Windsor Bridge replacement project

FLORA AND FAUNA WORKING PAPER – WORKING PAPER 10

NOVEMBER 2012

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Roads and Maritime Services

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Flora and fauna working paper – working paper 10

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Contents

Glossary of terms and abbreviations

Term	Meaning
ANZECC	Australian and New Zealand Environment Conservation Council.
CEMP	Construction Environmental Management Plan.
Construction footprint	Refers to the area of bridge replacement and includes any ancillary locations or drainage structures.
EIS	Environmental Impact Statement.
EP&A Act	*Environmental Planning and Assessment Act 1979.*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999.*
FM Act	*Fisheries Management Act 1994.*
Km	Kilometre.
LEC	LesryK Environmental Consultants.
m	Metre.
m^2	Metres squared.
NES	National Environmental Significance.
NPWS	National Parks and Wildlife Service (now included under OEH).
OEH	Office of Environment and Heritage.
Riparian	Transition zone between land and watercourse.
RMS	Roads Maritime Service NSW.
RTA	Roads Traffic Authority NSW (now known as the RMS).
Study area	Encompasses the construction footprint and any adjoining or adjacent habitat where potential indirect impacts may occur.
Locality	The broader bioregional context defined by Thackway and Creswell (1995) as the Sydney Bioregion and occurs within a 10 kilometre radius of the construction footprint.
Construction footprint	The immediate design footprint of the project.
TEC	Threatened Ecological Community.
TSC Act	*Threatened Species Conservation Act 1995.*
WIRES	NSW Wildlife Information Rescue and Education Service.

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Executive summary

This flora and fauna assessment has been prepared for the replacement of Windsor bridge over the Hawkesbury River at Windsor in western Sydney (the project). The assessment has been based on a review of recent relevant regional ecological studies supplemented with a field survey across the study area.

The study area supports riparian re-growth vegetation, cleared grasslands and parklands/landscaped areas in low ecological condition. Riparian vegetation is typically narrow and patchy with a high degree of disturbance associated with clearing, weed invasion and flooding. The remainder of vegetation across the site comprises modified grasslands, and artificial parklands and landscaped areas comprising scattered mature trees. Disturbance is widespread and associated with current and previous land-uses. Weeds are common throughout, particularly in rural and partially cleared land and in riparian areas. Previously mapped threatened ecological communities within the study area were not observed during the field survey, and are not considered likely to occur. Potential fauna use and connectivity across the study area appears low, reducing the potential for impact to fauna and permanent impacts to connectivity both during and after project delivery.

No threatened ecological communities or threatened species were observed during field surveys, however Windsor bridge may provide marginal potential as roosting habitat for some threatened microchiropteran bats. About 1.2 hectares (12,000 square metres) of grassland fauna habitat and 0.5 hectares (5000 square metres) of disturbed and modified forest habitat would be lost as a result of the project. The Hawkesbury River provides the only aquatic habitat in the study area with aquatic macrophytes and submerged woody debris largely absent due to the high flows and depth of the channel.

The project is likely to require about 1.7 hectares (17,000 square metres) of land clearing, which includes about 0.9 hectares (9000 square metres) of modified grasslands and about 0.5 hectares (5000 metres squared or 21 per cent) of native riparian re-growth Casuarina open forest. About 0.3 hectares (3000 square metres) of existing parkland and landscaped areas would also be removed as part of the project.

The project has the potential to impact upon aquatic habitats through over-shadowing and potential pollution and sedimentation during construction. Wherever possible, the design and construction would aim to avoid clearing natural vegetation cover, removing only those trees directly in the construction footprint. Additionally, stockpiles, storage and compound sites would be sited appropriately to avoid vegetation. Mitigation measures to minimise potential risks arising from water-based construction and sedimentation and erosion impacts would need to be developed and implemented during the construction phase to protect water quality and aquatic ecosystems.

This assessment has concluded that the project is not likely to significantly impact upon the terrestrial and aquatic biodiversity of the study area. As a result a species impact statement is not required.

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1 Introduction

1.1 Overview

The Roads and Maritime Services NSW (RMS) is proposing to construct a new bridge across the Hawkesbury River at Windsor to replace the existing bridge that has reached the end of its economic life. To support the design and approval of the Windsor bridge replacement, RMS is preparing an Environmental Impact Statement (EIS) under Part 5.1 of the *Environmental Planning and Assessment Act 1979*. This flora and fauna assessment has been prepared as a specialist component of the EIS to identify and assess the potential impacts of the project on terrestrial and aquatic flora and fauna and advise mitigation actions to avoid or minimise impacts on biodiversity.

1.2 Project description

1.2.1 Overview

The project would comprise:

- Construction of a new bridge over the Hawkesbury River at Windsor, around 35 metres downstream of the existing Windsor bridge.
- Reconstruction and upgrading of existing intersections and bridge approach roads to accommodate the new bridge, including:
    - Removal of the existing roundabout and installation of traffic signals at the intersection of George and Bridge Streets.
    - Construction of a new dual lane roundabout at the intersection of Freemans Reach Road, Wilberforce Road, northern bridge approach road and the access road to Macquarie Park. All roads serviced by the new roundabout would require minor realignments.
    - Realignment of the southern and northern bridge approach roads. The new southern bridge approach road would generally follow the alignment of Old Bridge Street along the eastern side of Thompson Square. The northern bridge approach road would be a new road connecting the bridge to the new dual lane roundabout.
    - Construction of a shared pedestrian/cycle pathway for access to and across the new bridge.
    - Removal of the existing bridge approach roads and then backfilling, rehabilitating and landscaping these areas.
    - Demolition of the existing Windsor bridge including piers and abutments.
    - Landscaping works within Thompson Square parkland and adjacent to the northern intersection of Bridge Street, Wilberforce Road, Freemans Reach Road and the access road to Macquarie Park.
    - Redevelopment of part of The Terrace to provide continuous access along the southern bank of the river and under the replacement bridge to Windsor Wharf.
    - Construction of scour protection works on the southern and northern banks and around three bridge piers.
    - Construction of a permanent water quality basin to capture and treat stormwater runoff from the bridge and northern intersection prior to stormwater being discharged to the Hawkesbury River.

