ART GALLERY OF NSW TRUST

ART GALLERY OF NSW PROJECT - SYDNEY MODERN

TERRESTRIAL BIODIVERSITY IMPACT ASSESSMENT

NOVEMBER 2017

Question today
Imagine tomorrow
Create for the future

Art Gallery of NSW Project - Sydney Modern
Terrestrial Biodiversity Impact Assessment

Art Gallery of NSW Trust

WSP
Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
wsp.com

REV	DATE	DETAILS
A	13/05/2016	Draft
B	04/07/2016	Final
C	26/07/2017	Rev C - update
D	01/11/2017	Rev D - final

	NAME	DATE	SIGNATURE
Prepared by:	Troy Jennings	01/11/2017	
Reviewed by:	Mark Stables	01/11/2017	pp 
Approved by:	Mark Stables	01/11/2017	pp 

TABLE OF CONTENTS

CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF APPENDICES

GLOSSARY

Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (Federal Government of the United States America).
Cryptic species	A species that may be hidden from view. In plants this may be as a result of life cycle processes (e.g. presence as below-ground storage organs or seeds), growth form (i.e. small, species that are only conspicuous when flowering) or habitat (e.g. epiphytes growing in inaccessible tree canopy). In animals, this may refer to species that are secretive and difficult to detect through standard survey techniques (e.g. some small trap-shay mammals) or species that are only readily detectable during specific and infrequent climatic conditions (e.g. some frog species which are only readily dateable after very heavy spring/summer rain).
Direct impact	Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter(Commonwealth of Australia, 2012).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (NSW Government, 2016).
Indirect impact	Where an event or circumstance is a direct consequence of the action (Commonwealth of Australia, 2012).
Life cycle	The series or stages of reproduction, growth, development, ageing and death of an organism (Department of Environment and Climate Change, 2007).
Locality	The area occupied by a 'local population' of a species or the 'local occurrence' of an ecological community (Department of Environment and Climate Change, 2007).
Local population	The local population of a threatened plant species comprises those individuals occurring in the subject site or the cluster of individuals that extend into habitat adjoining and contiguous with the subject site that could reasonably be expected to be cross-pollinating with those in the subject site. The local population of resident fauna species comprises those individuals known or likely to occur in the subject site, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the subject site. The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the subject site from time to time (Department of Environment and Climate Change, 2007).
Local occurrence	The ecological community that occurs within the subject site. However the local occurrence may include adjacent areas if the ecological community on the subject site forms part of a larger contiguous area of that ecological community and the movement of individuals and exchange of genetic material across the boundary of the subject site can be clearly demonstrated (Department of Environment and Climate Change, 2007).
MNES	A matter/s of national environmental significance (MNES) protected by a provision of Part 3 of the EPBC Act.

Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (Department of Environment and Climate Change, 2002).
Mitigation	Action to reduce the severity of an impact.
Population	All the individuals of a species or a sub-specific taxon (subspecies, variety) that interbreed within a given area (Department of Environment and Climate Change, 2007).
Subject site	The area of land that would be directly impacted on by a proposed project, including ancillary areas such as access roads, and areas used to store construction materials.

ABBREVIATIONS

AGNSW	Art Gallery of New South Wales
BAM	Biodiversity Assessment Methodology 2017
BAR	Biodiversity Assessment Report
BBCC	BioBanking Credit Calculator
BC Act	Biodiversity Conservation Act 2016
BVT	Biometric Vegetation Type
CMA	Catchment Management Authority
CEMP	Construction Environmental Management Plan
DP&E	Department of Planning and Environment
DPI	Department of Primary Industries
EEC	Endangered ecological community
EIS	Environmental Impact Statement
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999 (Federal)
FBA	Framework for Biodiversity Assessment)(NSW Office of Environment and Heritage, 2014)
FM Act	Fisheries Management Act 1994 (NSW)
GDE	Groundwater dependent ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia
LGA	Local Government Area
MNES	Matters of National Environmental Significance
OEH	Office of Environment and Heritage
PCT	Plant Community Type
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SMP	Sydney Modern Project
SSDA	State Significant Development Application
TECs	Threatened Ecological Communities
TSPD	Threatened Species Profile Database
TSC Act	Threatened Species Conservation Act 1995 (NSW)
VIS	Vegetation information system

EXECUTIVE SUMMARY

The Art Gallery of NSW proposes to undertake a major expansion of the existing art gallery adjacent to the Phillip Precinct of the Domain. The expansion, proposed as a separate, stand-alone building, is located north of the existing gallery, partly extending over the Eastern Distributor land bridge and includes a disused Navy fuel bunker located to the north east of this land bridge.

The new building comprises a new entry plaza, new exhibition spaces, shop, food and beverage facilities, visitor amenities, art research and education spaces, new roof terraces and landscaping and associated site works and infrastructure, including loading and service areas, services infrastructure and an ancillary seawater heat exchange system.

The relevant Secretary Environmental Assessment Requirements (SEARs) specific for ecological impacts (Key Issue 9) include:

— *An ecological impact assessment is to be provided, addressing both terrestrial and aquatic ecosystems. The assessment must consider direct impacts on ecological values, as well as indirect impacts that may be associated with water quality conditions and flow characteristics in the vicinity of intake and discharge infrastructure*

— *Provide detailed assessment of any vegetation clearing on the site including the removal of significant trees, any impact on threatened species populations, endangered ecological communities or their habitat and potential for offset requirements*

This report is consistent with Key Issue 9 of the SEARs in regards to terrestrial ecological impact assessment, including both direct and indirect impacts and impacts on terrestrial threatened species, populations and ecological communities. Aquatic ecological impact assessment is provided in the Sydney Modern Project, Seawater Heat Exchange System - Marine Impact Assessment.

Impact assessments were completed for all terrestrial threatened species, populations and ecological communities known or with medium or higher likelihood to occur in the subject site. Impact assessments concluded that the project is unlikely to have a significant impact if the mitigation measures and recommendations in Section 6 are implemented.

Due to the relatively small area, prevalence of built structures under a large part of the site (land bridge and fuel bunkers), and lack of intact remnant native vegetation within the area to be affected, the project is unlikely to result in significant impacts to matters of national environmental significance and as such, a Referral to the Commonwealth Department of the Environment is not considered necessary.

Further, the proposal is not likely to have a significant impact on any threatened species, populations, ecological communities or their habitats listed under the *Biodiversity Conservation Act 2016* and as such a Species Impact Statement is not required to support this application.

1 INTRODUCTION

WSP have been engaged by Art Gallery of NSW Trust to undertake a Terrestrial Biodiversity Impact Assessment (BIA) of the proposed major expansion of the existing Art Gallery of NSW known as the Sydney Modern building.

The Art Gallery of NSW proposes to undertake a major expansion of the existing art gallery adjacent to the Phillip Precinct of the Domain. The expansion, proposed as a separate, stand-alone building, is located north of the existing gallery, partly extending over the Eastern Distributor land bridge and includes a disused Navy fuel bunker located to the north east of this land bridge.

The new building comprises a new entry plaza, new exhibition spaces, shop, food and beverage facilities, visitor amenities, art research and education spaces, new roof terraces and landscaping and associated site works and infrastructure, including loading and service areas, services infrastructure and an ancillary seawater heat exchange system.

1.1 STUDY OBJECTIVES

The objectives of this BIA are to:

- describe the existing environment, including vegetation communities, terrestrial flora and fauna habitats
- describe ecological constraints and provide recommendations for the proposal, with particular reference to species, populations and communities, listed under the *Biodiversity Conservation Act 2016* (BC Act) and/or the *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act)
- prepare significance assessments for the proposal's potential impacts, where required, on locally occurring terrestrial threatened species, populations and ecological communities listed under the BC Act and/or the EPBC Act
- develop mitigation measures appropriate for the proposal relating to biodiversity protection.

A separate Marine Ecology Risk Assessment has been prepared by WSP | Parsons Brinckerhoff for the marine parts of the site associated with the proposed sea water heat exchange system component of the project.

This report addresses the second modification of the Secretary Environmental Assessment Requirements (SEARs) of the project issued by the Department of Planning and Environment dated 8 June 2016 for the State Significant Development Application (SSDA), with specific reference to following section:

> *9. Ecological Impacts*
>
> *An Ecological Impact Assessment is to be provided, addressing both terrestrial and aquatic ecosystems. The assessment must consider direct impacts on ecological values, as well as indirect impacts that may be associated with water quality conditions and flow characteristics in the vicinity of intake and discharge infrastructure.*
>
> *Provide a detailed assessment of any vegetation clearing on the site including the removal of significant trees, any impact on threatened species populations, endangered ecological communities or their habitat and potential for offset requirements.*

It should be noted that the NSW *Biodiversity Conservation Act 2016* (BC Act) came into effect on the 25 August 2017. This Act replaced the NSW *Threatened Species and Conservation Act 1995* (TSC Act), *Native Vegetation Act 2003* and parts of the *National Parks and Wildlife Act 1974*. Transitional provisions for pending or interim planning applications are outlined under Part 7 Reg 29(1)(b) of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 which states that;

> *an application for planning approval (or for the modification of a planning approval) made within 18 months after the commencement of the new Act if an environmental impact statement is to be submitted*

in connection with the application and the Secretary of the Department of Planning and Environment issued, before the commencement of the new Act, environmental assessment requirements for the preparation of the statement.

As such, this ecological assessment (including impact assessments) have been prepared in accordance with the former Section 5A of the *Environmental Planning & Assessment Act 1979* with reference to the BC Act listed threatened species, populations and ecological communities.

1.2 DESCRIPTION OF THE PROPOSAL

The Art Gallery of NSW proposes to undertake a major expansion of the existing art gallery adjacent to the Phillip Precinct of the Domain. The expansion, proposed as a separate, stand-alone building, is located north of the existing gallery, partly extending over the Eastern Distributor land bridge and includes a disused Navy fuel bunker located to the north east of this land bridge.

The new building comprises a new entry plaza, new exhibition spaces, shop, food and beverage facilities, visitor amenities, art research and education spaces, new roof terraces and landscaping and associated site works and infrastructure, including loading and service areas, services infrastructure and an ancillary seawater heat exchange system.

Development consent is sought for:

- Site preparation works, including:
  - site clearing, including demolition of former substation, part of road surfaces, kerbs and traffic islands, pedestrian crossings, foot paths, retaining walls, stairs, and part of disused underground former Navy fuel bunkers
  - tree removal
  - excavation and site earthworks
  - remediation works.
- Construction of the new building comprising:
  - covered public entry plaza
  - five building levels, including entry pavilion following the site topography down to Lincoln Crescent
  - retention of part of existing former underground Navy fuel bunker for use as gallery space and support spaces
  - art exhibition spaces
  - outdoor publicly accessible terraces
  - shop and cafe
  - multipurpose space
  - education spaces
  - ground level loading dock (accessed via Lincoln Crescent) with associated art handling facilities, workshops, service parking, plant, and storage areas.
- Landscaping and public domain improvements including:
  - continuation of the east-west pedestrian link over the land bridge between the Domain and Woolloomooloo Bay, including dedicated lift structure for universal access
  - improved public access of the north south pedestrian link
  - enhancement of the public open space on the land bridge to create a landscape and art connection between the two buildings
  - hard and soft landscaping to roofs and terraces
  - plantings and new pathways
  - increased landscaped area to forecourt of existing Art Gallery building and removal of car parking

  - relocation of selected trees to the south-eastern corner of the site
  - sound barrier to edge of land bridge.
- Upgrade works to part of Art Gallery Road, Cowper Wharf Road, Mrs Macquaries Road, and Lincoln Crescent, including new pedestrian crossings.
- Provision of vehicle drop off points including a taxi stand, private vehicle drop off and bus/coach drop off, at Art Gallery Road.
- Installation of an ancillary seawater heat exchange system to act as the new building's cooling system, adjacent to and within Woolloomooloo Bay.
- Diversion, extension and augmentation of physical infrastructure and utilities as required.

