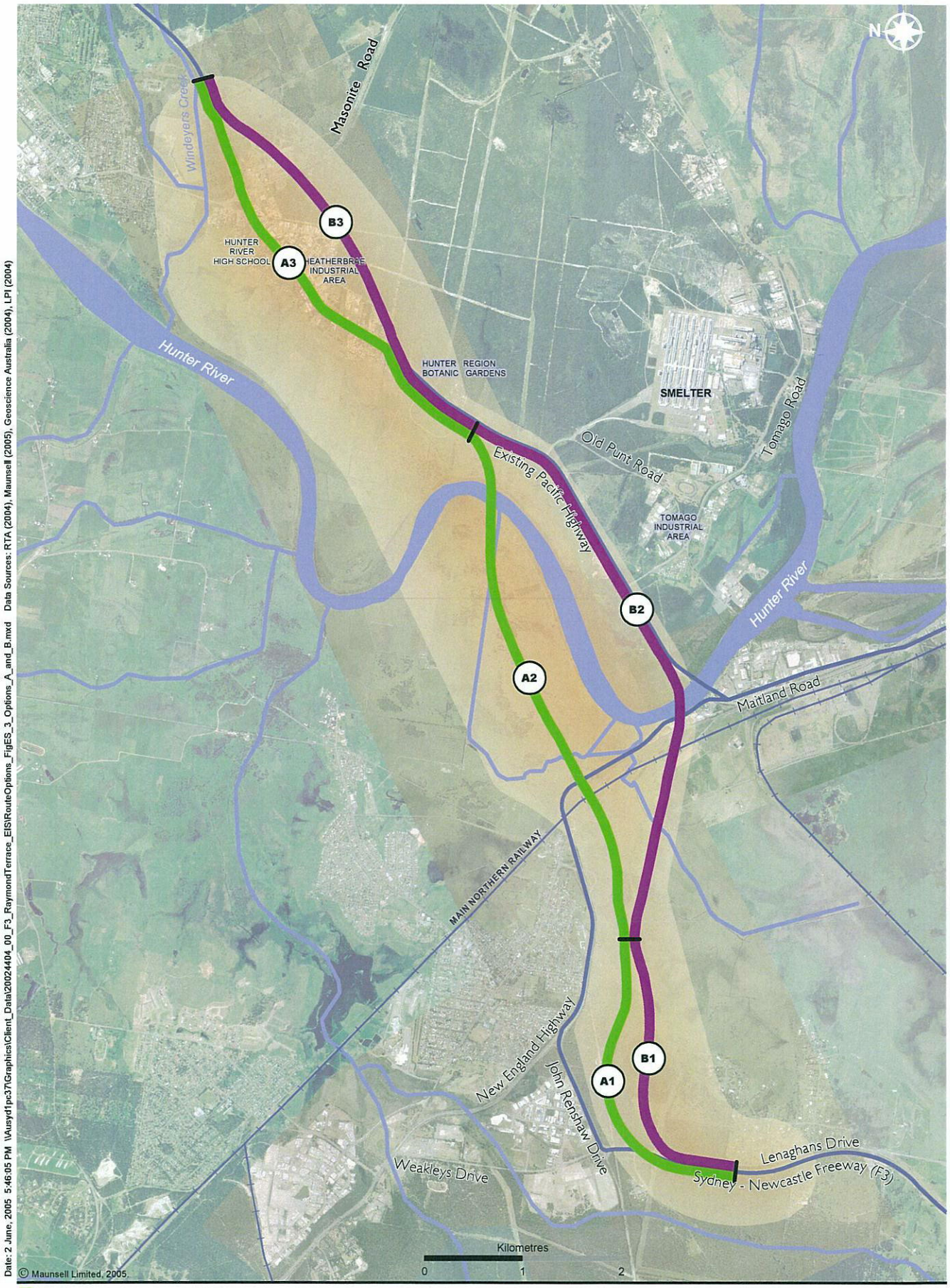
F3 TO RAYMOND TERRACE

FIGURE 1.1: PACIFIC HIGHWAY UPGRADING PROGRAM



Date: 2 June, 2005 5:41:43 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig1_2_StudyArea.mxd Data Sources: RTA (2004), Maunsell (2005), DIPNR (2004), LPI (2004)

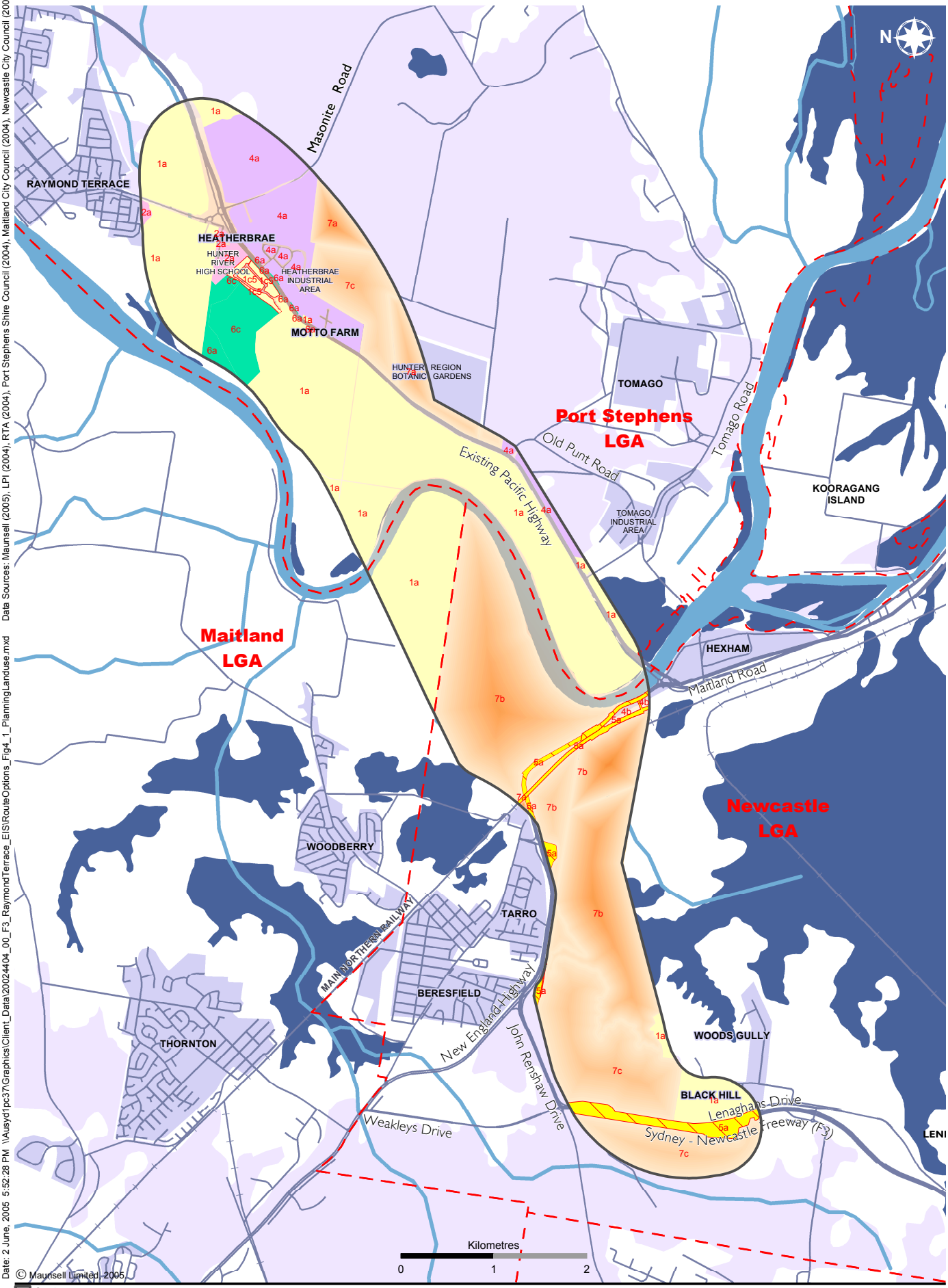
NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 1.2: STUDY AREA



Date: 2 June, 2005 5:46:05 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_FigES_3_Options_A_and_B.mxd Data Sources: RTA (2004), Maunsell (2005), Geoscience Australia (2004), LPI (2004)

- Option A
- Option B
- Study area
- Existing traffic route
- Main Northern Railway line
- Waterway

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE ES.1.5: OPTIONS A AND B



Study area
LGA Boundaries
Main Northern Railway line
Existing traffic route
Local road
Waterway
SEPP 14 wetlands
Vegetated area
Built-up area

Residential
Rural residential
Business
Industrial
Special uses
Recreation / open space
Environmental protection
National Park