- Architectural treatments for noise mitigation, as required, where feasible and reasonable and in agreement with affected property owners.
- Flood mitigation works at individual properties.
- Ancillary works including:
    - Adjustment, relocation and/or protection of utilities and services, as required.
    - Construction and operation of temporary construction, stockpiling and compound sites.

In **Figure 1-1** the main elements of the project are shown including the construction zone and project boundary.

In addition to the above-listed work elements, early works for further identification, salvage, recording and protection of Aboriginal and historic heritage, would be carried out as part of impact mitigation for the project. These early works would include:

- Salvage excavation at identified Aboriginal heritage sites on the southern bank of the river in accordance with the procedures identified in the Aboriginal heritage chapter of the Environmental Impact Statement for the project.
- Excavation, recording and protection of historic heritage in accordance with the procedures identified in the historic heritage chapter of the Environmental Impact Statement for the project.

1.2.2 The replacement bridge and intersections

The replacement bridge would be located around 35 metres downstream of the existing Windsor bridge. The southern bridge approach road would be via a new realigned section of Bridge Street, which would start at the existing intersection of George Street and Bridge Street and head generally north-west along the alignment of Old Bridge Street on the eastern side of the Thompson Square parkland. The existing roundabout at the George Street and Bridge Street intersection would be replaced by traffic signals. The replacement bridge would connect with the junction of Wilberforce Road, Freemans Reach Road and the Macquarie Park access road at a new dual lane roundabout intersection.

The replacement bridge would be an incrementally launched bridge constructed of reinforced concrete and comprising five spans. The bridge deck would be about 15.5 metres wide and be supported on up to four piers in the river. It would have an overall length of about 160 metres, spanning both the river and The Terrace. This would enable The Terrace to be reconnected to provide vehicular, pedestrian and cyclist access to Windsor Wharf. The clearance under the bridge where it spans The Terrace would be about 3.6 metres, which would allow a range of service and emergency vehicles to pass under the bridge and access Windsor Wharf.

The replacement bridge would initially comprise two traffic lanes (one in each direction), each about 3.5 metres wide and with an adjacent two metre wide shoulder. There would also be a three metre wide shared pedestrian/cycle path on the western side of the bridge. The two metre wide road shoulders of the replacement bridge would allow the bridge to be re-configured to a three lane bridge in the future, when required. The introduction of the three lane configuration would occur when additional traffic capacity is required. The three traffic lanes would consist of two southbound lanes and one northbound lane.

The low point of the replacement bridge would be around 9.8 metres Australian Height Datum (AHD), making it around 2.8 metres higher than the lowest point of the existing bridge.

The height of the replacement bridge may change slightly during the detailed design phase. This would give the replacement bridge a slightly higher level of flood immunity than the existing bridge. While the existing bridge is overtopped in a one in two year flood event, the replacement bridge is predicted to remain above water for the one in two year flood event but be overtopped in an event just smaller than the one in three year flood. This level of flood immunity is consistent with that of the northern approach roads (Wilberforce Road and Freemans Reach Road), which have a flood immunity that lies about midway between the one in two year and one in three year flood levels.

1.2.3 Demolition of the existing bridge

The existing Windsor bridge would be removed following commissioning of the replacement bridge and associated bridge approach roads. The existing bridge superstructure and substructure would be removed in sections, with temporary bracing installed, as required, to maintain the stability of remaining sections during the demolition process. Where possible the process of demolition would involve cutting or dismantling the superstructure and substructure into sections, with each section transported off-site for further demolition at an appropriately approved and licensed facility. Where possible the dismantled bridge elements would be reused or recycled, however some components of the bridge would require disposal at a landfill. Lead based paint has also been found on the bridge, so demolition activities would need to comply with relevant standards for managing lead based paint. Disruption of waterway traffic would be limited to the greatest extent practicable, with alternative navigation channels provided while the existing navigation span is closed for the demolition works.

1.2.4 Pedestrian and cycling facilities

The project would incorporate facilities for pedestrians and cyclists and include a shared pedestrian/cycle pathway that would be constructed from Wilberforce Road and Macquarie Park, across the western side of the replacement bridge and southern approach road to the corner of George and Bridge Streets. Pedestrian and cyclist access along the southern bank of the river would also be improved with the connection and redevelopment of The Terrace. In addition, the following general works would be undertaken to improve pedestrian safety and access:

- Provision of a new 1.2 metre wide footpath adjacent to properties fronting Old Bridge Street.
- Provision of a new signalised pedestrian crossing on all four approaches to the intersection of Bridge Street and George Street.
- Provision of new pedestrian footpaths for safe access around and across the proposed dual lane roundabout at the junction of Freemans Reach Road, Wilberforce Road and the Macquarie Park access road including a path under the northern bridge abutment.