The Sydney Modern project is classified as a SSDA and SEARs have been issued for the preparation of an Environmental Impact Statement (EIS). This report addresses Key Issue 9 – Ecological Impacts of the SEARs, which include:

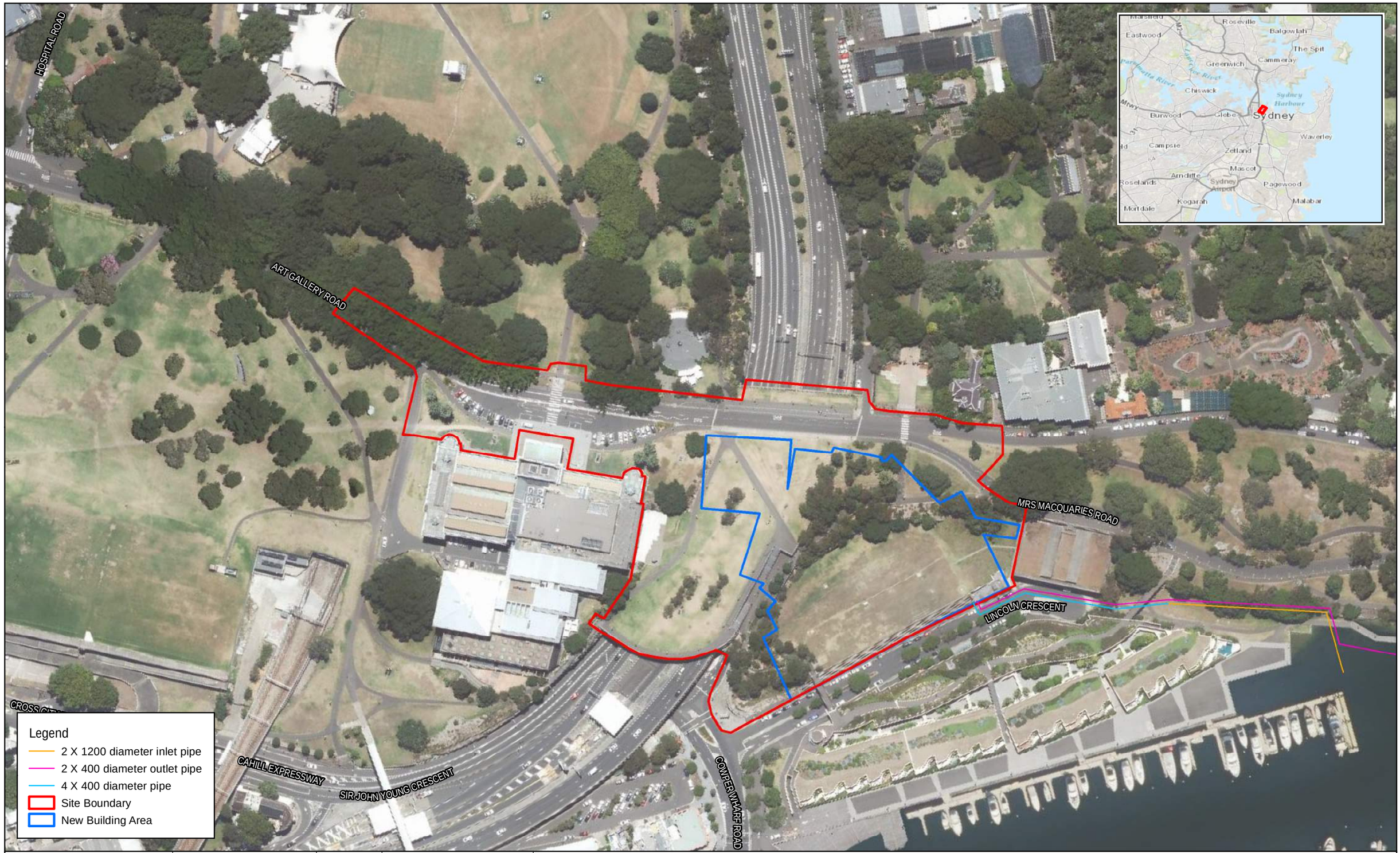
- *An ecological impact assessment is to be provided, addressing both terrestrial and aquatic ecosystems. The assessment must consider direct impacts on ecological values, as well as indirect impacts that may be associated with water quality conditions and flow characteristics in the vicinity of intake and discharge infrastructure*
- *Provide detailed assessment of any vegetation clearing on the site including the removal of significant trees, any impact on threatened species populations, endangered ecological communities or their habitat and potential for offset requirements*

This report is consistent with Key Issue 9 of the SEARs in regards to terrestrial ecological impact assessment, including both direct and indirect impacts and impacts on terrestrial threatened species, populations and ecological communities. Aquatic ecological impact assessment is provided in the Sydney Modern Project, Seawater Heat Exchange System - Marine Impact Assessment.

It should be noted that due to the modified nature of the site that includes a land bridge and fuel bunkers, the lack of remnant native vegetation and associated NSW Plant Community Types (PCT) and the absence of reference in the SEARs, this report has not be prepared in accordance with the NSW Framework for Biodiversity Assessment guidelines (NSW Office of Environment and Heritage, 2014). This report does however specifically address all legislation requirements that are applied to threatened species matters under the NSW planning framework.

It should be noted that whilst the subject site does not contain remnant native vegetation, this report will focus on the likelihood of habitat utilisation of horticultural plantings by listed threatened species.

As part of the proposal a total of 141 existing trees are to be removed from the subject site. A total of two figs and six palms are to be transplanted. A total of 71 existing trees are to be retained. Landscape gardens are proposed to be undertaken on the subject site that will consist of a variety of locally occurring native plants that represent local native vegetation communities and vegetation that is similar to the surrounding Domain Gardens.



Map: 2270174A_GIS_F001_A3_A1	Author: David.Naiken		0 20 40 m 1:1,748
Date: 1/11/2017	Approved by: T Jennings		Coordinate system: GDA 1994 MGA Zone 56 Scale ratio correct when printed at A3

Data source: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community © Land and Property Information 2015

ART GALLERY OF NSW EXPANSION - SYDNEY MODERN

Figure 1.1
Location of subject site

2 STUDY METHODOLOGY

This assessment included a desktop review of available databases and literature as well as field surveys undertaken on 9 May 2016. The methods are described in detail below.

2.1 DEFINITIONS

For the purpose of this report the following definitions apply:

- **Subject site** is defined as a footprint of the project around NSW Art Gallery property (refer to Figure 1.1) and includes the area occupied by the proposed sea water heat exchange system but that the marine area will be subject to Marine Ecology Risk Assessment (WSP 2016).
- **Locality** is defined as an approximate 5 km radius around the Subject site.
- **Region** is a bioregion defined in a national system of bioregionalisation. For this study, this is the Sydney Basin bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell, 1995).

2.2 PERSONNEL

The contributors to the preparation of this report, their qualification and roles are provided in Table 2.1.

Table 2.1 Contributors and their role

NAME	QUALIFICATIONS	ROLE
Troy Jennings	Bachelor of Biodiversity and Conservation, Conservation and Land Management Certificate III, Masters of Wildlife Management	Ecologist – field survey and report preparation
Mark Stables	Bachelor of Science (Hons)	Senior Ecologist – field survey, report preparation and project management
Alex Cockerill	Bachelor of Science (Hons) NSW BioBanking accreditation 0058, Office of Environment and Heritage (OEH)	Principal Ecologist –report review
Emily Mitchell	Bachelor of Development Studies, Certificate IV Spatial Information Services, Masters of Information Technology (currently enrolled)	Mapping and data management – GIS operator

All work was carried out under the appropriate licences, including a scientific licence as required under Clause 22 of the National Parks and Wildlife Regulations 2002 and Section 132C of the National Parks and Wildlife Act 1974, Animal Research Authority issued by the Department of Industries and Investment NSW (Agriculture).

2.3 NOMENCLATURE

Names of plants used in this document follow Harden (Harden, 2000, Harden, 1992, Harden, 1993, Harden, 2002) with updates from PlantNet (Royal Botanic Gardens, 2016). Scientific names are used in this report for species of plant followed by the common names in brackets. Scientific and common names of plants are listed in Appendix A and C. Introduced species are identified within the text with an asterisk following the name, for example *Lantana camara**.

Names of vertebrates follow the Australian Faunal Directory (Department of the Environment and Energy, 2016a) maintained by the Commonwealth Department of the Environment (DoE). Common names are used in the report for species of animal. Scientific names are included in species lists found in Appendix B and D.

2.4 LITERATURE AND DATABASE ASSESSMENT

The aim of this background research was to identify threatened flora and fauna species, populations and ecological communities, Commonwealth listed Migratory species or critical habitat recorded previously or predicted to occur in the vicinity of the survey area.

This allowed for known habitat characteristics to be compared with those present within the survey area to determine the likelihood of occurrence of each species or populations. These results informed the identification of appropriate field survey effort and the groups likely to occur.

Records of threatened species, populations and ecological communities known or predicted to occur in the locality of the proposal were obtained from a range of databases as detailed in Table 2.2.

Table 2.2 Database searches undertaken

DATABASE	SEARCH DATE	AREA SEARCHED	REFERENCE
OEH Bionet Atlas of NSW Wildlife	4 May 2016 (flora and fauna)	5 km radius around the proposal centre point of the subject site[1]	Office of Environment and Heritage (Office of Environment and Heritage, 2016)
PlantNet	4 May 2016	5 km radius around the subject site centre point[1]	Royal Botanical Gardens, Sydney (Royal Botanic Gardens, 2016)
Protected Matters Search Tool	13 April 2016 (flora and fauna)	5 km buffer around the subject site centre point[1]	Department of the Environment (Department of the Environment and Energy, 2016b)

Note: Database searches were based around the central point of latitude -33.8687222, longitude 151.2171722 with 5 km radius.

In addition to the above database searches other relevant resources were reviewed including:

- research papers, books and other published data (see section 9: Reference list)
- aerial photography
- existing broad-scale vegetation mapping of the survey area i.e. The Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area (Tozer et al., 2010).

2.5 FIELD SURVEY

The subject site was inspected during daylight hours by a team of two ecologists on the 9 and 11 May 2016. This survey was structured primarily to assess the extent and condition of vegetation and fauna habitat, especially for the threatened species and ecological communities that were considered likely to occur.

2.5.1 WEATHER CONDITIONS

The weather conditions during the survey period were mild and cool. No rainfall was recorded during the survey period and light winds were observed (Table 2.3).

Table 2.3 Weather conditions

DATE	TEMPERATURE °C (MIN)	TEMPERATURE °C (MAX)	RAIN (mm)	WIND (MAX SPEED (km/h)/DIRECTION)
9 May 2016	18	21.8	0.00	NNE (22 km/h)
11 May 2016	12.6	22.6	0.00	WNW (11 km/h)
26 September 2017	14.9	18.4	0.00	SW (46 km/h)

Data obtained from Bureau of Meteorology Sydney Observatory Hill (Station 066062).

2.5.2 FLORA

The floristic diversity, possible presence of threatened species and identity of vegetation communities was assessed using random meander surveys. These were conducted throughout the subject site and focused on areas of vegetation.

Random meander transects were completed in accordance with the technique described by (Cropper, 1993) whereby the recorded walks in a haphazard manner throughout the subject site. Attributes recorded during the random meander transects included variation in species composition and vegetation structure, the presence or absence of threatened or noxious species of plant and boundaries between vegetation communities.

The random meander surveys were used as a method of searching for threatened species of plant undertaken throughout the accessible sections of the subject site covering all native vegetation.

2.5.2.1 FIELD VALIDATION OF EXISTING VEGETATION MAPPING

Vegetation within the subject site and locality has been previously mapped at a regional scale by the *Native Vegetation of southeast NSW: A revised classification map for the coast and tablelands* (Tozer et al., 2010). Field validation (ground-truthing) of the initial vegetation classification identified from aerial photograph interpretation and existing vegetation mapping was undertaken to determine the site specific classification of the vegetation structure, dominant canopy species, native diversity and condition.

2.5.2.2 VEGETATION CONDITION

The condition of vegetation was assessed using parameters such as structural intactness, native species diversity, evidence of disturbance, weed invasion and plant health. Random meander surveys were the primary method of data collection for the vegetation community identification and condition assessment.

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

- **Good:** Vegetation still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation has usually changed very little over time and displays resilience to weed invasion due to intact groundcover, shrub and canopy layers.
- **Moderate:** Vegetation generally still retains its structural integrity, but has been disturbed and has lost some component of its original species complement. Weed invasion can be significant in such remnants.
- **Low:** Vegetation that has lost most of its species and is significantly modified structurally. Often such areas have a discontinuous canopy of the original tree cover, with very few shrubs. Exotic species, such as introduced pasture grasses or weeds, replace much of the indigenous ground cover. Environmental weeds are often co-dominant with the original indigenous species.

2.5.3 FAUNA

Fauna surveys were restricted to opportunistic surveys, hollow bearing tree surveys and habitat assessments.

2.5.3.1 OPPORTUNISTIC SURVEY

Opportunistic surveys consisted of random meanders across the survey area and while completing other survey techniques, including habitat assessments and hollow-bearing tree surveys. Specimens were either identified visually or by aural recognition of calls (frogs and birds).

2.5.3.2 HOLLOW BEARING TREE SURVEY

A visual inspection for any hollow bearing trees throughout the subject site was undertaken during the site inspection.

2.5.3.3 FAUNA HABITAT ASSESSMENT

Fauna habitat assessments were completed to assess the likelihood of threatened species of animal occurring in the subject site. Habitat assessments included the assessment and identification of habitat features through visual inspection.

During inspections, opportunistic recordings of species were made through incidental sightings, aural recognition of calls and observations of indirect evidence of species' presence such as Glossy-black Cockatoo chewed cones, nests/dreys, whitewash, burrows and scats. This provided supplementary information on faunal species presence.

Fauna habitats were assessed generally by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation, the structure and composition of the litter layer, and other habitat attributes important for feeding, shelter roosting and breeding (e.g. tree hollows, caves and rock outcrops). The following criteria were used to evaluate habitat values:

- **Good:** All fauna habitat components are present at a similar density to that expected for an undisturbed occurrence of the relevant broad habitat type (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- **Moderate:** Some fauna habitat components are missing or are substantially reduced in density (for example, old-growth trees and fallen timber); linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.
- **Poor:** Many fauna habitat components are absent or occur at very low density, including old growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

2.6 LIKELIHOOD OF OCCURRENCE

For this study, likelihood of occurrence of threatened species within the survey area for species recorded or predicted to occur in the locality is defined in Table 2.4.