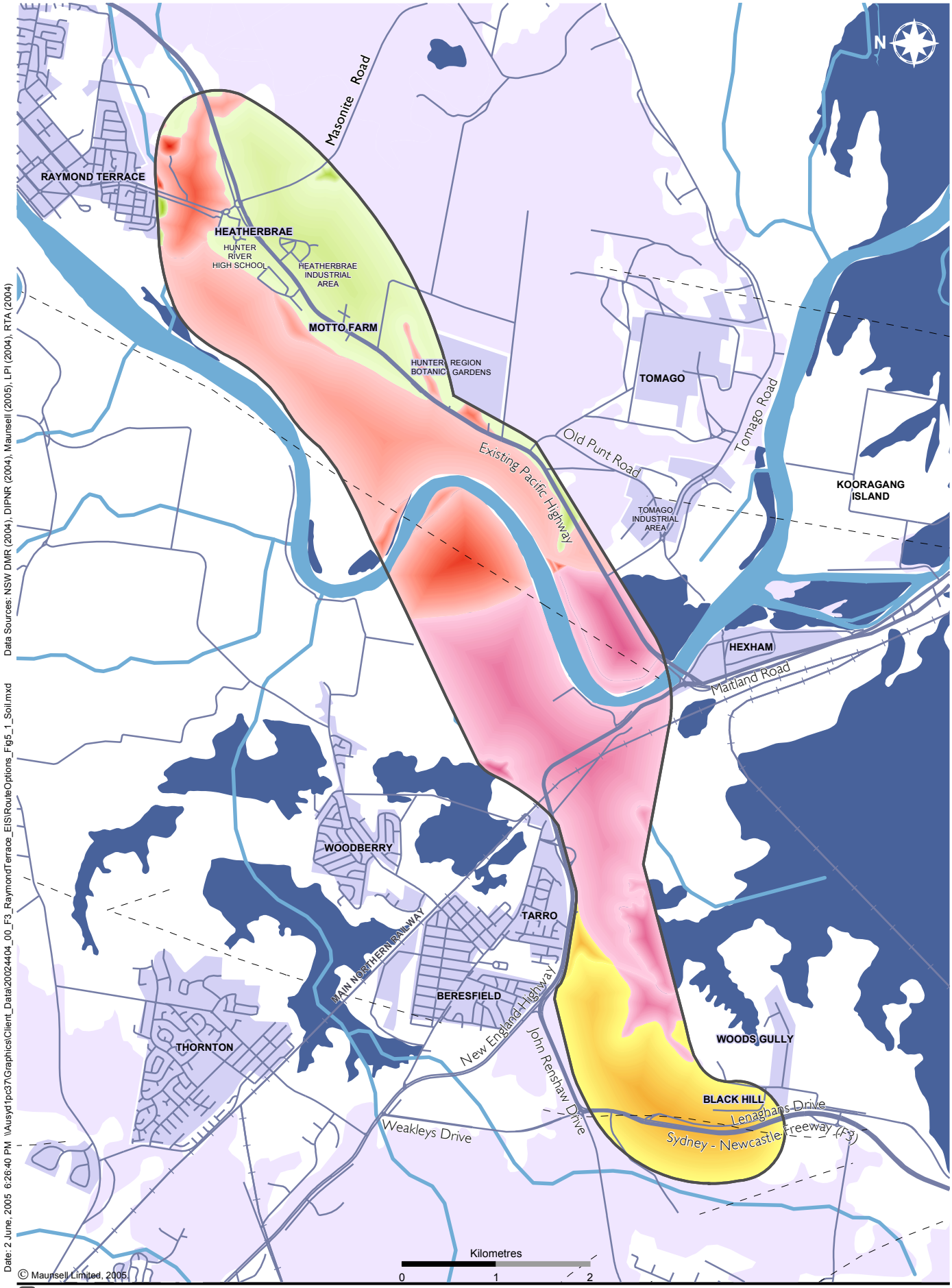
Data Sources: Maunsell (2005), LPI (2004), RTA (2004), Port Stephens Shire Council (2004), Maitland City Council (2004), Newcastle City Council (2004)

Date: 2 June, 2005 5:52:28 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig4_1_PlanningLanduse.mxd

NSW ROADS AND TRAFFIC AUTHORITY

F3 TO RAYMOND TERRACE

FIGURE 4.1: LGA BOUNDARIES AND LEP ZONES

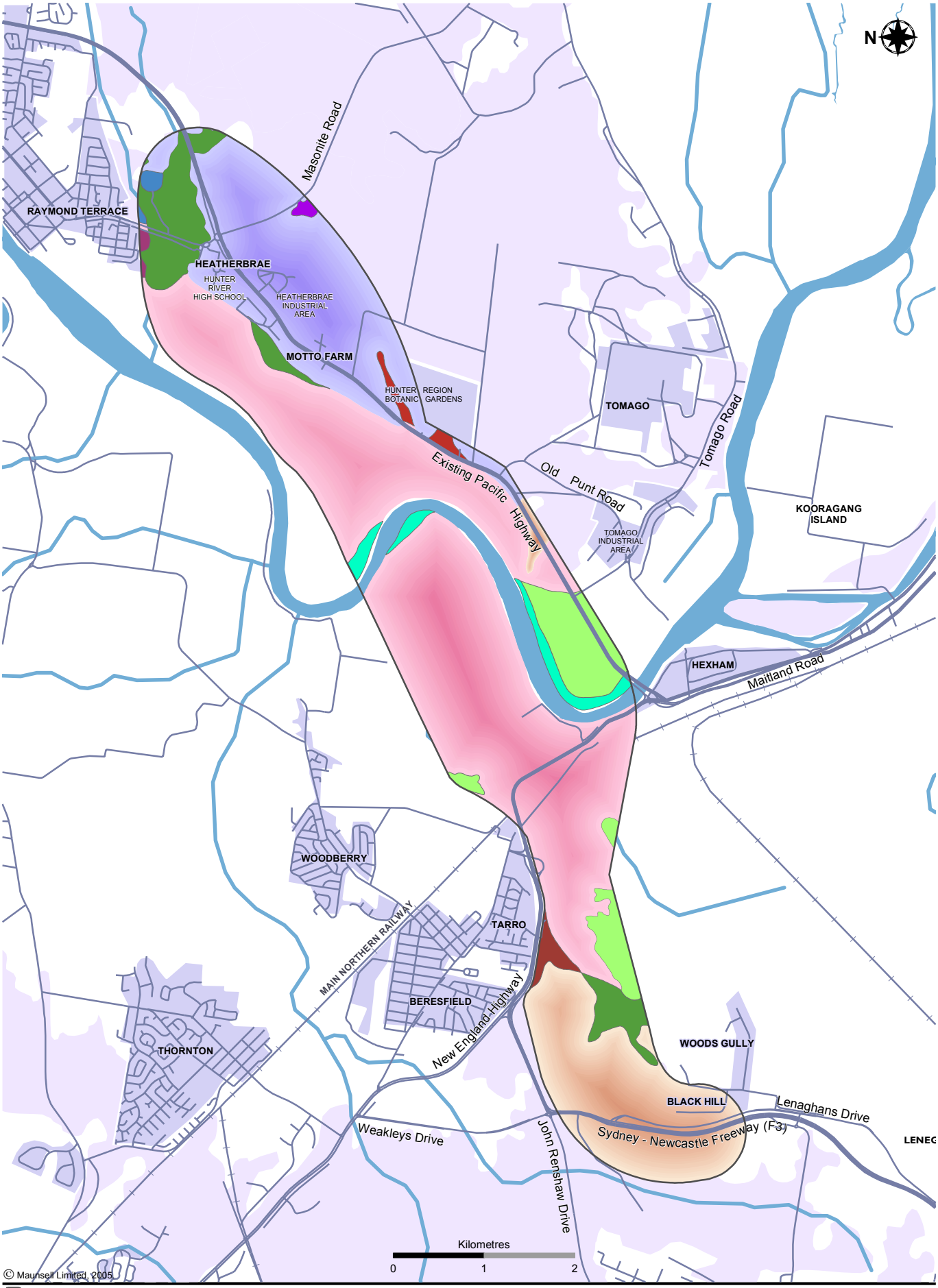


Data Sources: NSW DMR (2004), DIPNR (2004), Maunsell (2005), LPI (2004), RTA (2004)

Date: 2 June, 2005 6:26:40 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig5_1_Soil.mxd

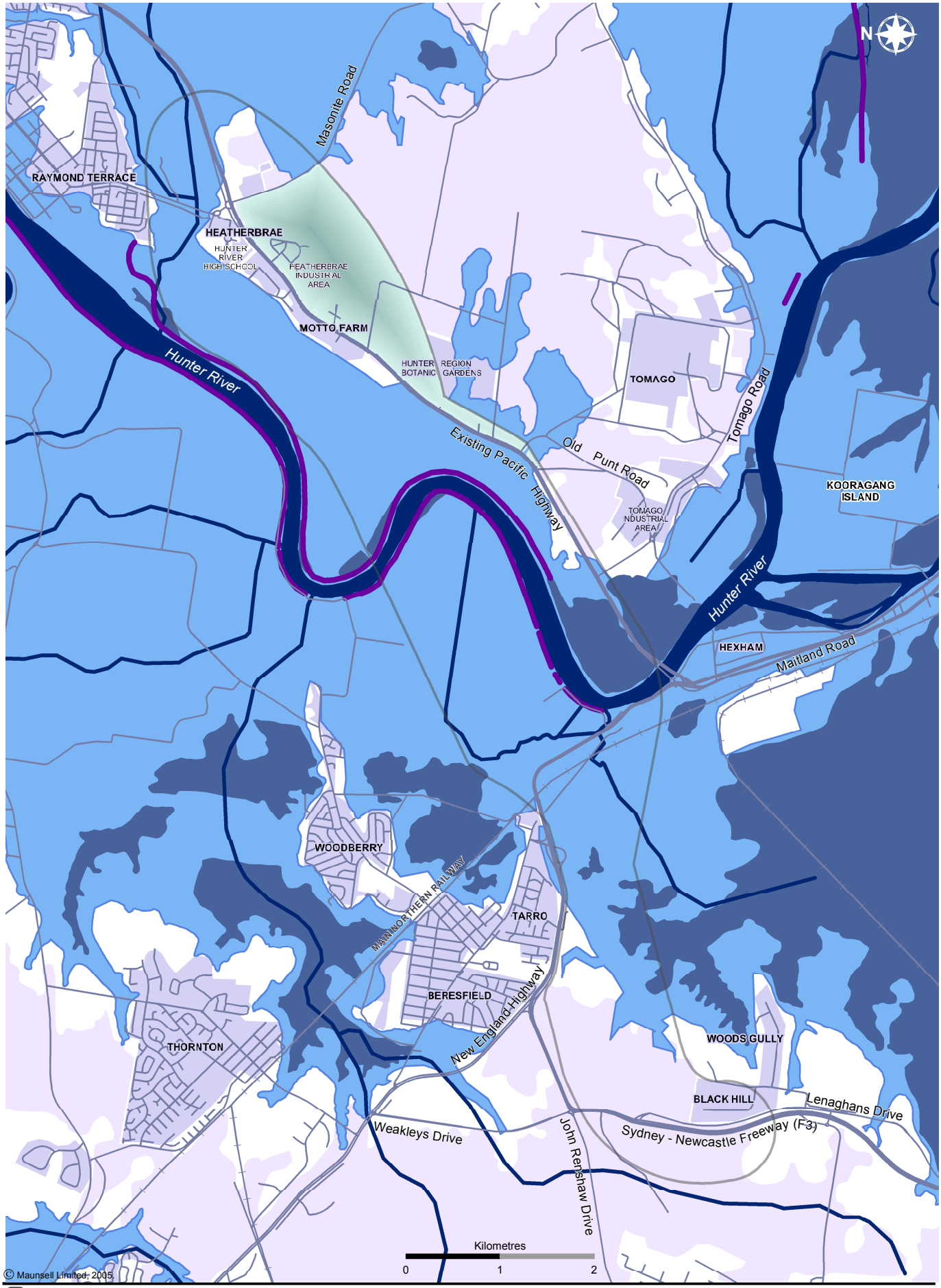
- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area
- Fault Line
- Domain A - Shallow residual soils
- Domain B - Deep alluvial soils of soft consistency
- Domain C - Deep alluvial soils of soft consistency
- Domain D - Moderate to deep aeolian soils of variable consistency