1.2.5 Water quality basin

The project would include construction of a permanent water quality basin to capture and treat stormwater runoff from the bridge and northern intersection prior to stormwater being discharged to the Hawkesbury River. The water quality basin would be located on the eastern side of the proposed roundabout at the junction of Freemans Reach Road, Wilberforce Road and the Macquarie Park access road.

For the southern approach road a trash net to collect litter and a shut-off-valve to contain any spills in the stormwater system would be installed at the discharge point of the drainage system near Windsor Wharf.

1.2.6 Scour protection

Scour protection would be provided to protect the bridge abutments and piers from the erosive impacts of high river flows. On the southern bank, the scour protection would consist of a concrete panel retaining wall between Windsor Wharf and the existing bridge. Large diameter rocks (900 millimeters) and/or sandstone blocks would also be used to provide scour protection in some locations on the southern bank.

On the northern bank extensive rock and sandstone block scour protection would be required extending up the bank to about five meters above the usual water level. Other forms of scour protection such as a concrete grid planted with grass would be installed in areas above this where scour protection is required.

Scour protection using large rocks would be provided around three of the four bridge piers. Scour protection for each pier would cover an eight metre radius and would be to a depth of 4.5 metres. Dredging around the piers would be required to place the rocks below the river bed level. For the southernmost pier little or no scour protection would be required as bedrock is close to the surface in this location.

During the detailed design phase further work would be undertaken to minimise the visual impact of all visible scour protection.

1.2.7 Public utility works

The existing bridge supports a number of public utilities which would be replicated on the replacement bridge including:

- A 450 millimetre water main (cement lined steel pipe).
- A 50 millimetre sewer rising main (galvanised iron pipe).
- A 100 millimetre electrical conduit.
- Telecommunications conduits (3 x 80 millimetre galvanised iron conduits).

Other public utilities that may need to be adjusted as part of the project include:

- High voltage overhead power lines from Macquarie Street to Wilberforce Road which cross the river on a similar alignment to the replacement bridge. These power lines would need to be relocated prior to bridge construction.
- Power lines near the corner of Wilberforce Road and Freemans Reach Road.
- Local stormwater drainage infrastructure.
- A rising main from Windsor Wharf to the local sewer system, which is used to pump out boat sewage holding tanks.
- A gravity sewer main, which runs beneath Old Bridge and Bridge Streets.
- A number of water mains on both the northern and southern river banks.
- Street lighting on both the northern and southern river banks.
- Telstra assets located on both sides of the river. In particular, Telstra assets located near the proposed southern bridge abutment would need to be relocated prior to construction of the bridge abutment.
- A new recycled water main for future use if required.
- Traffic signal cables along Bridge Street between George Street and Macquarie Street.

1.2.8 Urban and landscape concept design

The urban design and landscape concept design associated with the project was developed by applying project specific urban design principles and treatments. Works associated with the current concept design are described below.

Southern bank and Thompson Square area

At this stage of project development, the scope of works in Thompson Square parkland has yet to be fully defined and would be subject to further consultation with the community, government stakeholders and most importantly Hawkesbury City Council – who would be responsible for managing Thompson Square parkland in the longer term. For the purposes of assessment in the EIS, preliminary urban design and landscaping works for Thompson Square have been identified. These works have been developed with the objectives of providing pedestrian and cyclist access from the replacement bridge to various areas in Thompson Square and providing a base for additional urban design and landscaping works arising from the consultation process. The consultation process for the additional urban design and landscaping works for Thompson Square is ongoing and if possible the full scope of works would be presented and assessed in the Submissions Report. However, it is recognised that the full scope of works may not have been agreed before the completion of the Submissions Report and a post-approval Urban Design and Landscaping Plan for Thompson Square parkland maybe be required.

The scope of works assessed in the EIS include:

- Infilling the southern approach road to the existing bridge.
- Removal of some trees which are either in poor condition or would be impacted by the project.
- Minor earthworks in the Thompson Square lower parkland area to improve the connection of the parkland to the river.
- Construction of stairs from the bridge pedestrian/cyclist path to The Terrace and from Thompson Square road to The Terrace to provide pedestrian access.
- Reinstatement of the section of The Terrace and river bank currently bisected by the existing bridge and approach roads.
- Planting of trees and other vegetation in Thompson Square parkland.
- Landscaping in the road reserve between the three properties on Old Bridge Street and the southern approach road.

Bridge

The project specific urban design principles have been used to refine the visual appearance of the replacement bridge. This includes refinements to the pier shape, bridge superstructure and abutments to minimise its visual impact and provide context to the heritage values of Windsor.

Northern bank

- Infilling the northern approach road to the existing bridge.
- Minor earthworks to improve the visual appearance of the bank.
- Construction of pedestrian/cyclist paths to Wilberforce Road and Macquarie Park.
- Planting of trees and other vegetation.

1.2.9 Construction works

Temporary construction and compound sites

There would be two main construction and compound sites required for the duration of the project (about 18 months, excluding pre-construction and early works). One of these sites would be located within the turf farm between the Hawkesbury River and Wilberforce Road (Lot 2 DP 1096472 and Lot 2 DP65136); while the other would be sited on land between Old Bridge Street and Windsor Wharf (refer to Figure 1-1). The lower Thompson Square parkland would also be closed to public access and used to provide access for the construction of the southern abutment and approach road. The majority of the construction activity would be concentrated on the northern bank as this would be the location of casting yard for the incrementally launched bridge and would be the location where access to the river would predominately occur.

The construction compound on the southern bank would be located in the car parks and grassed areas and would support the construction of the southern approach road and other minor works.