Table 2.4 Likelihood of occurrence of threatened species

LIKELIHOOD	DESCRIPTION
Low	Species considered to have a low likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: — have not been recorded previously in the survey area and surrounds and for which the survey area is beyond the current distribution range — rely on specific habitat types or resources that are not present in the survey area — are considered locally extinct — are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
Moderate	Species considered to have a moderate likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: — have infrequently been recorded previously in the survey area and surrounds — use habitat types or resources that are present in the survey area, although generally in a poor or modified condition — are unlikely to maintain sedentary populations, however, may seasonally use resources within the survey area opportunistically during variable seasons or migration — are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
High	Species considered to have a high likelihood of occurrence include species not recorded that fit one or more of the following criteria: — have frequently been recorded previously in the survey area and surrounds — use habitat types or resources that are present in the survey area, that are abundant and/or in good condition within the survey area — are known or likely to maintain resident populations surrounding the survey area — are known or likely to visit the site during regular seasonal movements or migration.
Recorded	Any threatened species recorded during field surveys.

2.7 IMPACT ASSESSMENTS

Assessments of impact significance were completed for threatened species, populations or ecological communities known or considered to have a moderate or higher likelihood of occurrence in the subject site; full assessments are provided in Appendix C, a summary of the assessment findings are provided in section 7.

2.8 LIMITATIONS

In preparing this study, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations. Except as otherwise stated in this study, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this study (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any

data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

2.8.1 RELIANCE ON EXTERNALLY SUPPLIED INFORMATION

This ecological assessment has been prepared for the exclusive benefit of the client and no other party. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with in this study, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in this study (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in this study). Other parties should not rely upon this study or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

2.8.2 STUDY FOR BENEFIT OF THE CLIENT

No sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present on site during surveys. The conclusions in this report are based upon data acquired for the site and the environmental field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. It should be recognised that site conditions, including the presence of threatened species, can change with time.

The field survey sought primarily to verify the presence or otherwise of threatened flora species and vegetation communities. The likelihood that threatened species would utilise the habitat resources within the subject sites was assessed using habitat assessments undertaken during the field survey. No targeted fauna surveys were conducted as part of this study. Therefore, fauna species that use the habitat within the subject sites may not have been recorded during the field surveys undertaken. This level of survey effort is reflective of the modified nature of the sites in general, and the scope of potential impacts.

Identifying vegetation composition and condition within the subject sites was limited to rapid data point surveys which were limited to collecting data relating to dominant species and random meander for threatened species. As a result a precautionary approach was taken when verifying vegetation communities, threatened ecological communities and determining whether grasslands were either dominated by either exotic or native species.

2.8.3 FIELD SURVEY LIMITATIONS

To the best of WSP's knowledge, the investigation presented and the facts and matters described in this study reasonably represent the client's intentions at the time of preparation of the study. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation of the project and of its possible environmental impact.

WSP will not be liable to update or revise this report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

3 EXISTING ENVIRONMENT

3.1 LANDSCAPE CONTEXT

The surrounding land uses of the subject site have been heavily disturbed due to previous and current land uses. It has been subjected to land clearing and disturbance associated with residential infrastructure and industrial infrastructure.

The majority of the subject site consists of urban development and recreational parks and gardens (including Royal Botanic Garden and Domain). The site's vegetation appears likely to consist of a mixture of native and exotic landscape plantings which are unlikely to be consistent with a native vegetation type or a threatened ecological community listed under the BC Act and/or the EPBC Act.

A summary of the Subject site is provided in Table 3.1.

Table 3.1 Subject site locality

CRITERIA	LOCATION
Council	Sydney City Council
Bioregion	Sydney Basin Bioregion
CMA	Sydney Metro Catchment
Botanical subdivision	Central Coast
Noxious Weed Control Area	Sydney City Council

3.2 VEGETATION COMMUNITIES

Desktop analysis of the vegetation mapping and ground-truthing during field surveys found no native vegetation communities present within the subject site (Table 3.2).

Table 3.2 Vegetation communities recorded

OBSERVED VEGETATION TYPE	NSW PLANT COMMUNITY TYPES (PCT) & BIOMETRIC VEGETATION TYPE (BVT)	BROAD-SCALE VEGETATION	THREATENED ECOLOGICAL COMMUNITY ON BC ACT & EPBC ACT
Horticultural plantings	N/A	Not mapped	Not listed
Exotic grasslands – managed lawns	N/A	Not mapped	Not listed

3.2.1 HORTICULTURAL PLANTINGS

This vegetation is not consistent with any remnant native vegetation community, although many of these horticultural plantings comprise of native species, with unknown genetic origin. The characteristics and dominant species that occurred in this community included planted *Angophora costata, Ficus rubiginosa, Ficus macrophylla, Ficus microcarpa* var. *hillii Eucalyptus tereticornis* and *Eucalyptus botryoides* (Photo 3.1, Photo 3.2 & Photo 3.3).

Photo 3.1 Horticultural plantings dominated by the native tree species *Angophora costata* and native ground layer species *Lomandra longifolia* and *Dianella sp.*

Photo 3.2 Horticultural plantings dominated by the native tree species *Angophora costata* and *Eucalyptus tereticornis*

Photo 3.3 Horticultural plantings – *Ficus macrophylla*

3.2.2 EXOTIC GRASSLANDS – MANAGED LAWNS

This vegetation is not consistent with any remnant native vegetation community. This vegetation association occurs throughout majority of the project area and is dominant by exotic perennial grasses (Photo 3.4 and Photo 3.5).

Photo 3.4 Exotic grasslands – managed lawns

Photo 3.5 Exotic grasslands – managed lawns

3.3 FAUNA HABITATS

As the area of vegetation on the site is small and isolated from substantial areas of habitat in the locality, it is only likely to provide habitat for a very limited variety of native animals. The threatened animal species with potential to occur would generally be restricted to those highly mobile species (birds and bats) which are capable of using small, isolated patches of habitat in a landscape otherwise cleared of native vegetation. If such species utilise the site at all, it would most likely be on a seasonal or sporadic basis. Given that these species are unlikely to constantly occupy the site, surveys during a single season are unlikely to be very informative with regard to the species' utilisation of the site.

The suitability, size and configuration of the fauna habitats correlated broadly with the vegetation communities. The subject site provided habitat for a range of birds and mammals, and were in low to moderate condition.

Bush rock that was located within the area was limited and mainly in the form of exposed escarpment rock, however the extent of available rock habitat is small. Identified bush rock was identified to be limited in providing medium-large crevices or overhangs for fauna species.

Habitat features recorded in the survey area generally included those associated with disturbed planted vegetation and cleared areas.

3.4 FAUNA MICROHABITATS

Fauna microhabitats such as hollow bearing trees and flowering plant species can provide microhabitats for fauna species.

Given the highly disturbed nature of the vegetation within the subject site, feeding resources are generally limited and are not likely to provided significant habitat for threatened and non-threatened fauna species. The survey area contains flowering eucalypts and fruiting *Ficus* and *Syzygium* species that are feeding resources for some birds species (such as nectivorous and frugivorous birds) and mammals species (e.g. Ringtail possum, Brush-tail possum) (Photo 3.6). Given the disturbed nature of the site (including limited tree growth potential on land bridge areas, lack of hollow bearing trees and its location within a highly developed region this habitat is likely to provide marginal habitat and to be used by species tolerant of disturbance.

Photo 3.6 *Ficus macrophylla* – native food resource

4 THREATENED BIODIVERSITY

Threatened species, populations and communities (Critically Endangered, Endangered and Vulnerable) are listed under the *Biodiversity Conservation Act 2016* (BC Act), *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

4.1 THREATENED ECOLOGICAL COMMUNITIES

No threatened ecological communities listed under either the EPBC Act, BC Act and/or the FM Act were recorded within the survey area during either the database searches or the field validation surveys.

4.2 ENDANGERED POPULATIONS

No endangered populations listed under the BC Act known or considered likely to occur, were identified in the subject site.

4.3 THREATENED SPECIES

4.3.1 THREATENED FLORA SPECIES

No threatened plant species were recorded within the subject site. Based on the results of the database searches and presence of suitable habitat no threatened species of plant are considered to have a moderate or higher likelihood of occurrence. All species are considered to have a low likelihood of occurrence based on the availability of habitat. Full details of species requirements and reasons for not considering impacts of the proposal further are provided in Appendix A.

A number of planted native shrub species that were observed growing within the horticultural planting within the subject site were further examined to ensure they were not planted threatened species. These observations are further discussed below.

A single planted specimen of *Acacia terminalis* was observed within the horticultural plantings above the playing field area. The specimen was observed with bud set and it was examined to ensure it was not the endangered *Acacia terminalis* subsp. *terminalis*. The specimen did not exhibit characteristic puberulous/ pubescent branchlets, leaf rachises or peduncles of *Acacia terminalis* subsp. *terminalis* and as such is considered to be most likely the common occurring and widely planted *Acacia terminalis* subsp. *angustifolia.*

Planted Callistemon specimens were also observed within the native horticultural plantings. Specimens were examined to ensure they did not constitute the threatened *Callistemon linearifolius*. All specimens appeared consistent with *Callistemon rigidus* and as such it is considered unlikely that any of the horticultural planting of Callistemon constitute *Callistemon linearifolius.*

A planted Grevillea species observed within the native horticultural plantings was examined to ensure it did not constitute the threatened species *Grevillea parviflora* subsp. parviflora. Specimens of this Grevillea exhibited leaf widths greater than 1.3 mm and the specimens appear consistent with the description of the common horticulturally grown *Grevillea linearifolia*.

4.3.2 THREATENED FAUNA SPECIES

No threatened species of fauna were recorded within the subject site. Based on the results of the database searches and presence of suitable habitat seven threatened species of animal are considered to have a moderate or higher likelihood of

occurrence (See Table 4.1 and Appendix B). Significance assessments for these seven species were undertaken and provided in Appendix C.

The remaining species are considered to have a low likelihood of occurrence based on the availability of habitat. Full details of specimen requirements and reasons for not considering impacts of the proposal further are provided in Appendix B.

Table 4.1 Threatened fauna species known or considered to have a moderate to high likelihood of occurring

SCIENTIFIC NAME	COMMON NAME	BC ACT[1]	EPBC ACT[1]	LIKELIHOOD
Ninox strenua	Powerful Owl	V		**High.** Suitable foraging and nesting habitat suggest the subject site is likely to represent part of the home range of local individuals.
Miniopterus australis	Little Bent-wing Bat	V		**Moderate.** Potential foraging habitat within subject site, so may visit site on an intermittent basis.
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V		**Moderate.** Potential foraging habitat within subject site, so may visit site on regular basis.
Mormopterus (Micronomus) norfolkensis	Eastern Freetail Bat	V		**Moderate.** Potential foraging habitat within subject site, so may visit site on an intermittent basis.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	**High.** Likely that local individuals visit the subject site regularly when site trees flower/fruit.

(1) Listed as Vulnerable (V) or Endangered (E) under the BC Act and/or EPBC Act.

4.4 MIGRATORY SPECIES

Migratory species are protected under international agreements to which Australia are a signatory, including the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement (CAMBA), the Republic of Korea Australia Migratory Bird Agreement (RoKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered to comprise 'Matters of National Environmental Significance' and are protected under the EPBC Act.

Based on the findings of the database searches and presence of suitable habitat two Migratory species are considered to have potential habitat within the subject site; Black-faced Monarch and Rufous Fantail.

While terrestrial Migratory species of bird may potentially use the area, the site would not be classed as 'important habitat' as defined *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (Department of the Environment, 2013) as the site does not contain:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- habitat utilised by a migratory species which is at the limit of the species range
- habitat within an area where the species is declining.

As such, it is not likely that the proposed activity would significantly affect Migratory species and this group is not considered further.

4.5 CRITICAL HABITAT

Critical habitat is listed under the *Threatened Species Conservation Act 1995* and/or the *Environmental Protection and Biodiversity Conservation Act 1999*. Critical habitat is the whole or any part or parts of an area or areas of land comprising habitat critical to the survival of an endangered species, population or ecological community.

There is no listed critical habitat in the Subject site and none is likely to be affected by the proposal.

4.6 GROUNDWATER DEPENDENT ECOSYSTEMS

Groundwater dependant ecosystems (GDEs) are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater (Department of Land and Water Conservation, 2002). When considering GDEs, groundwater is generally defined as the saturated zone of the regolith (the layer of loose rock resting on bedrock, constituting the surface of most land) and its associated capillary fringe, however it excludes soil water held under tension in soil pore spaces (the unsaturated zone or vadose zone) (Eamus et al., 2006).