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.1: GEOTECHNICAL CONSTRAINTS



Date: 3 June, 2005 4:49:05 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig5_2_Soil_Landscapes.mxd Data Sources: NSW DMR (2004), DIPNR (2004), Maunsell (2005), LPI (2004), RTA (2004)

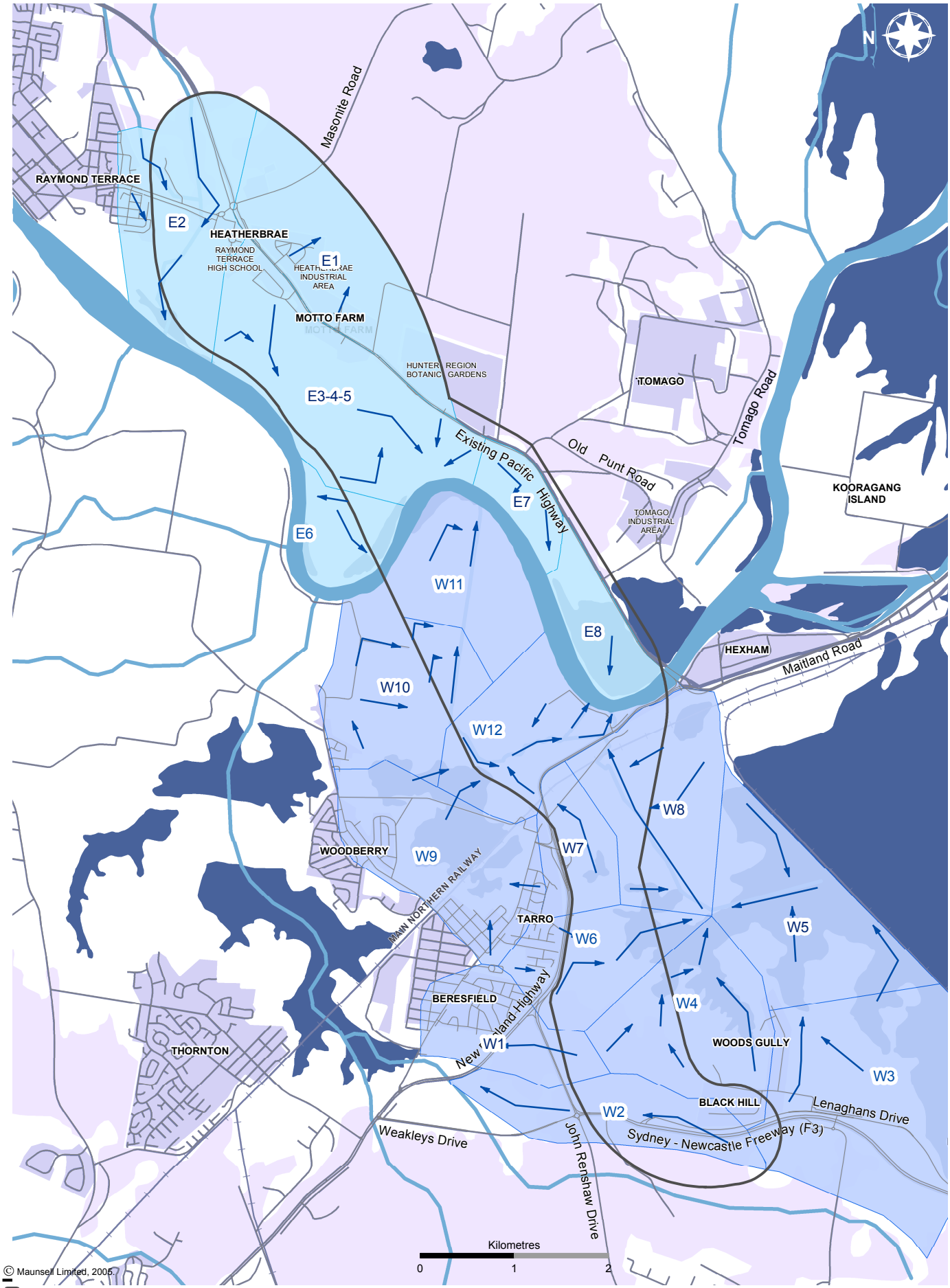
NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.2: SOIL LANDSCAPES



Study area
Main Northern Railway line
Existing traffic route
Local road
Waterway
SEPP 14 wetlands
Vegetated area
Built-up area
Levee banks
Tomago Groundwater Management Area
1% Annual Exceedance Probability level

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.4: 1% ANNUAL EXCEEDANCE PROBABILITY EXTENT

Date: 3 June, 2005 4:49:41 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig5_4_Hydro.mxd Data Sources: NSW DMR (2004), Port Stephens Shire Council (2004), Maitland City Council (2004), Maunsell (2005), LPI (2004), RTA (2004)

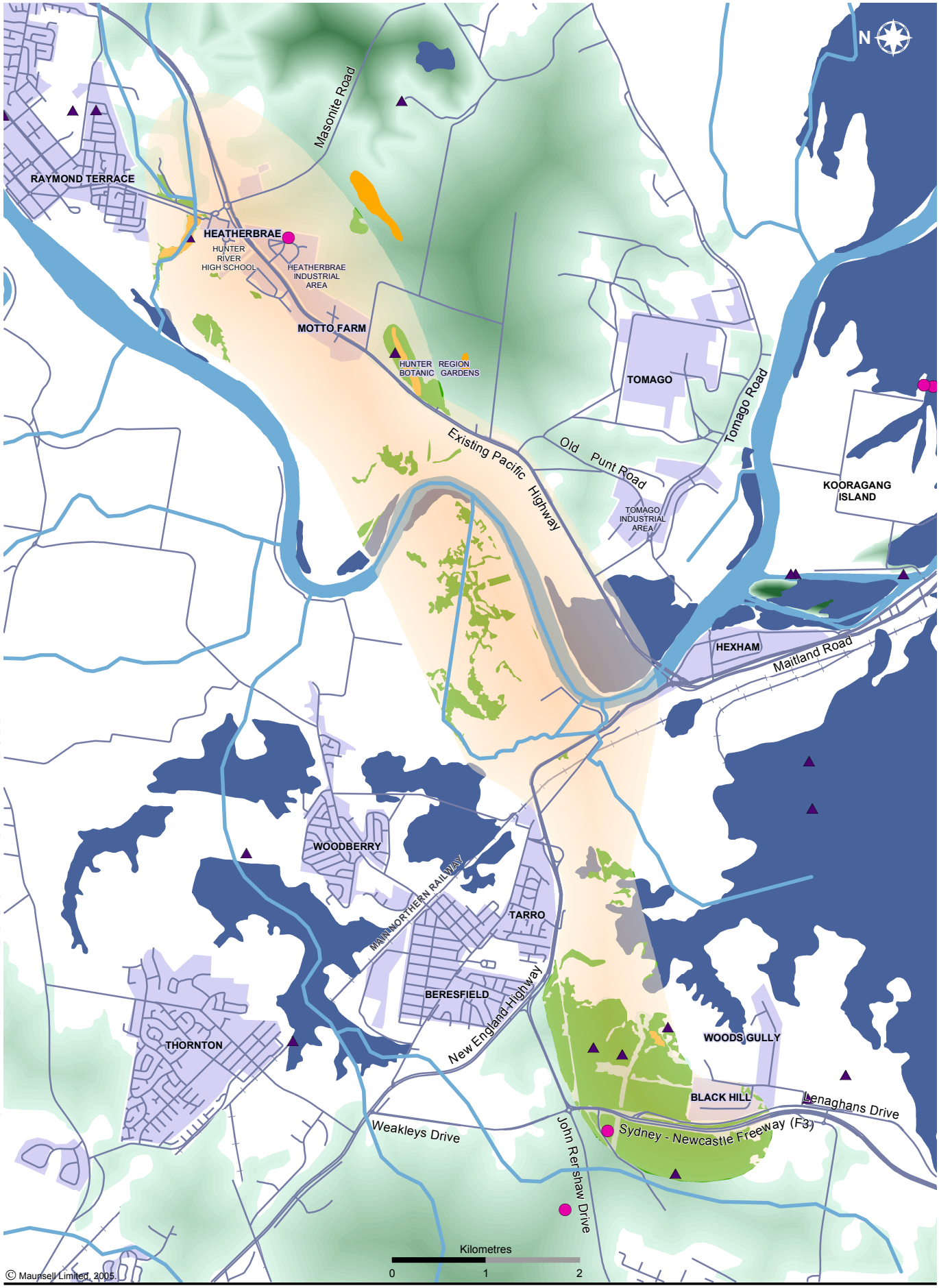


Study area
Main Northern Railway line
Existing traffic route
Local road
Waterway
SEPP 14 wetlands
Vegetated area
Built-up area
Eastern subcatchments
Western subcatchments
Local subcatchment flowpaths

Data Sources: NSW NPWS (2004), Biosis Research (2005), Maunsell (2005), LPI (2004), RTA (2004), LHCCREMS (2004), Geoscience Australia (2004)

Date: 6 June, 2005 10:33:27 AM \\ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig5_5_Catchments.mxd