Offices may be leased near Thompson Square for construction personnel.

Order of Construction Works

The order of construction works would be implemented to minimise environmental and traffic impacts as far as practical. The likely order of construction works would consist of the following:

- Pre-construction activities and early works – including construction compound and casting bed establishment, installation of environmental controls, public utility relocations or adjustments and additional investigations and heritage salvage.
- Construction of the bridge - including construction of the piers in the river, two bridge abutments and construction and launching of the bridge superstructure.
- Installation of scour protection on the banks and in the river.
- Construction of the northern roundabout and approach road and most of the southern approach road.
- Construction of temporary pavement both at Wilberforce Road and near the corner of George and Bridge Streets to provide additional road width to enable construction of the subsequent stages.
- Construction of the remainder of the southern approach road and the new sections of Freemans Reach Road, Wilberforce Road and Macquarie Park access road.
- Commissioning and opening of the replacement bridge to traffic.
- Demolition of the existing bridge and urban design works in Thompson Square, on the southern bank, northern bank and other adjacent areas.
- Removal of temporary structures and demobilisation of the construction facilities.

This proposed order of construction works is indicative and may change once detailed construction planning is completed. It is likely that some aspects of construction may overlap.

Construction period

It is anticipated that a construction period of around 18 months (excluding pre-construction and early works) would be required to complete the proposed works including demolition of the existing bridge.

Work hours

The majority of the construction works would be carried out during standard working hours, as detailed in **Table 1-1**. Some construction activities, in particular those requiring road closures, would need to be undertaken outside of standard working hours to prevent major disruptions to traffic and access. Other construction activities such as service relocations and cutovers may also need to be undertaken outside normal working hours. Low noise activities may also be undertaken outside of normal working hours to optimise construction efficiency.

Table 1-1 Standard working hours

Day	Start time	Finish time
Monday to Friday	7am	6pm
Saturday	8am	1pm
Sunday and public holidays	No work	

Construction equipment

The types of construction equipment likely to be used for the project would include (but would not necessarily be limited to) the following:

- Excavation plant, such as excavators, back hoes and front end loaders for pavement cutting, removal and general earthworks.
- Bobcats and sweepers.
- Compaction plant, including rollers, vibrating rollers, concrete vibrators and trench plate compactors.
- Pneumatic jack hammers.
- Profiling, milling and road paving plant.
- Jet-blasting and shot-blasting machines.
- Miscellaneous vehicles, including utilities, trucks, bogies and semi-trailers.
- Miscellaneous hand tools and equipment.
- Generators, lighting towers, signage and variable message boards.
- Various barges, workboats and pontoons.
- Piling rigs and various mobile and fixed cranes.
- Concrete and grouting pumps and transport vehicles.
- Support trusses, stress jacks and scaffold systems.

1.3 Study area

The study area extends north and south of the Hawkesbury River at Windsor (Western Sydney) and is dominated by farming land (pasture crops and turf farms), parklands and urban development. The historical township of Windsor is located south of the Hawkesbury River while the northern portion of the study area includes Macquarie Park and agricultural lands. The river is about 100 metres wide. **Figure 1-1** illustrates the study area for this assessment.

Throughout the report reference is made to the terms, 'subject site', 'construction footprint', 'study area' and 'locality'. The subject site is the immediate design footprint. The construction footprint refers to the area of bridge replacement and includes any ancillary locations or drainage structures. The 'study area' encompasses the construction footprint and any adjoining or adjacent habitat where potential indirect impacts may occur. Finally, the locality is discussed in terms of the broader bioregional context defined by Thackway and Creswell (1995) as the Sydney Bioregion and occurs within a 10 kilometre radius of the construction footprint.

1.4 Legislative context

1.4.1 State legislation and assessment requirements

Environmental Planning and Assessment Act 1979

The project is being assessed as state significant infrastructure under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). As such an EIS is required.

According to Part 5.1 of the EP&A Act, the EIS must address important factors and/or assessment of significance with respect to assessing potential impacts on threatened species, populations or ecological communities, or their habitats as listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act). The EIS must consider the Director General's requirements from the NSW Department of Planning and Infrastructure. These requirements are presented in Section 1.5.