GDEs include a diverse range of ecosystems as shown in Figure 4.1. These ecosystems range from those entirely dependent on groundwater to those that may use groundwater while not having a dependency on it for survival (i.e. ecosystems or organisms that use groundwater opportunistically or as a supplementary source of water) (Hatton and Evans, 1998). Serov et al. (2012) considers the following broad classes of these ecosystems:

- Subsurface Ecosystems, which include the following:
  - Karst and cave ecosystems, where stygofauna (groundwater-inhabiting organisms) may reside within the groundwater resource.
  - Subsurface phreatic aquifer ecosystems, ecosystems which support invertebrate, microbial species and occasionally vertebrate species. These hypogean species exist in a continuum of different types of aquifers including kartic, cave, porous and fissued aquifers, and can exist been the subsurface and surface water.
  - Subsurface baseflow streams or hyporheic zones (see ecosystem 5 in Figure 4.1) of rivers and floodplains are also included in this category because these ecotones often support stygobites (obligate groundwater inhabitants).
- Surface Ecosystems, which include the following:
  - Groundwater dependant wetlands – these wetlands exist at the boundary of the surface water and groundwater systems.
  - Baseflow streams (surface water ecosystems).
  - Estuarine and near shore marine ecosystems.
  - Phreatophytes – Groundwater dependent terrestrial ecosystems, these GDEs can be dependent upon groundwater intermittently or permanently depending upon the groundwater table level. Groundwater is often accessed via the capillary fringe (non-saturated zone above the saturated zone of the water table) when roots penetrate this zone. Roots can be shallow or deep (e.g. River Red Gum) Forest on the Murray–Darling basin (see ecosystems 1 and 4 in Figure 4.1). No surface expression of groundwater is required in this class of groundwater dependant ecosystems.

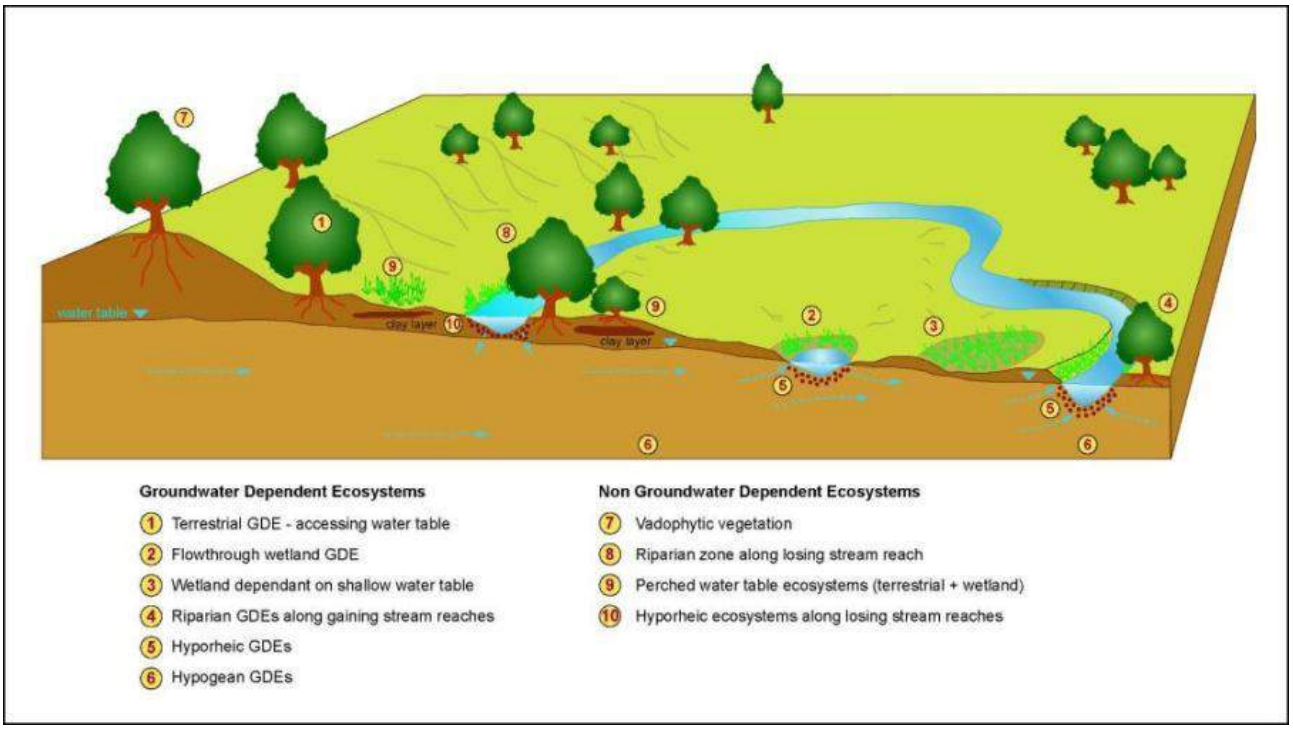


Figure 4.1 Conceptual biophysical model of groundwater dependant ecosystems

GDEs possess a range of values, including being important and sometimes rare ecosystems in themselves, as well as providing important ecosystem services such as water purification (Department of Land and Water Conservation, 2002). Groundwater is also an increasingly important resource for human uses in Australia (there was a 90 per cent increase in groundwater extraction between 1985 and 1997 (National Land and Water Resources Audit, 2001). Nationally groundwater is extracted for uses including irrigation (48%), urban and industrial use (33%) and stock watering and rural use (19%) (Department of the Environment and Heritage, 2001).

The potential for groundwater extraction to exceed recharge has resulted in awareness of the effects of groundwater availability or regimes that may result in adverse impacts to groundwater dependent ecosystems (2003), and thereby threaten the values they provide.

4.6.1 LEGISLATION

Due to the concern of the impacts upon groundwater dependent ecosystems several levels of legislation have been developed. These include state legislation and state planning polices and these include the following:

— *Water Management Act 2000* in which the Minister for Land and Water Conservation manages and controls the extraction of groundwater. Section 5(2) a of the Act relates to protection of water source: and Section 5(2)c relates to water quality. Both of these sections of the Act would directly relate to GDEs as both water quality and quantity would impact upon these ecosystems.

— The NSW State Groundwater Dependent Ecosystem Policy (2002) has been developed to protect ecosystems which have a reliance on groundwater for survival. This document outlines a rapid assessment process which is used for identifying and valuing GDEs which assists in the management of GDEs at a state level.

— Groundwater Dependent Ecosystems Assessment, Registration and Scheduling of High Priority (Department of Land and Water Conservation, 2006). This document was written by Department of Land and Water Conservation and was developed to classify GDEs in order of priority of protection.

— Risk Assessment Guidelines for Groundwater Dependant Ecosystems, consisting of four volumes (Serov et al., 2012, Williams et al., 2012, Kuginis et al., 2012a, Kuginis et al., 2012b). These documents were commissioned by the Department of Primary Industries – Office of Water as part of the National Water Commission Coastal Groundwater

Dependent Ecosystem Project. This project was commissioned to gain further information on the Coastal GDE environment to support ecological and dependency evaluations for GDEs.

4.6.2 GDES IN THE SURVEY AREA

Vegetation within the subject site comprises of horticultural plantings that do not form part of any remnant native plant community that would be reliant on groundwater surface flows. Groundwater within the subject site has been identified as variable with depth to groundwater in the vicinity of the fuel bunkers identified to range from 1.86 and 4.80 meters below ground surface (Coffey;, 2016) . The proposal is unlikely to lead to significant changes to hydrological flows throughout the site that would result in a decline in native and exotic ornamental horticultural planted vegetation.

5 IMPACTS OF THE PROPOSAL

Potential impacts to biodiversity resulting from the construction and operational phases of the proposed art gallery subject site are considered in this section and summarised in Table 5.1.

Potential impacts are described below and mitigation measures to ameliorate these impacts are discussed in section 6. Assessments of significance for threatened biodiversity that occur or have potential habitat in the subject site (discussed in Section 4) are provided in Appendix E and summarised in section 7.

Table 5.1 Potential impacts

POTENTIAL IMPACTS	POTENTIAL PHASE OF IMPACT	
	Construction	Operation
Loss of vegetation	●	
Potential environmental impact of noise on wildlife	●	●
Weed and pest invasion	●	●
Introduction of disease-causing pathogens	●	
Erosion and sedimentation	●	
Changed hydrology	●	

5.1 LOSS OF VEGETATION AND HABITAT

No native vegetation community was identified within the subject site. Majority of the available vegetation community was highly disturbed as it had been subjected to previous clearing, vegetation maintenance works, plantings and invasion of exotic plant species. As a result the vegetation community that occurs is predominantly as horticultural plantings which contain a number of semi-mature trees. Notwithstanding the presence of native and exotic planted vegetation there is generally an overall low likelihood of occurrence of threatened species, populations and ecological communities based on the availability of habitat.

The recommendations within the arborist report (Earthscape Horticultural Services, October 2017) identify the project will require the removal of 141 existing trees that provide habitat for a number of threatened species (refer section 4.3 and 4.4). Of the 141 trees, 43 trees are classified as low retention and ecological value, 91 trees of moderate retention value and 7 are considered as high retention value. To compensate the loss of moderate and high value trees, a revegetation and replacement planting of native species will be undertaken as part of the overall Landscape Master Plan (McGregor Coxall, 2016).

As part of the current proposal eight trees are to be transplanted elsewhere within the subject site, these include: two Moreton Bay Figs (*Ficus macrophylla*), four Cabbage Palms (*Livistona australis*), one Mediterranean Fan Palm (*Chamaerops humilis*) and one Canary Island Palm (*Phoenix canariensis*). No hollow-bearing trees would be removed from the subject site. Bush rock removal would be in the form of removing exposed ridgeline/escarpment rock, however it was identified that minimal habitat (in the form of crevices and overhangs) is available.

5.2 DIRECT FLORA AND FAUNA MORTALITY

Fauna injury or death could occur as a result of the proposed activities during the construction phase, particularly when vegetation and habitats are being cleared. The risk of vehicle collision is also present during the operational phase when vehicles enter, park and leave the facility grounds, however the occurrence of this is considered to be low. The incidence of mortalities is unlikely to increase significantly above current levels.

While some mobile species, such as birds, have the potential to move away from the path of clearing, other species that are less mobile, or those that are nocturnal, may have difficulty moving over relatively large distances. Species of animal that may be particularly at risk of injury or death during vegetation clearing include small terrestrial and arboreal mammals, reptiles, nestling birds and frogs.

The vegetation within the subject site consists of areas of exotic vegetation and native planted trees with areas of disturbed habitat. Although much of the fauna habitats associated with this vegetation has been effectively degraded from past clearing for existing infrastructure and urban development the degraded remnants provide habitat for animal species and thus, there is potential for animals to be injured during vegetation removal.

Vehicle strike during construction, operation and maintenance works is unlikely to be significant and injury or mortality of wildlife is not likely to significantly increase as a result of the constructing the art gallery. Measures would be in place to minimise the likelihood of death or injury of wildlife, however, these cannot prevent all losses. The impact of such losses in relation to threatened species was considered in the significance assessment detailed and summarised in Appendix C and section 7.

Whilst bird strike mortality in urban areas of North America and Europe has been identified as a significant issue for migratory bird movements given our more temperate latitudinal context in central NSW, we don't tend to experience the mass north-south migrations of small passerine birds, raptors and waterfowl that they have in North America and Europe, which are both located in relatively high latitudinal contexts. While we do have large migrations of small birds, waterbirds and waders during seasonal turn, due to their relation to bird habitats and movements, city locations in Sydney are not likely to experience large bird kill events during east coast migration times.

In terms of potential bird strike mortality due to windows and reflective surfaces, the buildings have been designed to ensure they do not exceed 20% reflectivity iso-glare loops (Surface Design, 2017), as such bird strike mortality is unlikely to be a significant impact to fauna.

5.3 ARTIFICIAL LIGHTING

Artificial lighting can be both beneficial and detrimental to flora and fauna species, as some species have become well adapted to disturbed urban areas whilst some species are quite sensitive to disturbances. Artificial lighting due to the project is unlikely to have significant impacts on flora and fauna species. Measures to be put in place, such as timed lighting control and increased glazing are likely to minimise the impact artificial lighting has on flora and fauna.

Of fauna species to be most affected by artificial lighting is nocturnal species such as bats. Whilst artificial lighting can be beneficial to some insectivorous bat species (due to lights attracting nocturnal insects), it can also be detrimental to urban-sensitive bat species (P.B.Banks;, 2013, C.Catterall;, 2008, S.Harris;, 2009). However, due to mitigation measures as stated by Steensen Varming Consultants (Steensen Varming, 2017), impacts to bat species due to artificial lighting is unlikely to be significant. Measures include:

- Minimising upward light (by correctly positioning in ground up lights and selecting appropriate luminair types) to reduce impact on flight paths for birds and bats.
- Reducing luminance of equipment/glare and overall brightness in general illuminated areas. Various data indicate that a bat's vision is better in dim light than in bright light. The possibility that artificial light interferes with bat sensorial capabilities other than vision should also be considered; giving preference to 'dimmer' lighting at night.
- Use of warm lighting with reduced blue and UV wavelengths to reduce the risk of disturbance of vision and damage to their retina. It is noted that the use of warm light will also reduce the attraction of insects.
- Low light levels with warm light colour with timed approach and use of sensor technology to minimise night-time lighting and therefore the reduction of habitat availability and to avoid biological rhythm alteration.
- Use of shields, louvres and low brightness fixtures where appropriate.