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.5: DRAINAGE SUBCATCHMENTS

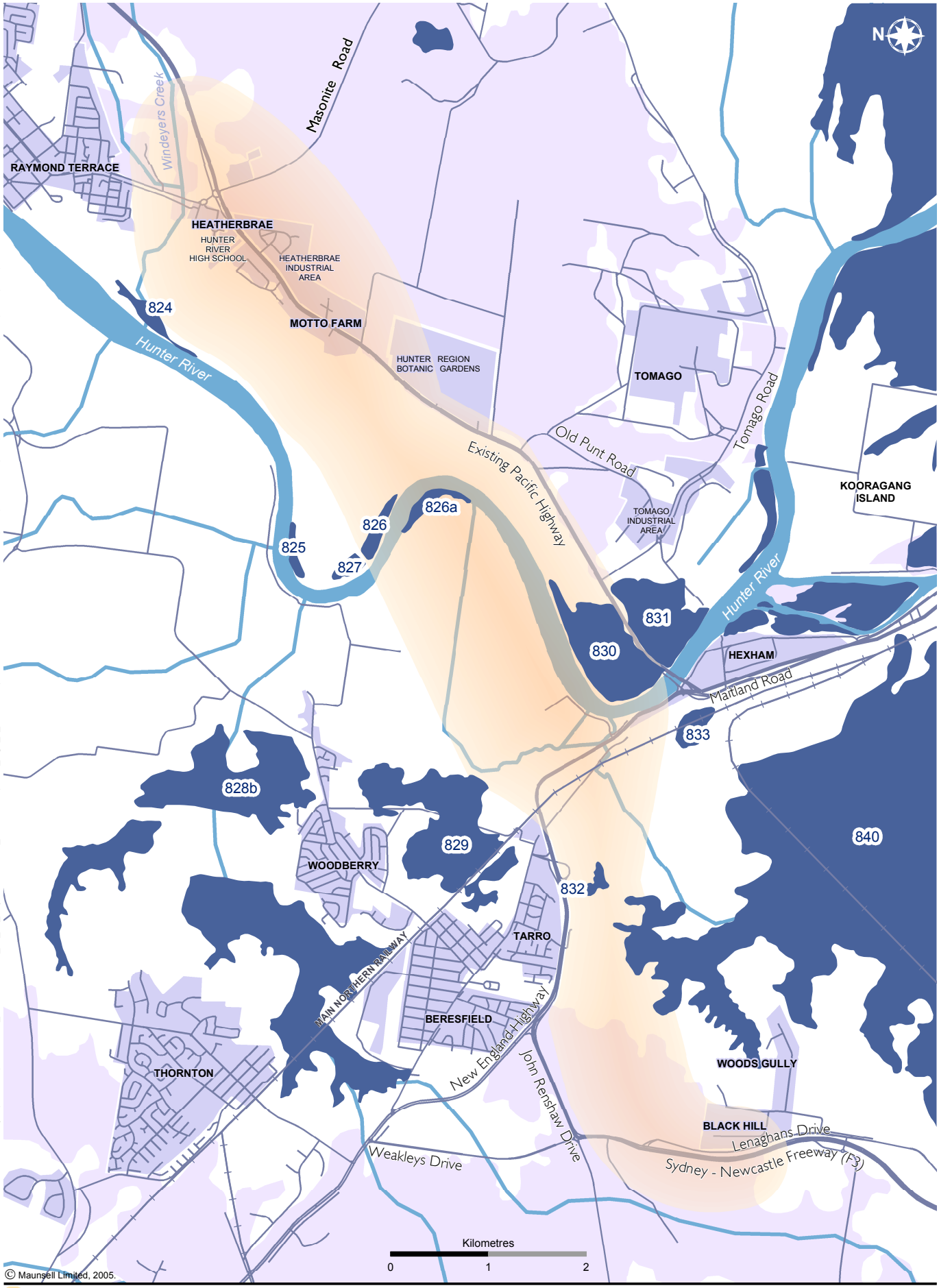


Data Sources: NSW NPWS (2004), Biosis Research (2005), Maunsell (2005), LPI (2004), RTA (2004), LHCCREMS (2004), Geoscience Australia (2004)

Date: 3 June, 2005 4:52:26 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig5_6_Eco.mxd

- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Built-up area
- Threatened flora sighting
- Threatened fauna sighting
- Core and potential koala habitat
- Endangered Ecological Community
- Vegetated area

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.6: PROTECTED HABITATS AND THREATENED SPECIES

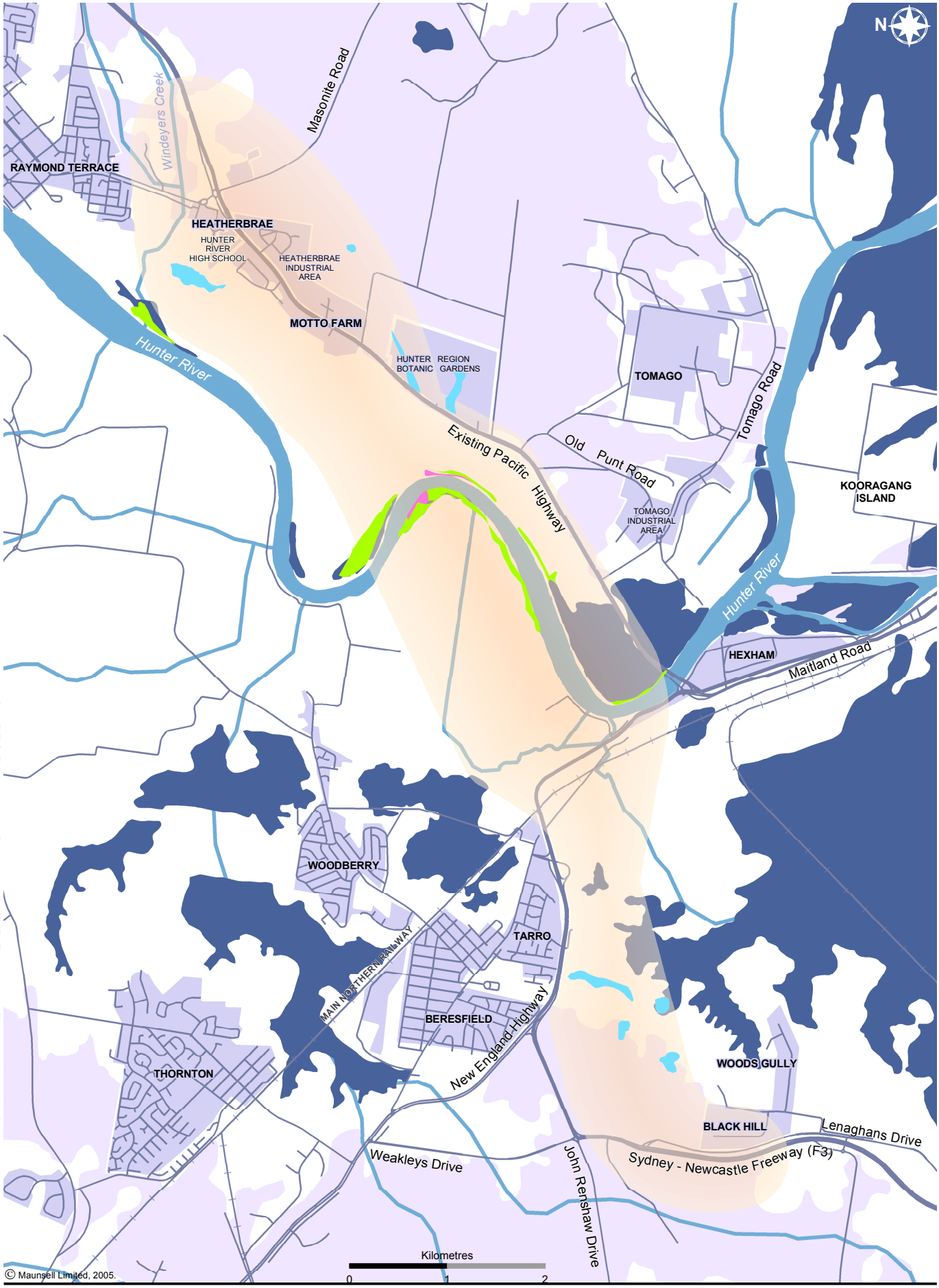


Data Sources: RTA (2004), Maunsell (2005), Geoscience Australia (2004), LPI (2004)

Date: 3 June, 2005 5:15:36 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig8_1_SEPP14Options.mxd

- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.7: LOCATION OF SEPP 14 WETLANDS