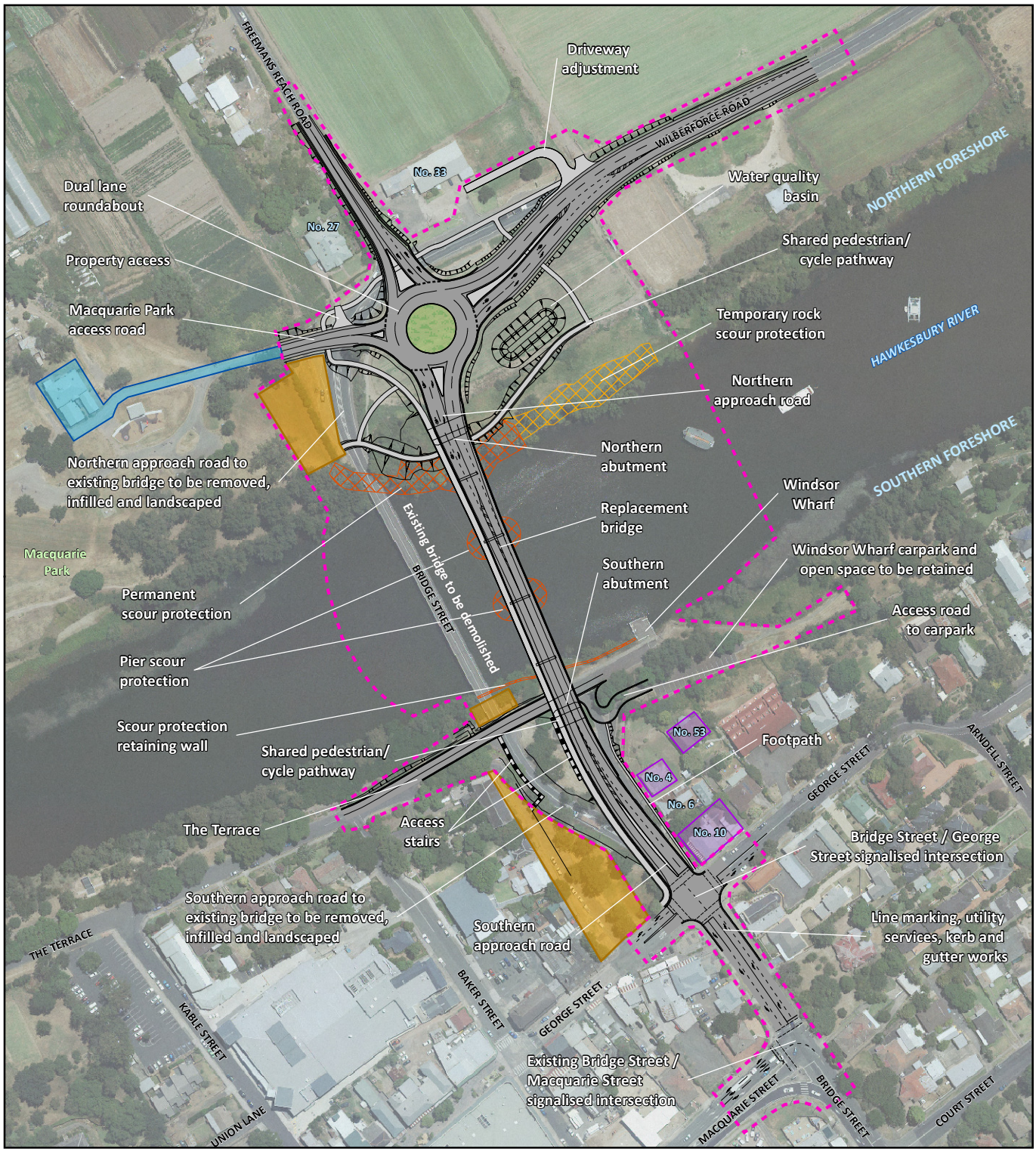
Threatened Species Conservation Act 1995 and Fisheries Management Act 1994

Schedules 1, 1A and 2 of the TSC Act and Schedules 4, 4A, and 5A of the FM Act provide for the listing of:

- Species presumed extinct, critically endangered, endangered and vulnerable in NSW
- Populations listed as endangered in NSW
- Ecological communities as critically endangered, endangered and vulnerable in NSW (threatened ecological communities – TEC).

The draft *Guidelines for Threatened Species Assessment* (Department of Environment and Conservation and Department of Primary Industries 2005) require that the biodiversity assessment must include a statement as to whether or not threatened species are likely to occur in the study area.

Figure 1-1 | Key project elements



Indicative only – subject to detailed design

LEGEND

- Concept design
- Construction work zone
- Permanent rock scour protection (if required)
- Temporary rock scour protection (if required)
- Properties requiring flood mitigation works. Works subject to further consultation with and agreement from affected property owners.
- Properties requiring noise mitigation works. Works that are feasible and reasonable would be subject to further consultation with and agreement from affected property owners.
- Works subject to further council and stakeholder consultation

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1.4.2 Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), any action which has, would have, or is likely to have a significant impact on a Matter of National Environmental Significance (NES) or on Commonwealth land, triggers the EPBC Act and may require Commonwealth assessment and approval from the Commonwealth Minister for the Environment. The eight matters of national environmental significance protected under the EPBC Act are:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines) (Department of Sustainability, Environment, Water, Population and Communities 2011

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DEWHA 2009). In considering the impacts on listed species, ecological communities and migratory species, the assessment must refer to the Significant Impact Guidelines 1.1 under the EPBC Act (DEWHA 2009).

1.5 Study aims

The draft '*Guidelines for Threatened Species Assessment'* (Department of Environment and Conservation 2005a) state that the objective of the threatened species assessment process is to provide information to enable decision makers to ensure that developments deliver the following environmental outcomes:

1. Maintain or improve biodiversity values (that is, there is no net impact on threatened species or native vegetation).
2. Conserve biological diversity and promote ecologically sustainable development.
3. Protect areas of high conservation value (including areas of critical habitat).
4. Prevent the extinction of threatened species.
5. Protect the long-term viability of local populations of a species, population or ecological community.
6. Protect aspects of the environment that are matters of national environmental significance.

1.5.1 Objectives and scope

The objectives of the biodiversity assessment are to identify and analyse relevant information to demonstrate that the project has been designed to be consistent with the principles outlined above, and where there are impacts, that adequate mitigation measures would be implemented.

Based on these objectives, the scope of this assessment is to:

- Determine and describe the characteristics and condition of the vegetation communities and flora and fauna habitats, both terrestrial and aquatic, within the study area
- Determine the occurrence, or likelihood of occurrence, of Threatened species, populations and communities listed under the TSC Act, FM Act and EPBC Act within the study area
- Undertake significance assessments for threatened biodiversity that occur or have potential habitat within the study area under the provisions of the above mentioned legislation
- Propose mitigation strategies to mitigate potential impacts on the ecological values of the study area.