5.4 HABITAT FRAGMENTATION, ISOLATION AND BARRIERS

The process of fragmentation can affect species within the newly created fragments in a number of ways, including barrier effects, genetic isolation, and edge effects. The degree to which these potential impacts affect the flora and fauna within the newly created fragments depends on a number of variables, including distance between the fragments, local environmental conditions, the species present and any proposed mitigation measures. Some of the potential impacts are summarised below.

5.4.1 BARRIER EFFECTS

Vegetation in the subject site currently exists as moderately fragmented and isolated remnants resulting from extensive clearing and development. Furthermore, the existing roads and urban infrastructure are likely to form an existing barrier to many locally occurring terrestrial and arboreal fauna species. While the proposal would potentially increase the distance between habitat fragments, it is not likely to add significantly to distances between vegetation/habitat patches in the subject site.

5.4.2 EDGE EFFECTS

Vegetation and fauna habitats in the subject site are fragmented and isolated by existing infrastructure and nearby urban development, and as a result the gallery subject site is already subject to edge effects. The extent of edge effects is not likely to significantly increase edge effects on vegetation and habitats remaining post construction.

5.5 POTENTIAL ENVIRONMENT IMPACT OF NOISE ON WILDLIFE

During construction, noise levels will increase in the subject site and surrounds due to ground disturbance, machinery operation and vehicle movements and vegetation clearing. These may cause disturbance for some fauna. A number of factors are thought to influence the reaction of animals to noise including the volume, the frequency and the characteristic of the noise (e.g. short and percussive versus long and constant).

The subject site is already affected by noise levels associated with vehicle movements along the existing roads and also recreational activity in surrounding parks. How fauna occupying the local area will respond to increased noise is not known, but given the degree of current habitat disturbance and existing noise environment, it is not likely to be significant.

5.6 WEED AND PEST INVASION

Construction works within the subject site has the potential to introduce additional weeds into the subject site or disperse weeds into areas where they do not currently occur. The most likely causes of weed dispersal associated with the proposed construction would include earthworks, movement of soil and attachment of seed (and other propagules) to vehicles and machinery. Spread of weeds during the operational phase would relate generally to the vehicles travelling along the roads and parking at the art gallery. These may, in turn, reduce the habitat quality of the sites for threatened species.

5.7 INTRODUCTION OF DISEASE-CAUSING PATHOGENS

Chytridiomycosis is a highly infectious disease of amphibians caused by the amphibian chytrid fungus *Batrachochytrium dendrobatidis* which has spread through wet areas along the eastern mainland of Queensland, New South Wales, Victoria, south of South Australia and south-western Western Australia. There are very few areas that remain uninfected in Australia. Amphibians are thought to contract the infectious disease through skin contact with water spores from infected animals. It is highly likely that the survey area is already subjected to Chytridiomycosis.

Phytophthora cinnamomi is a soil borne pathogen that appears to be widespread in coastal forests of NSW. Infection of native plants by *Phytophthora cinnamomi* has been identified as a threat to a number of species and communities listed under the BC Act and EPBC Act.

Myrtle rust is a disease caused by the introduced fungus *Puccinia psidii*, initially identified as *Uredo rangelii*. It affects trees and shrubs in the Myrtaceae family of plants which includes Australian natives like bottle brush (*Callistemon* spp.), tea tree (*Melaleuca* spp.) and eucalypts (*Eucalyptus* spp., *Angophora* spp. and *Corymbia* spp.). The disease can cause deformed leaves, heavy defoliation of branches, dieback, stunted growth and generally poor plant death. Myrtle rust is increasingly widespread on the east coast of Australia.

There is potential for the project to result in the introduction of spread of these pathogens in soil, mud and plant material. Any material imported to the site, including mulch and plants, should be sourced from suppliers who can guarantee that it is not infected with of *Phytophthora cinnamomi* or *Puccinia psidii.*

5.8 EROSION AND SEDIMENTATION

Excavation and earthworks undertaken during the construction phase would expose soils that have the potential to enter surrounding areas of vegetation and waterways, possibly resulting in sedimentation and dispersal of weeds, if not properly managed. Erosion during the operation stage of the proposal would generally relate to maintenance activities and is likely to be minor if properly managed. Mitigation measures have been provided in section 6 and if adhered to should minimise impacts appropriately. This issue is further addressed within the erosion and sedimentation assessment within the EIS.

5.9 CHANGED HYDROLOGY

The proposal involves the construction of a number new buildings and expansion of the existing art gallery which will increase the impermeable surfaces within the area. The increase in impervious ground cover is unlikely to alter the localised landform or hydrology within the Subject site. Impacts are most likely to occur during the construction phase and if mitigation measures provided in section 6 are implemented the proposed works are unlikely to significantly affect the hydrological conditions of the locality. This issue is further addressed within the hydrological assessment within the EIS.

5.10 KEY THREATENING PROCESSES

A process is defined as a key threatening process if it threatens or may threaten the survival, abundance, or evolutionary development of a native species or ecological community. A process can be listed as a key threatening process if it could cause a native species or ecological community to become eligible for adding to a threatened list (other than conservation dependant), or cause an already listed threatened species or community to become more endangered, or if it adversely affects two or more listed threatened species or ecological communities.

The project is unlikely to contribute to any NSW or Commonwealth listed key threatening processes.

6 MITIGATION MEASURES

Mitigation measures recommended include but are not restricted to the measures outlined in Table 6.1.

Table 6.1 Proposed mitigation measures

MITIGATION MEASURE	PRE-CONSTRUCTION	CONSTRUCTION	OPERATIONS
Check for the presence of flora and fauna species and habitat on site before clearing begins such as the presence of bird nests or arboreal mammals. Prevention of weed dispersal including noxious species recorded on site in accordance with control class categories under the *Noxious Weed Act 1993*. Vegetation restoration.	ü	ü	ü
Prior to commencing work, site personnel should be adequately informed of environmental management procedures including, but not limited to, issues related to flora and fauna management, weed control, erosion and sediment control.	ü	ü	ü
Prior to work commencing, temporary exclusion fencing zones to protect vegetation and fauna habitat outside of the assessed and approved clearing limits within the subject site to prevent access by workers or equipment and unintentional disturbance of these areas.	ü	ü	
Implement clearing protocols: Clearing of vegetation would be minimised, to only vegetation that is absolutely required to be removed in order to undertake work. Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation. Vehicles and equipment shall remain on existing roads and defined site access tracks.	ü	ü	

MITIGATION MEASURE	PRE-CONSTRUCTION	CONSTRUCTION	OPERATIONS
Weed control mitigation and management strategies shall be documented and implemented. This shall include: Wash down procedures to reduce the spread of weeds via vehicles and machinery prior to entering native vegetation areas. Target areas of potential new outbreaks including soil stockpiles, roadsides and any other disturbed areas. Cleaning of vehicle tyres, undersides and radiator grills of soil, seeds and plant material before leaving a property, cleaning of footwear and minimising soil movement between locations to prevent the introduction or spread of further exotic plant species and pathogens. Imported material (e.g. gravel) shall be weed free.	ü	ü	ü
When undertaking construction works the following should be implemented: All waste material would continually be removed from all areas on site throughout the duration of construction. Noise would be minimised where possible such as turning of vehicles when not in use. When accessing construction sites, contractors should only use designated tracks.		ü	
A **landscape master plan** would be developed and implemented i.e. areas will be rehabilitated and established to facilitate landscaping and vegetation plantings, this would include planting of native species which are representative of local native vegetation communities.		ü	ü

If a change in the design of the proposed art gallery subject site occurs outside those assessed in this report additional surveys will be required.

7 SIGNIFICANT IMPACT ASSESSMENT

Significance assessments for species recorded or with a moderate or higher likelihood of occurrence were completed (refer to Appendix C). The impacts to threatened biodiversity are summarised in Table 7.1. This assessment was based on a broad assessment and as such takes a precautionary approach to estimating the area of vegetation and habitats to be cleared.

Significance assessments concluded that the proposal is not likely to result in a significant impact to threatened biodiversity.

Table 7.1 Impacts to threatened biodiversity

SCIENTIFIC NAME	COMMON NAME	BC ACT[1]	EPBC ACT[1]	SIGNIFICANT IMPACT
Birds				
Ninox strenua	Powerful Owl	V		No
Mammals				
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	No
Microchiropteran Bats				
Miniopterus australis	Little Bent-wing Bat	V	-	No
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	No
Mormopterus (Micronomus) norfolkensis	Eastern Freetail Bat	V	-	No
Myotis macropus	Southern Myotis, Large-footed Myotis	V	-	No

(1) V = Vulnerable, E = Endangered, EP = Endangered Population and CE = Critically Endangered under the BC Act and/or EPBC Act.

Overall, the project is not likely to have a significant impact on any threatened species, populations or communities listed under the EPBC Act, BC Act or FM Act. As such, the preparation of a Species Impact Statement (SIS) is not required.

8 CONCLUSION

This biodiversity impact assessment report comprises the findings from the desk based investigation and field surveys completed within and in the vicinity of the site of the AGNSW Expansion Project - Sydney Modern, that is located next to the existing AGNSW. The report was undertaken to address Key Issue 9 of the SEARs.

As part of the proposal a total of 141 existing trees are to be removed from the subject site. A total of two figs and five palms are to be transplanted. A total of 71 existing trees are to be retained. Landscape gardens are proposed to be undertaken on the subject site that will consist of a variety of locally occurring native plants that represent local native vegetation communities and vegetation that is similar to the surrounding Domain Gardens.

No threatened species, populations or ecological communities were recorded within the Subject site. Although no threatened biodiversity was recorded, the horticultural plantings do provide marginal potential foraging habitat for a small number of threatened fauna species.

Impact assessments were completed for all threatened species, populations and communities known or with medium or higher likelihood to occur in the subject site. Impact assessments concluded that the project is unlikely to have a significant impact on threatened species, populations, ecological communities or their habitats. In addition a number of mitigation measures and recommendations in section 6 to further reduce impacts on threatened species from the project.

This report is consistent with Key Issue 9 of the SEARs in regards to terrestrial ecological impact assessment, including both direct and indirect impacts and impacts on terrestrial threatened species, populations and ecological communities.

The project is unlikely to result in significant impacts to matters of national environmental significance and as such, a Referral to DoE is not considered necessary.

The project is unlikely to have a significant impact on any threatened species, populations or communities listed under the *Biodiversity Conservation Act 2016* or their habitats.

REFERENCES

C.CATTERALL;, M. R. 2008. Spatial foraging behaviour and use of an urban landscape by a fast-flying bat, the Molossid *Tadarida australis. Journal of Mammalogy*, 89.

COFFEY; 2016. Sydney Modern Project - Groundwater monitoring adjacent to former fuel bunkers. Chatswood: Coffey Pty Ltd,.

COMMONWEALTH OF AUSTRALIA 2012. Environment Assessment Manual - Implementing Chapter 4, EPBC Act.: Commonwealth of Australia,.

CROPPER, S. C. 1993. *Management of Endangered Plants*, Melbourne, CSIRO Australia.

DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE 2002. Descriptions for NSW (Mitchell) Landscapes Version 2.

DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE 2007. Threatened species assessment guidelines. The assessment of significance. Hurstville: Department of Environment and Climate Change.

DEPARTMENT OF LAND AND WATER CONSERVATION 2002. The NSW State Groundwater Dependent Ecosystem Policy. Sydney: Department of Land and Water Conservation.

DEPARTMENT OF LAND AND WATER CONSERVATION 2006. Groundwater Dependent Ecosystems, Assessment, Registration and Scheduling of High Priority, Manual to Assist Groundwater Macroplanning. Department of Natural Resources.

DEPARTMENT OF THE ENVIRONMENT 2013. Matters of National Environmental Significance - Significant impact guidelines 1.1 Environmental Protection and Biodiversity Conservation Act 1999.

DEPARTMENT OF THE ENVIRONMENT AND ENERGY. 2016a. *Australian Faunal Directory* [Online]. Available: http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/home [Accessed].

DEPARTMENT OF THE ENVIRONMENT AND ENERGY. 2016b. *Protected Matters Search Tool* [Online]. Available: http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf [Accessed].

DEPARTMENT OF THE ENVIRONMENT AND HERITAGE 2001. Australia: State of the Environment 2001. Melbourne: CSIRO Publishing.

EAMUS, D., FROEND, R., LOOMES, R., HOSE, G. & MURRAY, B. 2006. A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation. *Australian Journal of Botany*, 24**,** 97–114.

EARTHSCAPE HORTICULTURAL SERVICES October 2017. Arboricultural Impact Assessment Report - Art Gallery of NSW Expansion Project - Sydney Modern. *In:* MORTON, A. (ed.). Berowra: Earthscape Horticultural Services,.

FEDERAL GOVERNMENT OF THE UNITED STATES AMERICA Title 40 of the Code of Federal Regulations; 1508.7 - Cumulative impact.