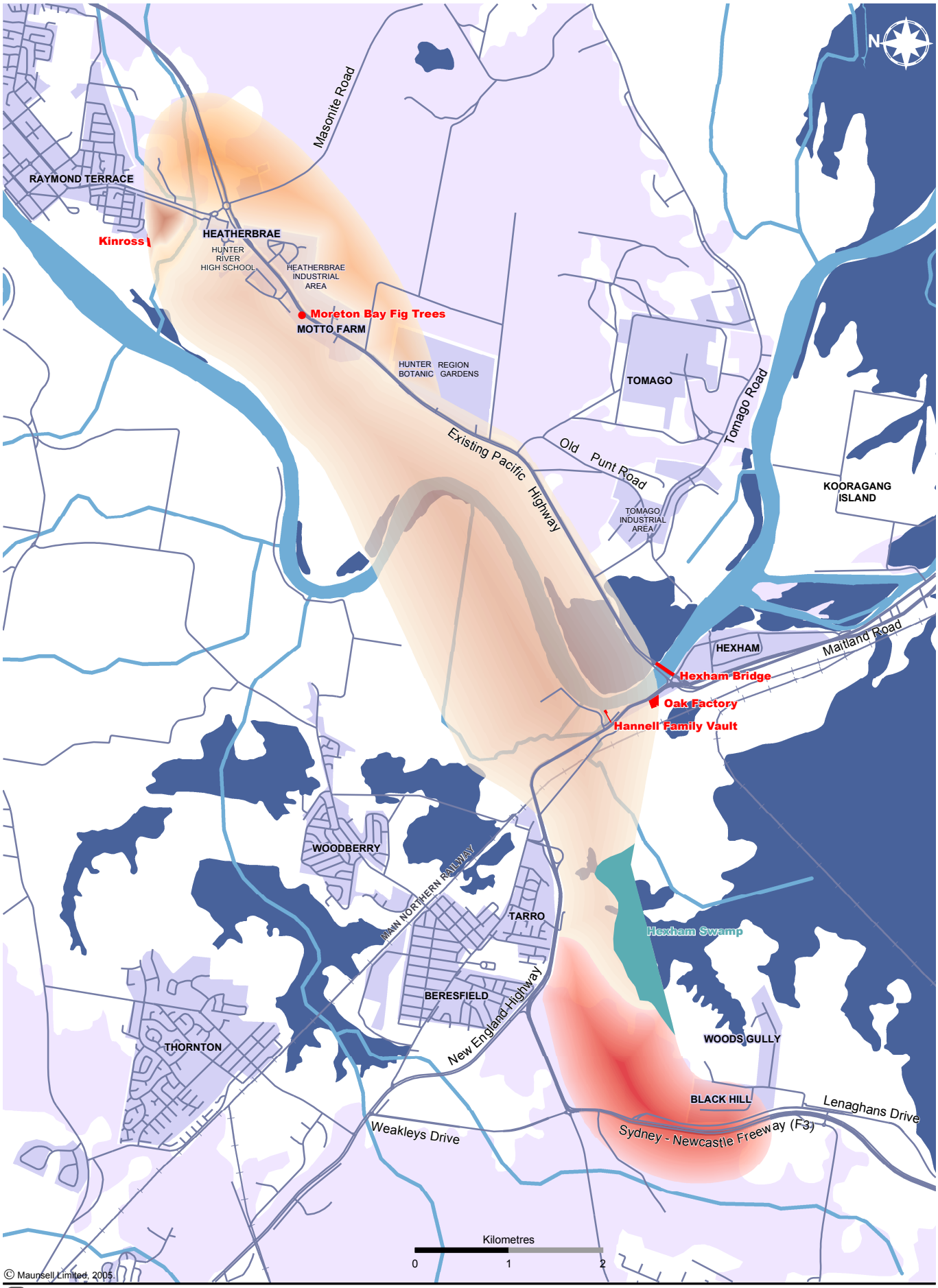


Data Sources: RTA (2004), Maunsell (2005), DIPNR (2004), LPI (2004)

Date: 2 June, 2005 5:41:43 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig1_2_StudyArea.mxd

- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area
- Freshwater wetland
- Mangrove
- Coastal saltmarsh

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.8: AQUATIC ECOLOGY



Data Sources: Maunsell (2005), LPI (2004), RTA (2004), Biosis Research (2005)

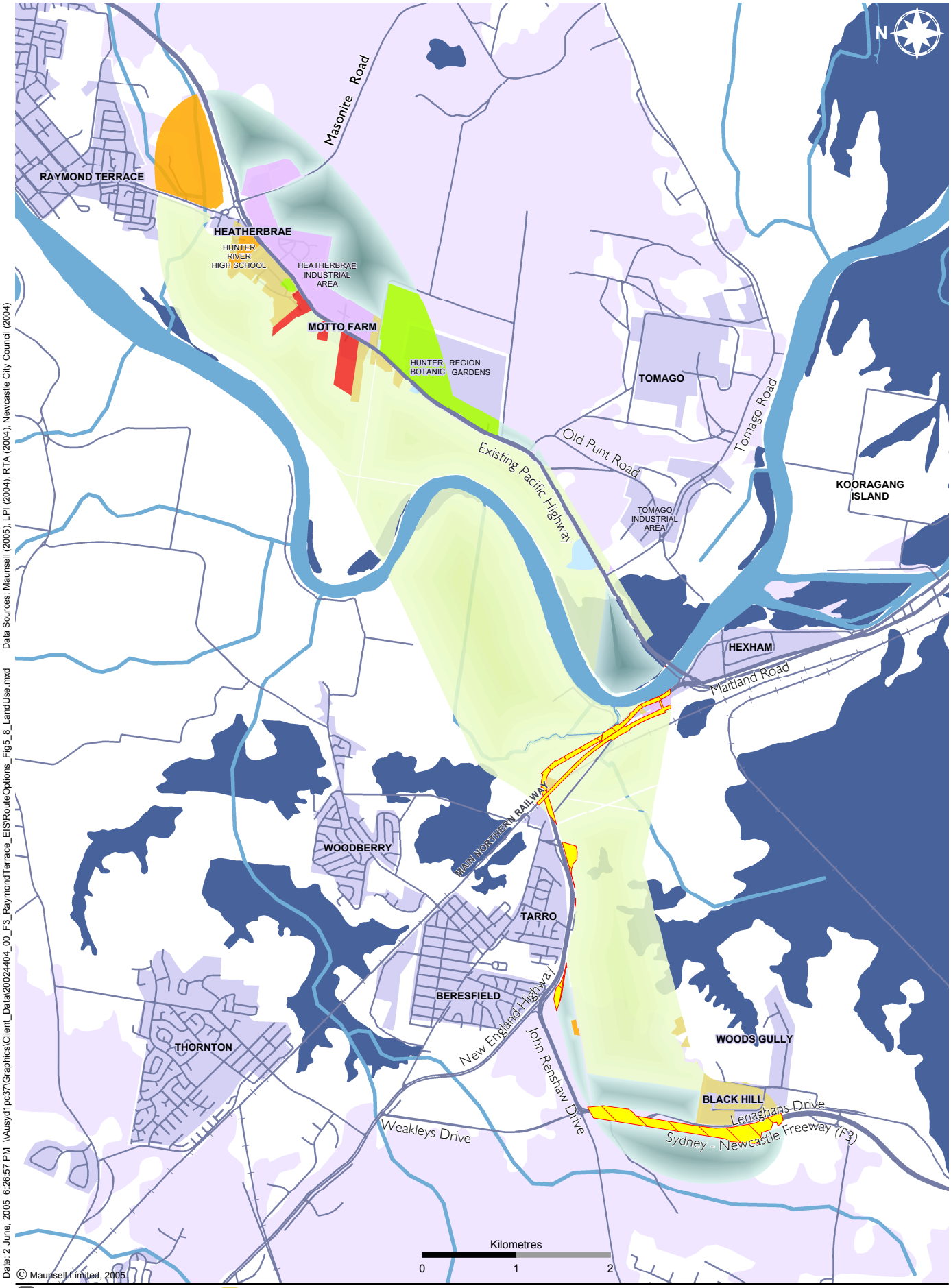
Date: 3 June, 2005 4:55:23 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig5_7_Heritage_indig_and_euro.mxd

- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area

Indigenous Heritage Potential
- Low
- Moderate
- High

Non-Indigenous Heritage Sites
- Local Government Heritage List
- Register of the National Estate

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.9: INDIGENOUS / NON-INDIGENOUS HERITAGE AREAS

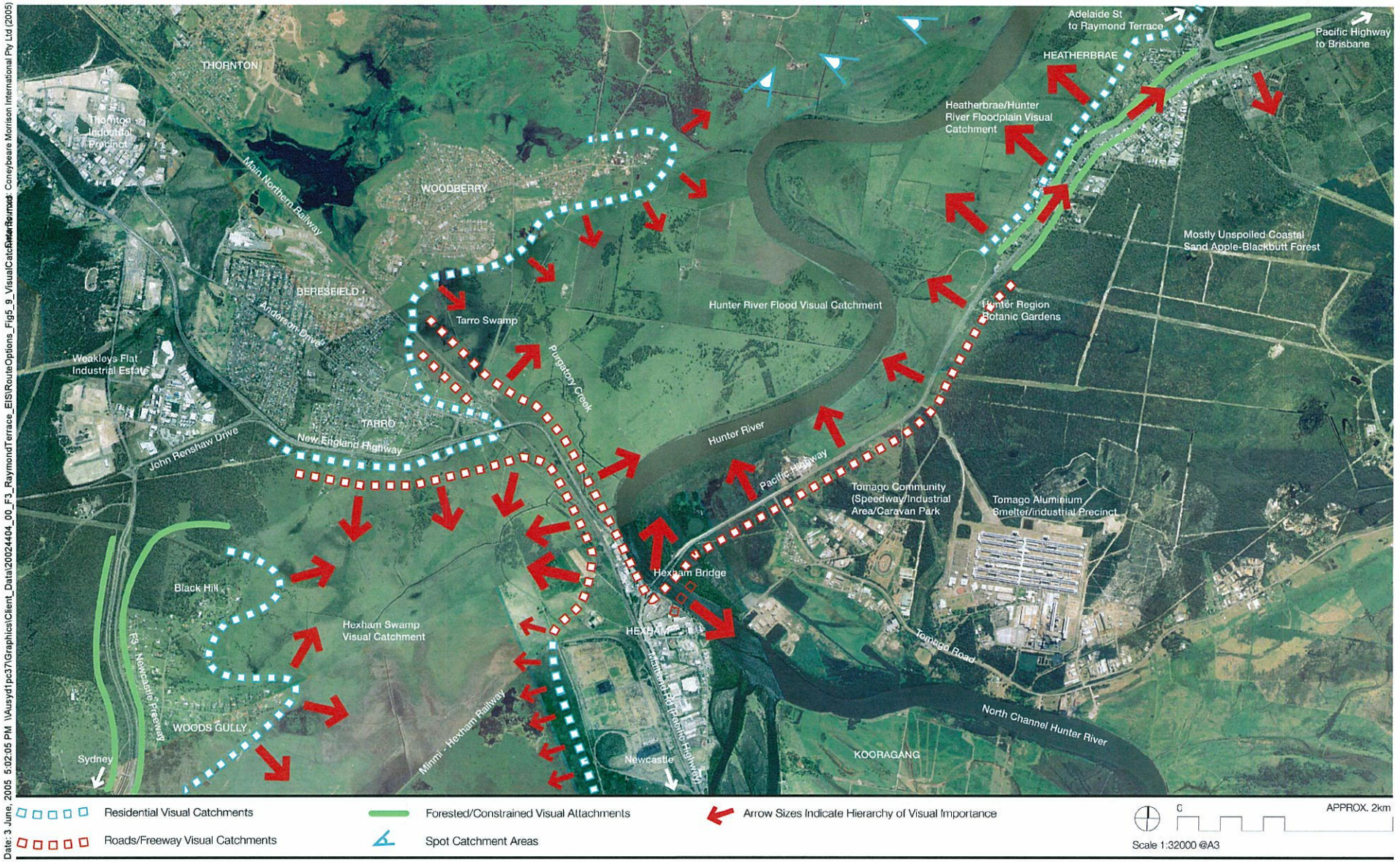


Data Sources: Maunsell (2005), LPI (2004), RTA (2004), Newcastle City Council (2004)