1.5.2 Study requirements

When an application is made for the Minister's approval for State significant infrastructure, the Director-General is to prepare environmental assessment requirements in respect of the infrastructure. The Director-General's environmental assessment requirements (DGRs) for the project with respect to biodiversity issues (terrestrial and aquatic flora and fauna) are listed in **Table 1-2** along with reference to where these issues are addressed in this report.

Table 1-2 Director General's environmental assessment requirements

Requirements	Where addressed in report?
Impacts on the biodiversity values of the site and adjoining areas, including terrestrial, riparian and aquatic habitats	Section 4
Impacts on critical habitats, threatened species, populations or ecological communities and their habitats	Section 4
Taking into account the *Draft Guidelines for Threatened Species Assessment* (Department of Environment and Conservation, 2005).	Section 2

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2 Assessment methodology

2.1 Personnel

The list of personnel responsible for the biodiversity assessment is identified in **Table 2-1**. Work was performed under a current Scientific Licence (SL10044) administered under the NSW *National Parks and Wildlife Act 1974*.

Table 2-1 Key personnel conducting the biodiversity assessment

Personnel	Qualification	Project role
Alex Callen	B. Env. Sc. (Hons)	Lead ecologist
Sarah Douglass	B. Env. Sc., M. Env. Mgt.	Aquatic ecologist
Jonathan Carr	B. Env. Sc.Mgt	Assistant ecologist
Chris Thomson	B. App. Sc. (Env Mgt), Grad. Cert. Nat. Res.	Technical Review

2.2 Database searches and literature reviews

A review of existing information and government maintained databases relevant to the study area was undertaken. The data sources used in this review are described in **Table 2-2**. Other literature sources which contributed to the biodiversity assessment are identified in **Table 2-3**.

These sources were reviewed to streamline survey effort for the assessment by confirming the presence or likelihood of occurrence of threatened species, ecological communities and endangered populations within the study area.

Table 2-2 Data sources reviewed as part of the biodiversity assessment

Database	Ecological Aspects	Search area	Date/s accessed
Bionet – Atlas of NSW Wildlife (Licensed user search)	Threatened flora and fauna records. Threatened ecological communities	10 km radius of study area (locality)	12/03/12
EPBC Protected Matters Database Search	Nationally threatened flora and fauna species, and threatened ecological communities	10 km radius of study area (locality)	29/02/12
OEH Vegetation Types Database	Vegetation types	10 km radius of study area (locality)	Continuous
OEH BioBanking Threatened Species Profile Database	Threatened species	10 km radius of study area (locality)	Continuous
Primary Industries Records viewer	Freshwater Catfish Macquarie Perch Trout Cod Australian Grayling	Hawkesbury LGA	29/02/12
DPI Noxious Weeds	Noxious Weeds	Hawkesbury LGA	Continuous

Table 2-3 Literature sources reviewed as part of the biodiversity assessment

Report	Author
Flora and Fauna Investigations for Windsor Bridge over the Hawkesbury River (RTA 2011b)	LesryK Environmental Consultants (LEC).
Current and preliminary listings	*Threatened Conservation Act 1995*, *Environment Protection Biodiversity Conservation Act 1999*, *Fisheries Management Act 1994, Fisheries Management Amendment Act 2009*
Native Vegetation Maps of the Cumberland Plain, Western Sydney	NSW National Parks and Wildlife Service (2002)
NSW Ecosystems database mapping unit descriptions.	Mitchell, P.B. (2003). Unpublished report to the NSW National Parks and Wildlife Service, Hurstville.

2.3 Nomenclature

Names of plants used follow Harden (1992, 1993, 2000, 2002) with reference to PlantNet (Royal Botanic Gardens 2012) or recent taxonomic changes. Scientific names are used in this report for plant species. Scientific and common names (where available) are provided in plant lists in **Appendix A**. Names of vertebrate fauna follow the Census of Australian Vertebrates (CAVS) database maintained by the (Department of Sustainability, Environment, Water, Populations and Communities 2012). Common names are used in the report for animal species. Scientific names are included in species lists found in **Appendix B**. These reflect the nomenclature for species identification under the EPBC Act and TSC Act.

2.4 Field survey

Ecological surveys were designed to identify the extent and quality of native vegetation, fauna habitats and species diversity while targeting the threatened biodiversity with a moderate to high likelihood of occurrence. The following information describes the field surveys including terrestrial and aquatic investigations.

2.4.1 Flora survey

A flora survey was conducted to provide baseline floristic data and determine the presence of threatened plant species, populations and/or endangered ecological communities in the study area. The data was used to predict the extent and magnitude of potential impacts and inform the development of mitigation measures. The rationale for the survey and a description of survey effort is described in **Section 2.5**.

The survey was undertaken in March 2012. Due to the relatively small study area, the entire site was surveyed with limitations to this approach outlined in **Section 2.6**. This approach was considered appropriate for observing any threatened flora species known to occur from the locality as it incorporated the Random Meander Method (Cropper, 1993). The foot traverse of the study area focussed on collecting the following information:

- Identification of the plant species and populations present (including weeds) across the study area.
- Identification of the density, diversity and abundance of plant species across the study area.
- Vegetation condition, including evidence of disturbance.
- Description of vegetation formation, class and type (in accordance with the OEH Vegetation Types Database).