HARDEN, G. 1992. *Flora of New South Wales Volume 3*, Kensington, University of New South Wales Press Ltd.

HARDEN, G. 1993. *Flora of New South Wales Volume 4*, Kensington, University of New South Wales Press Ltd.

HARDEN, G. 2000. *Flora of New South Wales Volume 1 (Revised Edition)*, Kensington, University of New South Wales Press Ltd.

HARDEN, G. 2002. *Flora of New South Wales Volume 2 (Revised Edition)*, Kensington, University of New South Wales Press Ltd.

HATTON, T. & EVANS, R. 1998. Dependence of ecosystems on groundwater and its significance to Australia. Canberra: Land and Water Resources Research and Development Corporation.

KUGINIS, L., BYRNE, G., WILLIAMS, J. & SEROV, P. 2012a. Risk Assessment Guidelines for Groundwater Dependent Ecosystems, Volume 3 "Identification of High Probability Groundwater Dependant Ecosystems on the Coastal Plains of NSW and their Ecological Value". Department of Primary Industries, Office of Water, Sydney.

KUGINIS, L., WILLIAMS, J., BYRNE, G. & SEROV, P. 2012b. Risk Assessment Guidelines for Groundwater Dependant Ecosystems Volume 4 "The Ecological Value of Groundwater Sources on the Coastal Plains of NSW and the Risk from Groundwater Extraction". Department of Primary Industries, Office of Water, Sydney.

MCGREGOR COXALL 2016. Landscape Master Plan - AGNSW Expansion: Sydney Modern Project. Sydney: McGregor Coxall Pty Ltd,.

MURRAY, B. R., ZEPPEL, M. J. B., HOSE, G. C. & EAMUS, D. 2003. Groundwater-dependent ecosystems in Australia: It's more than just water for rivers. *Ecological restoration and management*, 4**,** 110-113.

NATIONAL LAND AND WATER RESOURCES AUDIT 2001. Australian water resources assessment 2001. National Land and Water Resources Audit. Land and Water Australia. Canberra: Commonwealth of Australia.

NSW GOVERNMENT 2016. Threatened Species Conservation Act 1995.

NSW OFFICE OF ENVIRONMENT AND HERITAGE 2014. Framework for Biodiversity Assessment. Sydney: NSW Office of Environment and Heritage,.

OFFICE OF ENVIRONMENT AND HERITAGE. 2016. *BioNet the Atlas of NSW Wildlife Database Search* [Online]. Available: http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx [Accessed].

P.B.BANKS;, C. G. T. B. L. 2013. The urban matrix and artificial light restricts the nightly ranging behaviour of Gould's long-eared bat (*Nyctophilus gouldi*). *Austral Ecology,* 38.

ROYAL BOTANIC GARDENS. 2016. *PlantNet - The Plant Information Network System of The Royal Botanic Gardens and Domain Trust (Version 2.0)* [Online]. Available: http://plantnet.rbgsyd.nsw.gov.au/ [Accessed 2016].

S.HARRIS;, E. L. S. G. J. 2009. Street lighting disturbs commuting bats. *Current Biology,* 19**,** 1123-1127.

SEROV, P., KUGINIS, L. & WILLIAMS, J. P. 2012. Risk Assessment Guidelines for groundwater dependent ecosystems, Volume 1 - The conceptual framework. NSW Deparment of Primary Industries, Office of Water, Sydney.

STEENSEN VARMING 2017. Art Gallery of NSW Expansion Project - Sydney Modern State Significant Development Application Exterior Lighting. Sydney: Steensen Varming Pty Ltd,.

SURFACE DESIGN 2017. Art Gallery of NSW Expansion: Sydney Modern Project. Surface Design Pty Ltd,.

THACKWAY, R. & CRESSWELL, I. D. 1995. *An Interim Biogeographic Regionalisation of Australia,* Canberra, Australian Nature Conservation Agency.

TOZER, M., TURNER, K., KEITH, D., TINDALL, D., PENNAY, C., SIMPSON, C., MACKENZIE, B., BEUKERS, P. & COX, S. 2010. Native Vegetation of southeast NSW: a revised classification and map for the coast and tablelands. *Cunninghami,* 11.

WILLIAMS, J., SEROV, P., KUGINIS, L. & BYRNE, G. 2012. Risk Assessment Guidelines for Groundwater Dependant Ecosystems, Volume 2 "Worked Examples for 7 Pilot Coastal Aquifers in NSW". NSW Department of Primary Industries, Office of Water, Sydney.

APPENDIX A

FLORA LIKELIHOOD TABLE

Table 1 Threatened flora likelihood table

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Acacia bynoeana	Bynoes Wattle	V	E1	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with *Corymbia gummifera, Eucalyptus haemastoma, E. gummifera, E. parramattensis, E. sclerophylla, Banksia serrata* and *Angophora bakeri* (NSW National Parks and Wildlife Service 1999).	Bionet, EPBC	Low. Generally unsuitable habitat in the subject site subject site.
Acacia gordonii		E	E1	Occurs in the lower Blue Mountains from Bilpin to Faulconbridge and also in the Glenorie district. Grows on sandstone outcrops and amongst rock platforms in dry sclerophyll forest and heath (NSW Scientific Committee 1997, Harden 2002). Specifically this species occurs in Sydney Sandstone Ridgetop Communities (James 1997).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Acacia terminalis subsp. terminalis	Sunshine Wattle	E	E1	Grows in scrub and dry sclerophyll woodland between Botany Bay and the northern foreshore of Port Jackson. The locations from which several of the early collections were made no longer provide habitat, having been cleared for development of the eastern suburbs. Recent collections have been made only from Clifton Gardens, Dover Heights, Parsley Bay, Nielsen Park, Cooper Park, Chifley and Watsons Bay (NSW National Parks and Wildlife Service 2004).	Bionet, EPBC, Plantnet	Low. Generally unsuitable habitat available. Given the lack of native remnant vegetation it is unlikely this species would utilise the subject site subject site.
Allocasuarina glareicola		E	E1	Restricted to the Sydney basin where it occurs north east of Penrith in or near Castlereagh State Forest. Grows on lateritic soil in open forest (Harden 2000).	EPBC	Low. Generally unsuitable habitat in the subject site subject site.
Allocasuarina portuensis		E	E1	Known from only a single population within Sydney Harbour National Park. The single population has declined from only 10 individuals in 1986 to only a single female surviving in 2002, excluding re-introduced individuals (NSW National Parks and Wildlife Service 2004).	Bionet, EPBC, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Amperea xiphoclada var. pedicellata		X	E4	This species is presumed extinct but previously known to occur in Central Coast region in heath, woodland and forest on low fertility sandy soils (Harden 1993).	Bionet, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.
Angophora crassifolia				This is restricted in distribution, occurring in the Sydney region on sandstone, e.g. Ku-ring-gai Chase. It differs by the rigid, thicker leaves.	Plantnet	Low. Generally unsuitable habitat in the subject site subject site.
Asterolasia elegans		E	E1	Known from only seven populations, north of Sydney in the Baulkham Hills, Hawkesbury and Hornsby LGAs; also likely to occur in the western part of Gosford LGA. Occurs on Hawkesbury sandstone in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (*Syncarpia glomulifera subsp. glomulifera*), Smooth-barked Apple (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperita*), Forest Oak (*Allocasuarina torulosa*) and Christmas Bush (*Ceratopetalum gummiferum*) (Office of Environment and Heritage 2015).	EPBC	Low. Generally unsuitable habitat in the subject site subject site.
Caladenia tessellata	Thick Lip Spider Orchid	V	E1	Occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). Prefers low open forest with a heathy or sometimes grassy understorey (Bishop 2000). Within NSW, currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Previously known also from Sydney and South Coast areas (NSW Scientific Committee 2002).	Bionet, EPBC	Low. Generally unsuitable habitat in the subject site subject site.
Callistemon linearifolius	Netted Bottle Brush		V	Occurs chiefly from Georges to the Hawkesbury River where it grows in dry sclerophyll forest, open forest, scrubland or woodland on sandstone. Found in damp places, usually in gullies (Robinson 1994, Fairley and Moore 2002, Harden 2002). Within the Sydney region, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (NSW Scientific Committee 1999).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Camarophyllopsis kearneyi			E1	Small, pale, gilled fungus and is known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats (Harden 1993, NSW National Parks and Wildlife Service 1999).	EPBC	Low. Generally unsuitable habitat in the subject site subject site.
Darwinia biflora		V	V	Occurs from Cheltenham to Hawkesbury River where it grows in heath on sandstone or in the understorey of woodland on shale-capped ridges (Harden 2002). Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include *Eucalyptus haemastoma*, *Corymbia gummifera* and/or *E. squamosa.* The vegetation structure is usually woodland, open forest or scrub-heath (Department of Environment and Climate Change 2008).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Dichanthium setosum	Bluegrass	V	V	Grows in woodland and grassland (Harden 1993). On the New England Tablelands and North West Slopes it grows on stony red-brown hard-setting soils over basalt, or on black soil (Department of Environment and Conservation 2006).	Bionet, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.
Epacris purpurascens var. purpurascens	-		V	Occurs in Gosford and Sydney districts where it grows in sclerophyll forest, scrub and swamps (Harden 1992). Usually found in sites with a strong shale influence (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	Occurs in scattered locations within a restricted distribution in a narrow band with the most northerly records in the Raymond Terrace area south to Waterfall. Grows in poor coastal country in shallow sandy soils overlying Hawkesbury sandstone, in coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas (Office of Environment and Heritage 2012) . Associated species frequently include Brown Stringybark (*E. capitellata*), Scribbly Gum (*E. haemastoma*), Narrow-leaved Stringybark (*E. oblonga*), Silvertop Ash (*E. sieberi*), Smooth-barked Apple (*Angophora costata*), Dwarf Apple (*A. hispida*), Red Bloodwood *(Corymbia gummifera*), Scrub She-oak (*Allocasuarina distyla*), Slender Tea Tree (*Leptospermum trinervium*), and Fern-leaved Banksia (*Banksia oblongifolia*) (Leigh, Boden et al. 1984, Benson and McDougall 1998).	Bionet, EPBC, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Eucalyptus fracta			V	Known only from State Forests on parts of the northern escarpment of the Broken Back Range, near Cessnock, where it is locally frequent. It is restricted to shallow soils along the upper escarpment of a steep sandstone range (NSW Scientific Committee 1999, Harden 2002).	Bionet, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	Occurs from Niangala to Glenn Innes where it grows in grassy sclerophyll woodland on shallow relatively infertile soils on shales and slates, mainly on granite (Harden, 1991; DLWC, 2001). Endemic on the NSW Northern Tablelands, of limited occurrence, particularly in the area from Walcha to Glen Innes; often on porphyry or granite (Brooker and Kleinig 1999).