Date: 2 June, 2005 6:26:57 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig5_8_LandUse.mxd

- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area
- Residential
- Special uses
- Rural/Agricultural
- Business/Commercial
- Industrial
- Parks
- Urban Bushland/Vegetation
- Community Facilities
- Tourism/Entertainment

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 5.10: LAND USE PATTERN

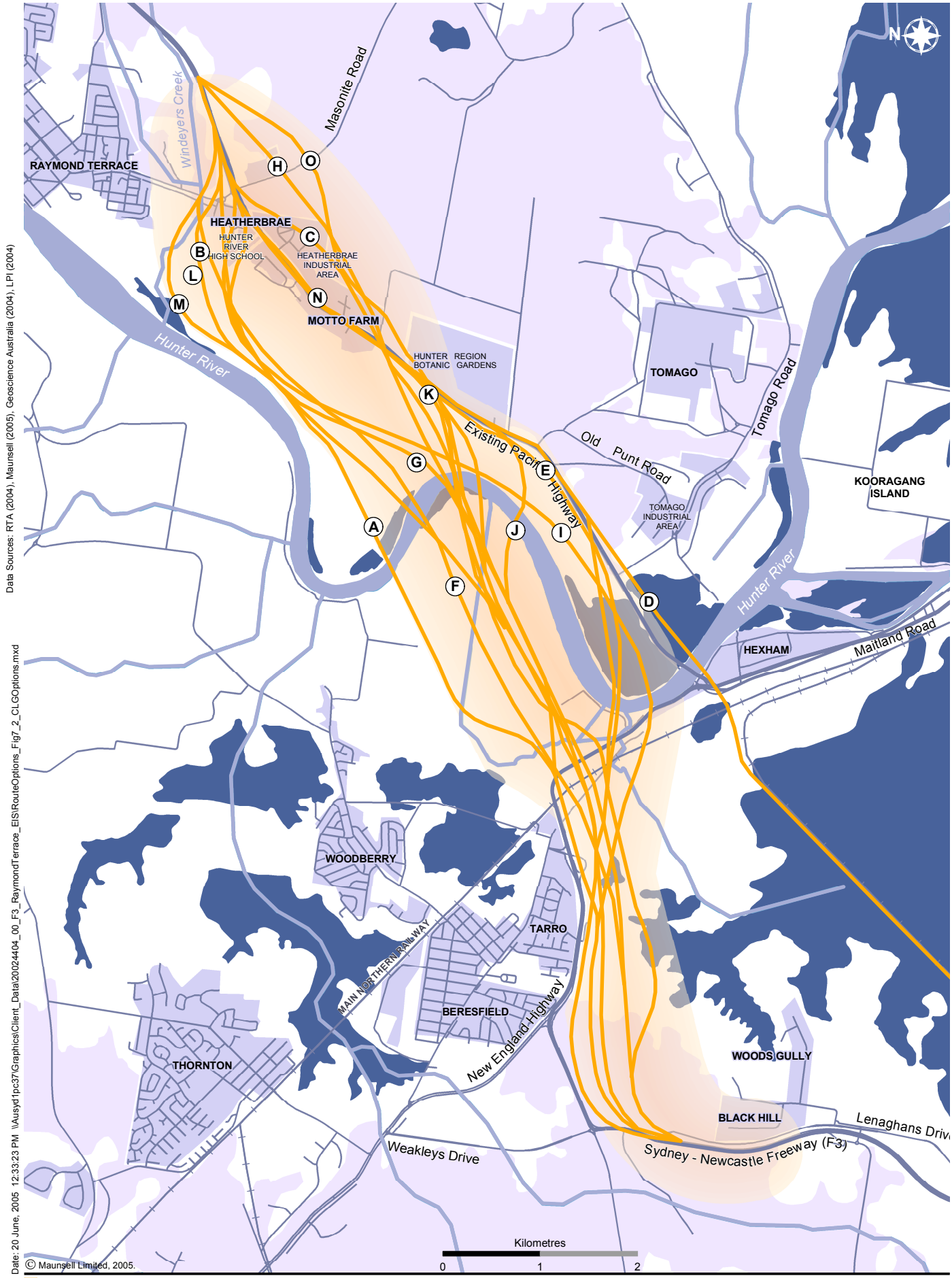


Date: 3 June, 2005 5:02:05 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EISRouteOptions_Fig5_9_VisualCatchmentAreas.mxd Conybeare Morrison International Pty Ltd (2005)

NSW ROADS AND TRAFFIC AUTHORITY

F3 TO RAYMOND TERRACE

FIGURE 5.11: REGIONAL VISUAL CATCHMENT AREAS

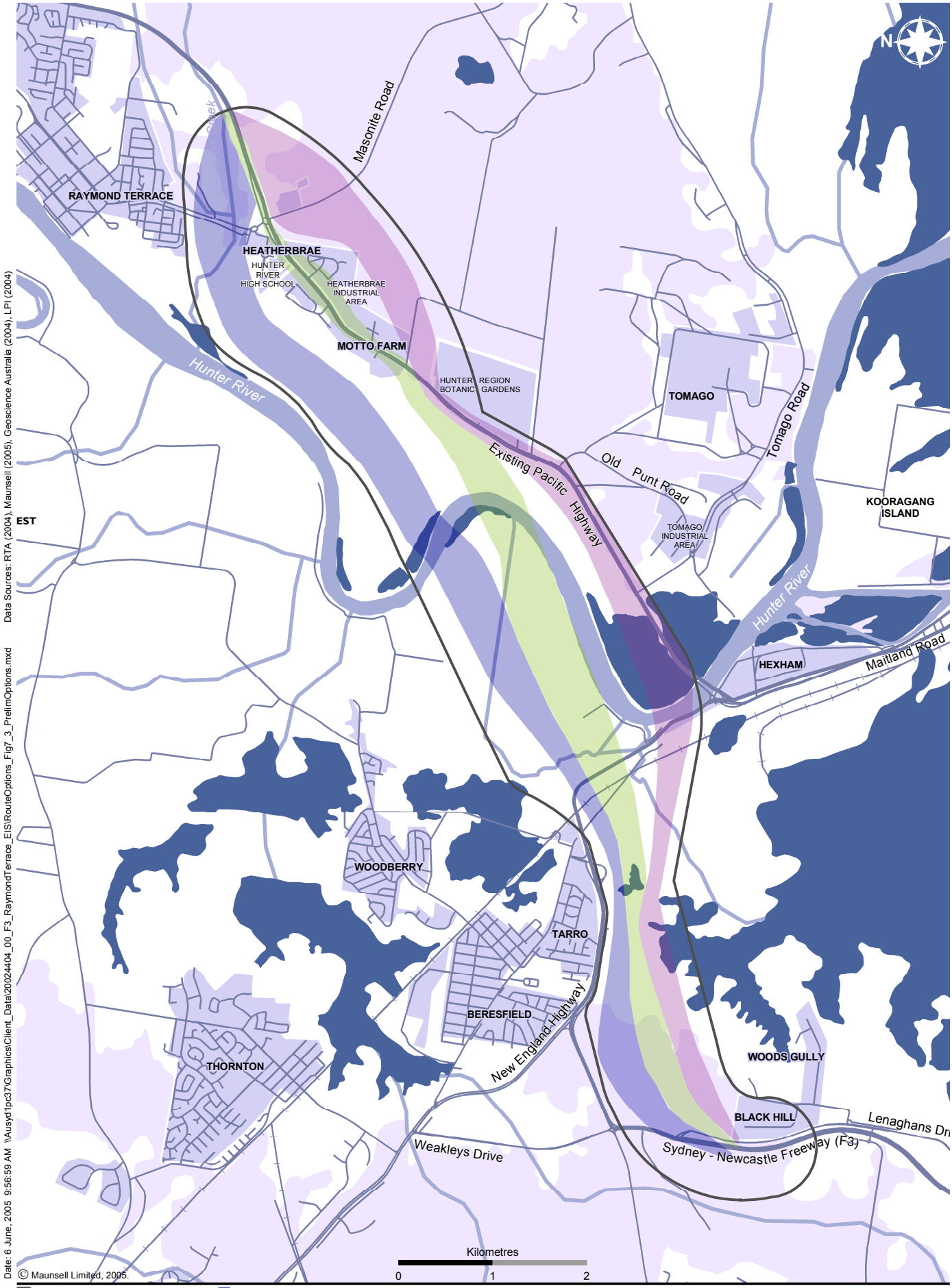


Data Sources: RTA (2004), Maunsell (2005), Geoscience Australia (2004), LPI (2004)

Date: 20 June, 2005 12:33:23 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig7_2_CLGOptions.mxd

- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area
- CLG route options A-O