- Determination of the presence, and recording of the location, of any threatened flora species, endangered populations or threatened ecological communities, with consideration of their local and regional conservation significance.
- Targeted searches for species identified as having a moderate to high likelihood of occurring in the locality.
- Habitat features and the potential for species and population presence.

Several small areas within the project corridor were identified as not being covered by the original vegetation mapping identified in the most recent flora and fauna investigations for the project (Roads Traffic Authority, 2011b). These areas were ground-truthed and aligned with the original vegetation community set developed by LesryK Environmental Consultants (RTA, 2011b). The remaining vegetation mapping was considered to be adequate to represent the distribution and abundance of vegetation communities within the study area.

Vegetation condition

Three categories were used to describe the condition of the vegetation:

- **High**: Vegetation retains the majority of native species and structural characteristics of the pre-European equivalent. Such vegetation is usually in a near-natural state and displays resilience to weed invasion due to intact ground cover, shrub and canopy layers and lack of soil disturbance. The understorey is generally dominated by native flora with weed cover being mainly restricted to edge habitats. These areas support a canopy cover of greater than 10 per cent and have a patch size of at least 5000 metres squared.
- **Moderate**: Vegetation generally retains a majority of the native species cover but has lost some of the structural layers (i.e. canopy, groundlayer) and some of its original species complement. Weed invasion varies from slight to significant. These areas generally include smaller remnants (less than 5000 metres squared) that are partially intact as well as larger remnants with a discontinuous canopy and areas of derived native grasslands
- **Low**: Vegetation that has lost most of its species and is substantially modified structurally. Such areas often have a discontinuous canopy with reduced shrub layer and little abundance of native groundcover species. These areas include spaced remnant trees with a maintained understorey, areas of regenerating shrubs and trees and other disturbed, highly modified or artificially constructed communities.

2.4.2 Fauna survey and habitat assessment

A targeted fauna survey was undertaken to assess the habitat value of areas which would be impacted by the project, and included consideration of the extent and quality of native vegetation, such as the number and location of hollow-bearing habitat trees. The disturbance history and the type and condition of waterbodies were also assessed. A particular focus of the survey was to assess the potential significance of the site to fauna species listed on Schedules 1 and 2 of the TSC Act, and the EPBC Act that were considered likely to occur. Any ‘key threatening processes’ likely to be exacerbated by, or introduced as a result of the project was also assessed. The data was used to predict the extent and magnitude of potential impacts and to inform the development of mitigation advice.

Quantitative and qualitative data collected from previous flora investigations for the project was considered in the design of the fauna survey. The rationale for the survey and a description of the survey effort is summarised in **Section 2.5**. Where threatened species were considered highly likely to occur within the study area, relevant threatened species survey and assessment guidelines were applied.

The field survey was undertaken in March 2012. Due to the relatively small study area the entire site was surveyed, with limitations to this approach outlined in **Section 2.5**. This approach was considered appropriate for the conduct of opportunistic bird, reptile and snail surveys, and determination of potential habitat within the riparian environment and below the bridge, particularly in terms of potential microbat habitat. Where required, survey methodology followed the 'Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities Working Draft' (DEC, 2004). The foot traverse of the study area focussed on collecting the following information:

- Direct observation of fauna species and populations and relative density
- Indirect observation of the presence of fauna species within the study area such as scats, tracks and other traces
- Habitat features (such as roosting and feeding resources, presence of prey species, feed trees and habitat connectivity on a local and regional scale)
- Determination of suitable and potential fauna habitat based on vegetation composition and structure. This included an inspection of the existing bridge structure to investigate the presence of roosting microbats or potential roosting opportunities
- Habitat condition, including descriptions of disturbance
- Consideration of listed threatened species and species and populations with local and regional conservation significance.

2.4.3 Aquatic habitat assessment

A qualitative habitat assessment of the Hawkesbury River upstream and downstream of the project was undertaken to assess the condition of aquatic habitats and identify any constraints and opportunities associated with the relocation of Windsor bridge. This assessment was undertaken at the aquatic survey locations shown on **Figure 3-2**. During the assessment the following data was recorded:

- Size (stream width) and landscape context (i.e. surrounding land use) of the Hawkesbury River.
- Presence of aquatic habitats (macrophytes, snags etc) and their condition.
- Presence of riparian vegetations including, type, condition and completeness.
- Existing barriers (natural or artificial) to fish passage.

The watercourse was also photographed at several locations, and the coordinates recorded using a GPS. As part of the aquatic habitat assessment, water quality of the Hawkesbury River was recorded upstream and downstream of the proposed bridge on 21 March 2012. Water quality parameters were measured using a calibrated Hydrolab Quanta water quality probe. The parameters recorded are described at **Table 2-4**.

Table 2-4 Water quality parameters sampled at the Hawkesbury River in the study area

Parameter	Description
Turbidity (NTU)	A measure of the 'muddiness' of water and is important because the turbidity of water is an indication of the amount of suspended colloidal and particulate matter in the water and how much light can penetrate for important biochemical processes such as photosynthesis. Elevated levels of particulate matter can also impact on dissolved oxygen concentrations and pH.
Conductivity (mS/cm)	A measure of the amount of dissolved salts in the water and its ability to conduct an electrical current. It is important as some plants and animals are salt sensitive while others require higher salt concentration.
Temperature (°C)	A measure of the degree or hotness or coldness of water. It is a form of pollution that varies naturally as part of daily and seasonal cycles and can impact on riverine biota and associated biological and chemical processes.
pH	A measure of the acidity or alkalinity of water. Most freshwater and estuarine biota have a range of tolerances between about 6.5 and 8.
Dissolved Oxygen (% saturation and mg/L)	A measure of the amount of oxygen dissolved in water. Dissolved oxygen is vital for many forms of riverine and estuarine biota including native fish and is also vital for the functioning of healthy aquatic ecosystems.