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Eucalyptus pulverulenta	Silver-leaved Gum	V	V	Tree or mallee to 10 m high, rare and scattered, in small stands almost in the understorey of grassy woodland on relatively poor soil; from Bathurst to Bombala (Royal Botanic Gardens 2004). It grows in shallow soils as an understorey plant in open forest, typically dominated by Brittle Gum (*Eucalyptus mannifera*), Red Stringybark (*E. macrorhynca*), Broad-leafed Peppermint (*E. dives*), Silvertop Ash (*E. sieberi*) and Apple Box (*E. bridgesiana*) (Department of Environment and Conservation 2005).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Genoplesium baueri	Bauers Midge Orchid		V	Grows in dry sclerophyll forest and moss gardens over sandstone. The species has been recorded from locations between Ulladulla and Port Stephens. About half the records were made before 1960 with most of the older records being from northern Sydney suburbs. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments (Office of Environment and Heritage 2014).	Bionet, EPBC	Low. Generally unsuitable habitat in the subject site subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Grevillea caleyi	Caleys Grevillea	E	E1	Restricted to an 8 km square area around Terrey Hills, approximately 20 km north of Sydney. Occurs in three major areas of suitable habitat, namely Belrose, Ingleside and Terrey Hills/Duffys Forest within the Ku-ring-gai, Pittwater and Warringah Local Government Areas. All natural remnant sites occur within a habitat that is both characteristic and consistent between sites. All sites occur on the ridgetop between elevations of 170 to 240 m asl, in association with laterite soils and a vegetation community of open forest, generally dominated by *Eucalyptus sieberi* and *E. gummifera* (Office of Environment and Heritage 2014).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Hibbertia puberula			E1	Recent work on this species (Toelken and Miller 2012) and its relatives have shown it to be widespread, but never common. It extends from Wollemi National Park south to Morton National Park and the south coast near Nowra. Early records of this species are from the Hawkesbury River area and Frenchs Forest in northern Sydney, South Coogee in eastern Sydney, the Hacking River area in southern Sydney, and the Blue Mountains. It favours low heath on sandy soils or rarely in clay, with or without rocks (Toelken and Miller 2012) (Office of Environment and Heritage 2014).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Hygrocybe anomala var. ianthinomarginata			V	Small, brightly-coloured gilled fungus and has been found in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney, and from Royal and Blue Mountains National Parks (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Hygrocybe aurantipes			V	Small, brightly-coloured gilled fungus known only from its type locality in the Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney and from the Blue Mountains National Park (Mt Wilson) and Hazelbrook and surveys in potentially suitable habitats elsewhere in the Sydney Basin Bioregion have failed to find Hygrocybe aurantipes A. M. Young. At Lane Cove the species occurs not only in leaf litter but also on mossy creek banks, under a closed canopy. The species does not produce basidiomes all year, but non-reproductive hyphal structures occur below ground (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Hygrocybe austropratensis			E1	Small, brightly-coloured gilled fungus and known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Hygrocybe collucera			E1	Small, brightly-coloured red gilled fungus and is known only from its type locality in the Lane Cove Bushland Park in the Lane Cove local government area in Sydney (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Hygrocybe griseoramosa			E1	Small, buff to brown gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove local government area in Sydney (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Hygrocybe lanecovensis			E1	Small, brightly-coloured gilled fungus and known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Hygrocybe reesiae			V	Small, lilac coloured gilled fungus and is known in New South Wales only from its type locality in the Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney, and from the Blue Mountains National Park (Hazelbrook Area). It is also found in Tasmania (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Hygrocybe rubronivea			V	Small, brightly-coloured gilled fungus and is known only from its type locality in the Lane Cove Bushland Park in the Lane Cove local government area in Sydney (NSW National Parks and Wildlife Service 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Leptospermum deanei		V	V	Occurs in Hornsby, Warringah, Ku-ring-gai and Ryde LGAs in woodland on lower hills and slopes or near creeks, sandy alluvial soil or sand over sandstone. Occurs in Riparian Scrub – e.g. Tristaniopsis laurina, Baeckea myrtifolia, Woodland (e.g. *Eucalyptus haemastoma*) and Open Forest (e.g. *Angophora costata*, *Leptospermum trinervium* and *Banksia ericifolia*) (Office of Environment and Heritage 2012). Only occurs near the watershed of Lane Cove River where it grows on forested slopes (Harden 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, with the main concentration of records is in the Gosford/Wyong area (NSW Scientific Committee 1998). Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects (Harden 2002, Department of Environment and Climate Change 2008).	Bionet, EPBC, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Melaleuca deanei	Deanes Paperbark	V	V	Occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas. The species occurs mostly in ridgetop woodland, with only 5% of sites in heath on sandstone (Office of Environment and Heritage 2014).	Bionet, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.
Pelargonium sp. Striatellum (G. W. Carr 10345), syn. Pelargonium sp., Pelargonium sp. 1	Omeo Stork's-bill	E	E1	Known to occur in New South Wales and Victoria in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes and in the transition zone between surrounding grasslands or pasture and the paludal and aquatic communities. During dry periods, the species is known to colonise exposed lake beds {NSW Scientific Committee, 2010 #3826}.	EPBC	Low. Generally unsuitable habitat in the subject site subject site.
Persoonia hirsuta	Hairy Geebung	E	E1	The species is distributed from Singleton in the north, along the east coast to Bargo in the south and the Blue Mountains to the west. It has a large area of occurrence, but occurs in small populations. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone or very rarely on shale (Harden 2002, Office of Environment and Heritage 2015). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Persoonia hirsuta subsp. hirsuta	Hairy Geebung	E	E1	Occurs from Gosford to the Royal National Park and Hill Top to Glen Davis and Putty inland where it grows in woodlands and dry sclerophyll forest on sandstone or very rarely on shale (Harden 2002). Typically occurs as isolated individuals or very small populations (NSW Scientific Committee 1998, Royal Botanic Gardens 2005). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997). Habitat in Castle Hill is considered to be 'critical habitat' (James 1997).	Plantnet	Low. Generally unsuitable habitat in the subject site subject site.
Pimelea curviflora var. curviflora		V	V	Confined to coastal areas around Sydney where it grows on sandstone and laterite soils. It is found between South Maroota, Cowan, Narrabeen, Allambie Heights, Northmead and Kellyville, but its former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Usually occurs in woodland in the transition between shale and sandstone, often on Lucas Heights soil landscape (James 1997, NSW Scientific Committee 1998, James, McDougall et al. 1999, Harden 2000).	Bionet, EPBC	Low. Generally unsuitable habitat in the subject site subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Pimelea spicata	Spiked Rice-flower	E	E1	This species occurs in two disjunct areas: in coastal districts from Lansdowne to Shellharbour, and in Cumberland Plain Woodland inland to Penrith. In western Sydney it grows on Wianamatta Shales in Greybox – Ironbark Woodland with Bursaria spinosa and Themeda australis. In the Illawarra, it occurs on well structured clay soils in grassland or open woodland (James 1997, Harden 2000, NSW National Parks and Wildlife Service 2000).	EPBC	Low. Generally unsuitable habitat in the subject site subject site.
Prostanthera marifolia		CE	CE	Thought to be extinct. Previously occurred in Mangrove Mountain and Sydney districts usually near the coast. Recorded within sclerophyll forest and woodland in sandy loamy soils on sandstone Occurs in the Springwood area where it grows in woodland on lateritic soils (Harden 1992). The taxonomic status of this name is uncertain (Royal Botanic Gardens 2004).	Bionet, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.
Syzygium paniculatum	Magenta Lilly Pilly	V	E1	Occurs between Bulahdelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea (Harden 2002). On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (Department of Environment and Climate Change 2008).	Bionet, EPBC, Plantnet	Low. Generally unsuitable habitat in the subject site subject site. However species has been recorded previously within locality. It should be noted that this species has been widely cultivated in the horticulture industry and as a result commonly planted in urban areas. Given the lack of remnant vegetation it is unlikely that any individual genetically viable specimens would occur.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	BC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Tetratheca glandulosa	Glandular Pink-bell	V	V	Occurs from Mangrove Mountain to the Blue Mountains where it grows in sandy or rocky heath or scrub (Harden 1992). Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gymea, Lambert and Faulconbridge. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam. Stony lateritic fragments are also common in the soil profile on many of these ridgetops. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. Vegetation communities correspond broadly to Benson & Howell's Sydney Sandstone Ridgetop Woodland (Map Unit 10ar). Common woodland tree species include: *Corymbia gummifera, C. eximia, Eucalyptus haemastoma, E. punctata, E. racemosa, and/or E. sparsifolia*, with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae (Department of Environment and Climate Change 2008).	Bionet, Plantnet	Low. Generally unsuitable habitat in the subject site subject site.
Tetratheca juncea	Black-eyed Susan	V	V	Occurs in coastal districts from Bulahdelah to Port Macquarie where it grows in dry sclerophyll forest and occasionally swampy heath in sandy, (Harden 1992) low nutrient soils with a dense understorey of grasses. Specifically it is known to occur within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland (Payne, Stevenson et al. 2002).	Bionet	Low. Generally unsuitable habitat in the subject site subject site.
Thesium australe	Austral Toadflax	V	V	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be Themeda australis and Poa spp. (Harden 1992, Department of Environment and Climate Change 2008).	Bionet, EPBC	Low. Generally unsuitable habitat in the subject site subject site.