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 7.2: CLG ROUTE OPTIONS

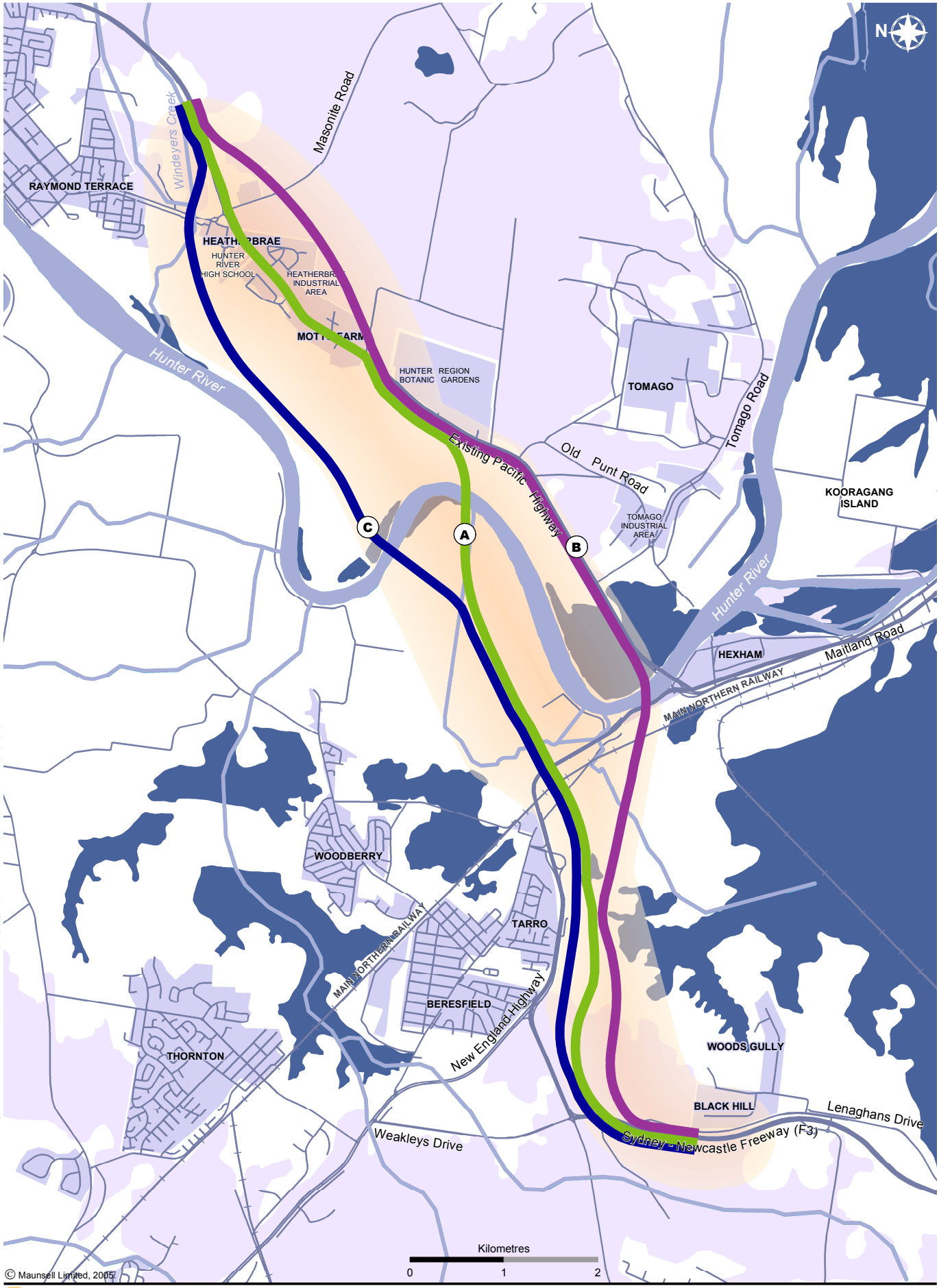


Data Sources: RTA (2004), Maunsell (2005), Geoscience Australia (2004), LPI (2004)

Date: 6 June, 2005 9:56:59 AM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig7_3_PrelimOptions.mxd

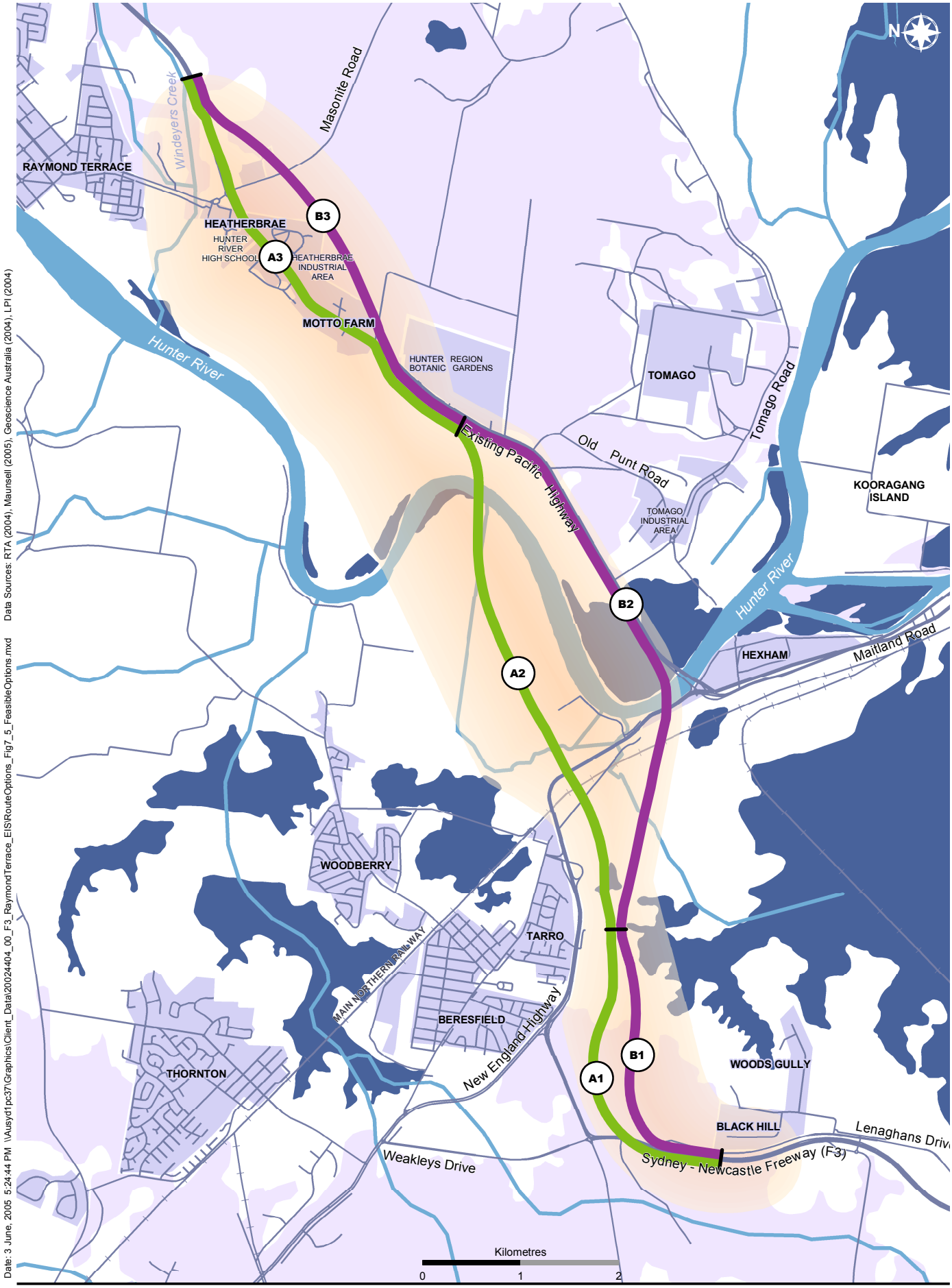
- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area
- Northern
- Central
- Southern

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 7.3: PRELIMINARY ROUTE CORRIDORS



Date: 3 June, 2005 5:23:08 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig7_4_ShortlistedOptions.mxd Data Sources: RTA (2004), Maunsell (2005), Geoscience Australia (2004), LPI (2004)

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 7.4: SHORTLISTED ROUTE OPTIONS



Data Sources: RTA (2004), Maunsell (2005), Geoscience Australia (2004), LPI (2004)

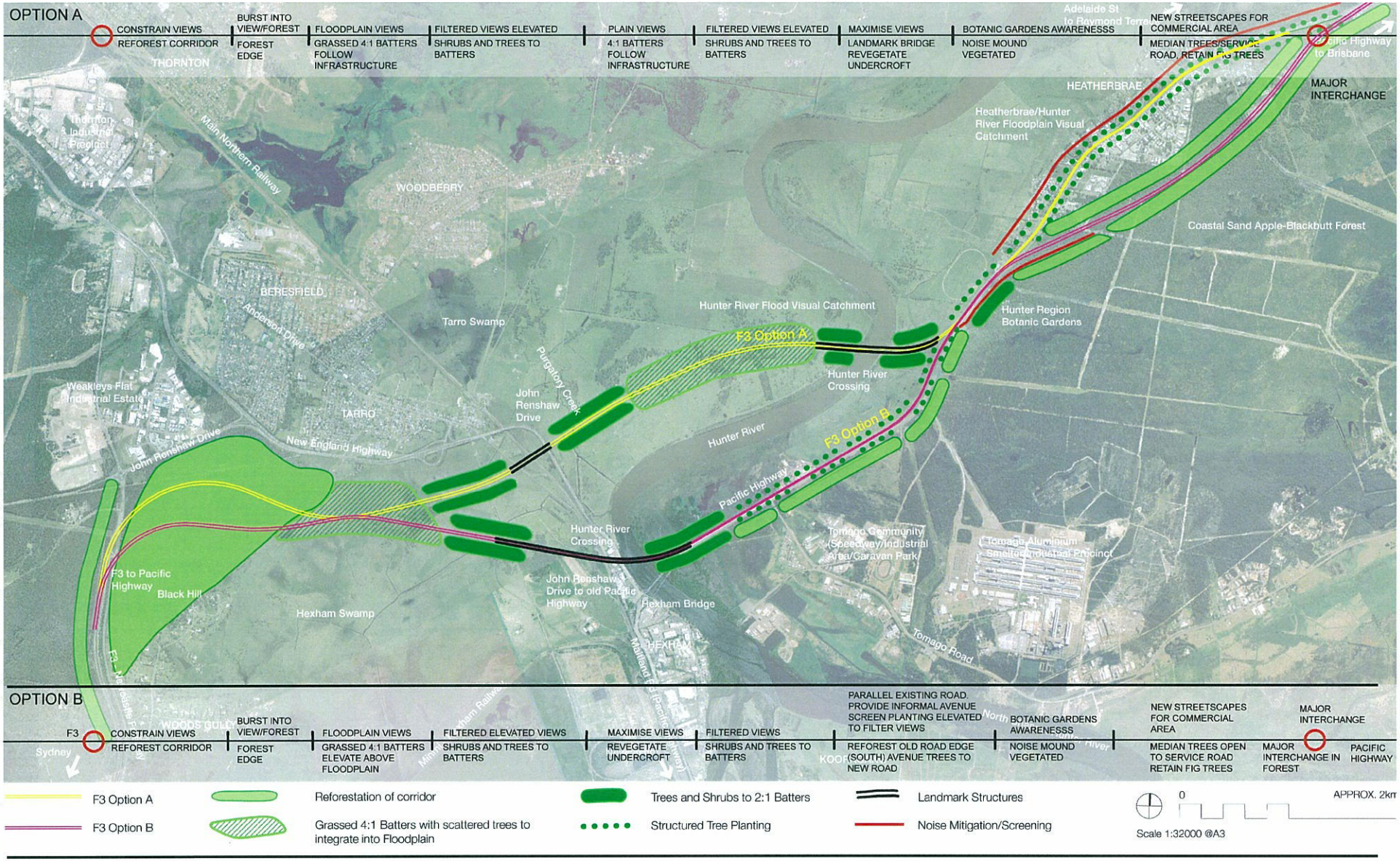
Date: 3 June, 2005 5:24:44 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig7_5_FeasibleOptions.mxd