Measurements were taken at 30 centimetres below the surface. The depths of all measurements were recorded in the field. For each parameter, two replicate measurements were recorded randomly at each site within a 20 metre radius of the access point. Each parameter was then reported as the average (arithmetic mean) of the three measurements. The individual replicates are also reported to provide an understanding of the variation between the individual readings.

A visual assessment at each monitoring site was also undertaken including water condition/colour, presence of nuisance organisms, oily films, floating debris, and any odour or frothing.

Water quality data for the relevant indicators is then compared against the default trigger values for chemical and physical stressors for the protection of aquatic ecosystems for south-east Australia for slightly disturbed lowland river ecosystems as outlined in the National Water Quality Management Strategy (ANZECC/ARMCANZ 2000).

2.5 Survey effort

The terrestrial flora and fauna survey was conducted in early autumn (13 March 2012). Weather conditions were generally calm and clear with temperatures ranging between 18–28 degrees Celsius. Zero rainfall was recorded, however the area received 135 millimetres of rainfall in the first two weeks of March (Bureau of Meteorology (BOM) 2012) which led to substantial flooding in the study area. About six person hours were spent surveying across the study area.

The aquatic assessment was undertaken on 21 March 2012 with overcast conditions. One millimetre of rain had fallen on 20 March recorded from the BOM gauge at Richmond RAAF (station 067105).

The study area is largely cleared and remaining vegetation and fauna habitats across the site are degraded, having been subjected to disturbance through agriculture, development, road infrastructure, weed infestation and parkland management. The highly modified nature of the natural environment in the study area, and pre-existing survey results (LesryK, 2011) justified a limited ecological survey methodology including opportunistic surveys and habitat assessment over one autumn event. Given the relatively small size of the study area the use of random meander surveys and general foot traverses are recognised under the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities Working Draft* (DEC, 2004) as appropriate. The lack of freshwater habitats for frogs, habitat for small mammals and lack of records for these threatened taxa in the study area precluded any detailed surveys for these groups.

Initial plans to undertake night surveys for bats using bat detectors under the bridge were discarded as a result of recent flooding at the site. At the time of survey evidence of flood debris under the bridge spans was observed. It is likely that the flood event would have destroyed any potential current bat roosts beneath the bridge. No bats were observed under the bridge during a daytime search. This is consistent with a previous bat roost assessment by LesryK (2011).

2.6 Limitations

It is possible for a species to be present in an area but not detected during searches at the site. This may occur if surveys are undertaken at a time when cryptic species are not in flower, if species are only seasonally present or only present in soil seedbanks until germination is triggered by disturbance such as fire or land clearing.

The original scheduled timing for field work (6-7 March, 2012) was abandoned due to widespread heavy rainfall and local flooding. The survey work was undertaken the following week to improve the representation of collected data. Heavy rainfall during the period of survey work also prevented obtaining potential records of bat species and populations that may have been utilising the bridge. Bank instability as a result of the flooding also made traversing the entire site dangerous, and surveys were undertaken in areas where bank slumping and gully erosion were not a risk. Substantial disturbance to the ground layer and shrub layer had occurred as a result of the recent rainfall and flooding, therefore it is possible that some groundcovers that have previously been detected at the site were not evident during the current survey. One eucalypt species was unidentified due to the absence of plant material on the ground at the time of survey as a result of the recent flooding.

2.7 Likelihood of occurrence criteria

State and nationally listed species with the potential to occur within the study region were assessed to identify their likelihood of occurrence in the study area based on known habitat requirements. This was compared with the habitats and their condition identified during the field survey. In determining the likelihood of occurrence of a threatened species, the following information was consulted:

- Threatened Species Profile Database - a component of the Biobanking assessment methodology credit calculator tool
- Atlas of NSW Wildlife (OEH) within a 10 kilometre radius from of the study area to identify previous records of threatened flora and fauna
- Previous surveys within the study area to identify the types and conditions of the flora and fauna habitats present and the species assemblage

- OEH state-listed threatened species profiles *and* Commonwealth listed Species Profile and Threat (SPRAT) Database (EPBC Act) (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl).

The likelihood of a species occurring was classified according to the criteria described in **Table 2-5**.

Table 2-5 Likelihood of occurrence criteria

Likelihood of occurrence	Criteria
Unlikely	• Species highly restricted to certain geographical areas not within the study area. • Specific habitat requirements were not present in the study area.
Low	• Species not recorded during field surveys and fit one or more of the following criteria: • Have not been recorded previously in the study area/surrounds and for which the study area would be beyond the current distribution range. • Use specific habitats or resources not present in the study area. • A non-cryptic perennial flora species that was specifically targeted by surveys and not recorded.
Medium	• Species not recorded during the field surveys that fit one or more of the following criteria: • Have infrequently been recorded previously in the study area/surrounds. • Use specific habitats or resources present in the study area but in a poor or modified condition. • Unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. • Cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
High	• Species recorded during the field surveys or species not recorded that fit one or more of the following criteria: • Have frequently been recorded previously in the study area/surrounds. • Use habitat types or resources that were present in the study area that are abundant and/or in good condition within the study area. • Known or likely to maintain resident populations surrounding the study area. • Known or likely to visit the site during regular seasonal movements or migration.

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