- Study area
- Main Northern Railway line
- Existing traffic route
- Local road
- Waterway
- SEPP 14 wetlands
- Vegetated area
- Built-up area
- Route option sections

Feasible Options

- Option A
- Option B

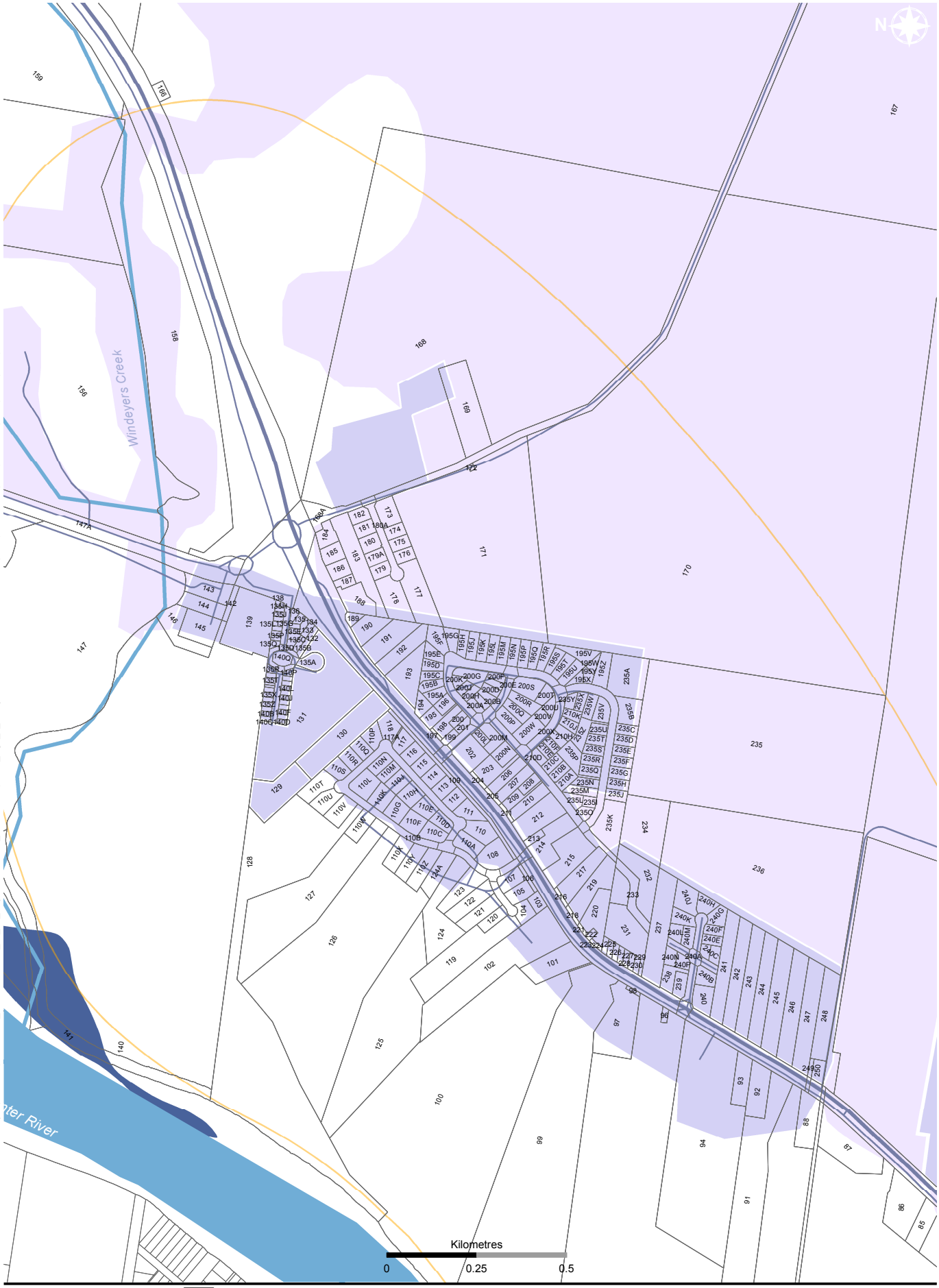
NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 7.5: FEASIBLE ROUTE OPTIONS



NSW ROADS AND TRAFFIC AUTHORITY

F3 TO RAYMOND TERRACE

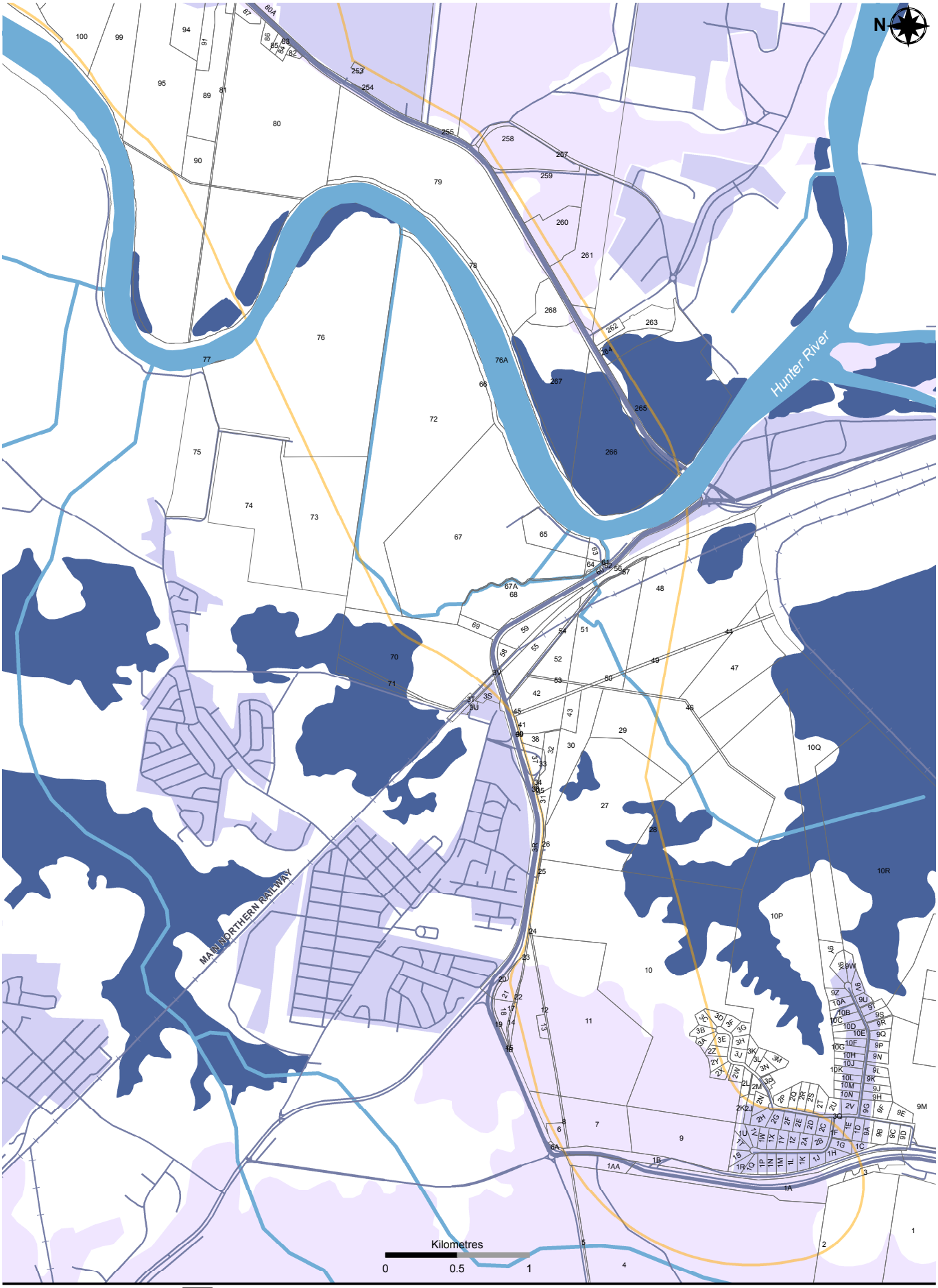
FIGURE 8.1: URBAN DESIGN AND LANDSCAPE STRATEGY



Date: 2 June, 2005 5:41:43 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig1_2_StudyArea.mxd Data Sources: RTA (2004), Maunsell (2005), DIPNR (2004), LPI (2004)

Study area
123 Property ID Number
Main Northern Railway line
Existing traffic route
Local road
Waterway
SEPP 14 wetlands
Vegetated area
Built-up area

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 8.2a: PROPERTY ID PLAN



Date: 2 June, 2005 5:41:43 PM \\Ausyd1pc37\Graphics\Client_Data\20024404_00_F3_RaymondTerrace_EIS\RouteOptions_Fig1_2_StudyArea.mxd Data Sources: RTA (2004), Maunsell (2005), DIPNR (2004), LPI (2004)

Study area
Main Northern Railway line
Existing traffic route
Local road
Waterway
SEPP 14 wetlands
Vegetated area
Built-up area

123 Property ID Number

NSW ROADS AND TRAFFIC AUTHORITY
F3 TO RAYMOND TERRACE
FIGURE 8.2b: PROPERTY ID PLAN