1. Listed as vulnerable (V), endangered (E), critically endangered (CE) under the EPBC Act.
2. Listed as an endangered population (E2), vulnerable (V), endangered (E1) or critically endangered (CE) under the BC Act.
3. EPBC Search = EPBC Act Protected Matters Search Tool Report, PlantNet = Royal Botanical Gardens, Sydney – 5 km buffer of subject site subject site, Bionet = Office of Environment and Heritage Bionet Atlas – 5 km buffer of subject site subject site

APPENDIX B

FAUNA LIKELIHOOD TABLE

Table 1 Threatened fauna likelihood table

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Heleioporus australiacus	Giant Burrowing Frog	V		Exists as two distinct populations: a northern population on the sandstone geology of the Sydney Basin, from Wollemi National Park in the north, south to Jervis Bay; and a southern population in disjunct pockets from about Narooma south into eastern Victoria. In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys where the frog is associated with small headwater and slow flowing to intermittent creeklines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from collected water. Also observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised and are surrounded by undisturbed habitat. In the southern population, records appear to be associated with Devonian igneous and sedimentary formations and Ordovician metamorphics and are generally from more heavily timbered areas. It is absent from areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks (Cogger 2000, NSW National Parks and Wildlife Service 2001).	EPBC	Low. No suitable habitat in the subject site.
Litoria aurea	Green and Golden Bell Frog	V	E1	This species occurs in fragment patches near coastal locations from Vic to south of the NSW-QLD border. For breeding it utilises a wide range of waterbodies, including both natural and man-made structures, such as marshes, dams and stream sides, and ephemeral wetlands. It is found in small pockets of habitat in otherwise developed areas and can occur in disturbed sites. There is a clear preference for sites with a complexity of vegetation structure and terrestrial habitat attributes which include extensive grassy areas and an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover used for foraging and shelter. Over-wintering shelter sites may be adjacent to or some distance away from breeding sites but the full range of possible habitat used is not yet well understood (Department of Environment and Conservation 2004, Department of Environment and Conservation 2005).	Bionet, EPBC	Low. No suitable habitat in the subject site.
Pseudophryne australis	Red-crowned Toadlet		V	Occurs within 160 km of Sydney where it is restricted to Hawkesbury Sandstone. It breeds in deep grass and debris adjacent to ephemeral drainage lines. When not breeding individuals are found scattered on sandstone ridges under rocks and logs (Cogger 2000).	Bionet	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Actitis hypoleucos	Common Sandpiper	M		The Common Sandpiper frequents a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity. It is mostly encountered along muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow, and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags (Higgins and Davies 1996, Geering, Agnew et al. 2007). Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other artificial structures, and to sometimes rest on mud or 'loaf' on rocks (Higgins and Davies 1996).	Bionet	Low. No suitable habitat in the subject site.
Anseranas semipalmata	Magpie Goose		V	Occurs in shallow wetlands such as large swamps and dams, especially with dense growth of rushes or sedges, and with permanent lagoons and grassland nearby. Feeds on seeds, tubers and green grass. Form large nesting colonies during the wet season. During the dry season this species migrates hundreds of kilometres to perennial swamps (Garnett and Crowley 2000, NSW National Parks and Wildlife Service 2002).	Bionet	Low. No suitable habitat in the subject site.
Anthochaera phrygia (syn. Xanthomyza phrygia)	Regent Honeyeater	EM	CE	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with Casuarina cunninghamiana and Amyema cambagei are important for feeding and breeding. Spotted Gum and Swamp Mahogany forests are also important feeding areas in coastal areas. Important food trees include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), *E. melliodora* (Yellow Box) and *E. leucoxylon* (Yellow Gum) (Garnett and Crowley 2000).	Bionet, EPBC	Low. Subject site is isolated although accidental or rare occurrences under suitable seasonal conditions cannot be discounted.
Apus pacificus	Fork-tailed Swift	M		Breeds in the northern hemisphere, wintering south to Australia. It is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground. It mostly occurs over inland plains but sometimes above foothills or in coastal areas over cliffs, beaches, islands and well out to sea. It also occurs over towns and cities. It mostly occurs over dry and/or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh, grassland, spinifex sandplains, farmland and sand-dunes. It sometimes occurs above forests. It probably roosts aerially, but has occasionally been observed to land (Higgins 1999).	Bionet	Low. Although this species is likely to occasionally fly over the site on a seasonal basis, there is no suitable terrestrial habitat onsite.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Ardea (Bulbulcus) ibis	Cattle Egret	M		Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands and very rarely in arid and semi-arid regions. High numbers may occur in moist, poorly drained pastures with high grass; it avoids low grass pastures but has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora (Morton, Brennan et al. 1989, Marchant and Higgins 1990).	Bionet, EPBC	Low. No suitable habitat in the subject site.
Ardea (Casmerodius) modesta	Eastern Great Egret	M		Great Egrets occur throughout most of the world. They are common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species, and roost at night in groups. In Australia, the breeding season of the Great Egret is normally October to December in the south and March to May in the north. This species breeds in colonies, and often in association with cormorants, ibises and other egrets. (Australian Museum 2003).	EPBC	Low. No suitable habitat in the subject site.
Ardenna pacificus	Wedge-tailed Shearwater	M		Returns from the North Pacific to their burrows on islands off the coast of NSW. Marine nomadic species that visits land to breed. Known breeding colony at Muttonbird island near Coffs Harbour and islands off Port Stephens in NSW (Garnett and Crowley 2000).	Bionet	Low. No suitable habitat in the subject site.
Arenaria interpres	Ruddy Turnstone	M		Occurs at beaches and coasts with exposed rock, stony or shell beaches, mudflats, exposed reefs and wave platforms (Morcombe 2003).	EPBC	Low. No suitable habitat in the subject site.
Botaurus poiciloptilus	Australasian Bittern	E	E1	Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but will also feed in more open territory. (Garnett and Crowley 2000, NSW National Parks and Wildlife Service 2002).	Bionet, EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Burhinus grallarius	Bush Stone-curlew		E1	Inland habitat consists of open forest and woodlands with few, if any, shrubs, and short, sparse grasses of less than 15 cm in height, with scattered fallen timber, leaf litter and bare ground present (Office of Environment & Heritage 2015). In coastal areas, structurally similar elements of tidal and estuarine communities (Casuarina woodlands, saltmarsh and mangroves) provide suitable habitat (Price 2004). Nesting sites are frequently located in relatively open areas, where ground cover is extremely low and/or sparse including native vegetation and mown lawns, ploughed paddocks and paddocks cut for hay, dirt and gravel roads, seaweed on sand beach, playing fields, vacant lots (Office of Environment & Heritage 2015).	Bionet	Low. No suitable habitat in the subject site.
Calidris acuminata	Sharp-tailed Sandpiper	M		Occurs in a variety of habitats: tidal mudflat, mangrove swamps, saltmarshes, shallow fresh, brackish, salt inland swamps and lakes; flooded and irrigated paddocks, sewage farms and commercial saltfields (Pizzey and Knight 2007).	Bionet, EPBC	Low. No suitable habitat in the subject site.
Calidris canutus	Red Knot	M		In Australasia the Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps (Higgins and Davies 1996).	EPBC	Low. No suitable habitat in the subject site.
Calidris ferruginea	Curlew Sandpiper	M	E1	Occurs in inter-tidal mudflats of estuaries, lagoons, mangrove channels and also around lakes, dams, floodwaters and flooded saltbush surrounding inland lakes (Morcombe 2003).	Bionet, EPBC	Low. No suitable habitat in the subject site.
Calidris melanotos	Pectoral Sandpiper	M		In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species frequents coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. It is usually found in coastal or near coastal habitat but occasionally further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. It has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands (Higgins and Davies 1996).	Bionet, EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Calidris ruficollis	Red-necked Stint	M		Mostly found in coastal areas, including sheltered inlets, bays lagoons and estuaries. They also occur in shallow wetlands near the coast or inland, including lakes, waterholes and dams (Higgins and Davies 1996). They forage in mudflats, shallow water, sandy open beaches, flooded paddocks and in samphire feeding along the edges. The species roosts on sheltered beaches, spits, banks or islets, of sand, mud, coral or shingle. Occasionally they roost on exposed reefs or shoals (Higgins and Davies 1996) and amongst seaweed, mud and cow-pats (Hobbs 1961). During high tides they may also use sand dunes and claypans.	EPBC	Low. No suitable habitat in the subject site.
Calidris tenuirostris	Great Knot	M	V	Generally a coastal species found on tidal mudflats and sandy ocean shores. A migratory species visiting Australian waters between September and March (Pizzey and Knight 2007).	EPBC	Low. No suitable habitat in the subject site.
Calyptorhynchus lathami	Glossy Black-Cockatoo		V	Occurs in eucalypt woodland and forest with Casuarina/Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (NSW National Parks and Wildlife Service 1999, Garnett and Crowley 2000).	Bionet	Low. Although this species is likely to occasionally fly over the site, so may visit site on an intermittent basis.
Charadrius bicinctus	Double-banded Plover	M		The Double-banded Plover is found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers. It is sometimes associated with coastal lagoons, inland saltlakes, exposed seagrass beds, exposed reefs and rock platforms and coastal sand dunes (Marchant and Higgins 1993).	EPBC	Low. No suitable habitat in the subject site.
Charadrius leschenaultii	Greater Sand Plover	M	V	Entirely coastal in NSW foraging on intertidal sand and mudflats in estuaries, and roosting during high tide on sand beaches or rocky shores. A migratory species it is found in New South Wales generally during the summer months (Pizzey and Knight 2007).	EPBC	Low. No suitable habitat in the subject site.
Charadrius mongolus	Lesser Sand Plover	M	V	Migratory bird that migrates from the northern hemisphere to coastal areas of northern and east coast of Australia (Garnett and Crowley 2000). The species is almost strictly coastal during the non-breeding season, preferring sandy beaches, mudflats of coastal bays and estuaries, sand-flats and dunes near the coast, occasionally frequenting mangrove mudflats (IUCN Redlist entry).	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Cuculus opatus (syn. Cuculus saturatus)	Oriental Cuckoo, Himalayan Cuckoo	M		A non-breeding migrant to Australia, it often inhabits rainforest, vine thickets, wet sclerophyll forest and open woodland and sometimes occurs in mangroves, wooded swamps and as vagrants in gardens (Higgins 1999). The population trend appears to be stable (BirdLife International 2009).	EPBC	Low. No suitable habitat in the subject site.
Daphoenositta chrysoptera	Varied Sittella		V	The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. The Varied Sittella feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (Department of Environment Climate Change and Water 2010).	Bionet	Low. No suitable habitat in the subject site.
Dasyornis brachypterus	Eastern Bristlebird	E	E1	The habitat of the Eastern Bristlebird is characterised by low dense vegetation. Fire is a feature of all areas where known populations occur. Given the poor flight ability of the species it is though that few individuals survive the passage of fire, survival is dependant on the availability of fire refuges and recolonisation may be relatively slow. The bird is cryptic and camouflaged and rarely seen but may be detected by its distinctive, loud calls. Confined to NSW/Queensland border region, Illawarra region and NSW/Victorian border region (NSW National Parks and Wildlife Service 1997).	EPBC	Low. No suitable habitat in the subject site.
Diomedea epomophora epomophora	Southern Royal Albatross	VM		Breeds on Campbell, Adams, Enderby and Auckland Islands, south of New Zealand (Garnett and Crowley 2000). A southern ocean pelagic species occasionally observe off southern Australian coasts, but rare in the north (Garnett and Crowley 2000).	EPBC	Low. No suitable habitat in the subject site.
Diomedea epomophora sanfordi	Northern Royal Albatross	EM		Breeds on Chatham Island and Taiaroa Head on South Island of New Zealand (Garnett and Crowley 2000). Observed regularly in Tasmanian and South Australian waters and extends into the southwest Atlantic, but more rarely off the NSW coast (Garnett and Crowley 2000).	EPBC	Low. No suitable habitat in the subject site.
Diomedea exulans	Wandering Albatross	VM	E1	Southern circumpolar distribution, breeding in Australian territory on Macquarie and Heard Islands (Garnett and Crowley 2000). Aslo breeds in subantarctic islands in the southern Atlantic and Indian oceans (Garnett and Crowley 2000). A pelagic species visiting mainland Australian waters seasonally occasionally occurring within sight of the coast.	Bionet, EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Diomedea exulans antipodensis	Antipodean Albatross	VM	V	Breeds on Antipodes and Campbell Islands, New Zealand, foraging across the southwest Pacific and the Tasman Sea, including waters off the coasts of NSW (Garnett and Crowley 2000). Essentially an oceanic species, usually uncommon in inshore habitats and not entering enclosed waters.	EPBC	Low. No suitable habitat in the subject site.
Diomedea exulans gibsoni	Gibson's Albatross	VM	V	Breeds on Auckland Island, New Zealand, and forages throughout the Tasman Sea (Garnett and Crowley 2000)where it is commonly encountered off the NSW coast during seabird surveys in the Austral winter. An oceanic species uncommon in inshore habitats and avoiding enclosed waters.	EPBC	Low. No suitable habitat in the subject site.
Egretta sacra	Eastern Reef Egret	M		Found in marine and estuarine habitats of mainland, islands and atolls. Prefers the rocky shorelines and reef mainlands in tropical Australia. Also found on intertidal areas of estuarine mudflats, mangrove-lined shores, rivers, creeks and beaches (gravel and mud). Sheltered sandy beaches rocky promontories are also used. Breed on islands, coral cays and rocky islets near intertidal habitats suitable for feeding.(Marchant and Higgins 2004). The population trend appears to be stable(BirdLife International 2009).	Bionet	Low. No suitable habitat in the subject site.
Epthianura albifrons	White-fronted Chat		E2	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level (North 1904; Higgins et al. 2001; Barrett et al. 2003). In New South Wales the White-fronted Chat occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state (Higgins et al. 2001). Along the coastline, White-fronted Chats are found predominantly in saltmarsh vegetation although they are also observed in open grasslands and sometimes in low shrubs bordering wetland areas. (North 1904; Higgins et al. 2001; Barrett et al. 2003). The population in the Sydney Metropolitan Catchment Management Authority region is listed as Endangered (Office of Environment and Heritage 2014).	Bionet, Bionet	Low. No suitable habitat in the subject site.
Erythrotriorchis radiatus	Red Goshawk	VM	CE	Lives in coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers and along edges of rainforest. Nests are only built in trees taller than 20 meters which occur within 1 kilometre of a watercourse or wetland. Has a home range of 200 square kilometres and hunts for medium to large birds in open forests and gallery forest (Garnett and Crowley 2000).	Bionet	Low. No suitable habitat in the subject site.
Fregetta grallaria	White-bellied Storm-Petrel		V	Marine species, breeding on Lord Howe Island (Department of Environment and Climate Change 2007).	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Gallinago hardwickii	Latham's Snipe	M		Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett and Crowley 2000).	Bionet, EPBC	Low. Although this species is likely to occasionally fly over the site on a seasonal basis, there is no suitable terrestrial habitat onsite.
Glossopsitta pusilla	Little Lorikeet		V	The Little Lorikeet is a small green lorikeet with black bill and red patch on forehead and throat. The underside is yellow-green. Immatures are duller with less red on face and brown bill. Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria (Higgins 1999).	Bionet	Low. Subject site is isolated although accidental or rare occurrences under suitable seasonal conditions cannot be discounted.
Grantiella picta	Painted Honeyeater		V	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus Amyema, though it will take some nectar and insects. Its breeding distribution is dictated by presence of mistletoes which are largely restricted to older trees. Less likely to be found in in strips of remnant box-ironbark woodlands, such as occur along roadsides and in windbreaks, than in wider blocks (Garnett and Crowley 2000).	EPBC	Low. No suitable habitat in the subject site.
Haematopus longirostris	Australian Pied Oystercatcher		E1	Occurs in undisturbed beaches, sandspits, sandbars, tidal mudflats, estuaries and coastal islands. Occasionally found on rocky reefs, shores, rock stacks, brackish or saline wetlands and also in grassy paddocks, golf courses or parks near coast. Eggs are laid in shallow scrape in sand on open beach or among low growth behind beach (Pizzey and Knight 2007).	Bionet	Low. Although this species is likely to occasionally fly over the site on a seasonal basis, there is no suitable terrestrial habitat onsite.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Haliaeetus leucogaster	White-bellied Sea-Eagle	M		Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey and Knight 2007).	Bionet, EPBC	Low. Although this species is likely to occasionally fly over the site, there is no suitable terrestrial habitat onsite.
Hieraaetus morphnoides	Little Eagle		V	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring. Prey includes birds, reptiles and mammals, with the occasional large insect and carrion. Most of its former native mammalian prey species in inland NSW are extinct and rabbits now form a major part of the diet (Marchant and Higgins 1993).	Bionet	Low. Although this species is likely to occasionally fly over the site on a seasonal basis, there is no suitable terrestrial habitat onsite.
Hirundapus caudacutus	White-throated Needletail	M		Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey and Knight 2007).	Bionet, EPBC	Low. Although this species is likely to occasionally fly over the site on a seasonal basis, there is no suitable terrestrial habitat onsite.
Hydroprogne caspia (syn. Sternia caspia)	Caspian Tern	M		The Caspian Tern is found in sheltered coastal embayments preferring sandy or muddy margins. Also found in near-coastal or inland terrestrial wetlands. It forages in open wetlands, preferring sheltered shallow water near the margins. It usually breeds in low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or banks and occasionally among beach-cast debris above the high-water mark or at artificial sites, including islands in reservoirs, or on dredge-spoil. Generally roosting occurs on bare exposed sand or shell spits, banks or shores. (Higgins and Davies 1996).	Bionet	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Ixobrychus flavicollis	Black Bittern		V	Usually found in dense vegetation in and fringing streams, swamps, tidal creeks and mudflats, particularly amongst swamp she-oaks and mangroves. Feeds on aquatic fauna along streams, in estuaries and beside billabongs and pools. Breeding occurs in summer in secluded places in densely vegetated wetlands. It nests in trees that overhang the water (Garnett and Crowley 2000, NSW National Parks and Wildlife Service 2002).	Bionet	Low. No suitable habitat in the subject site.
Lathamus discolor	Swift Parrot	E	E1	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering Acacia pycnantha, is indicated. Sites used vary from year to year. (Garnett and Crowley 2000),(Swift Parrot Recovery Team 2001).	Bionet, EPBC	Low. Subject site is isolated although accidental or rare occurrences under suitable seasonal conditions cannot be discounted.
Limosa lapponica	Bar-tailed Godwit	M		Occurs in coastal mudflats, sandbars, shores of estuaries, salt marsh and sewage ponds (Morcombe 2003).	Bionet, EPBC	Low. Although this species is likely to occasionally fly over the site on a seasonal basis, there is no suitable terrestrial habitat onsite.
Macronectes giganteus	Southern Giant-Petrel	EM	E1	A partly nomadic marine species that forages off the coast of New South Wales (Garnett and Crowley 2000).	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Merops ornatus	Rainbow Bee-eater	M		Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings (Higgins 1999).	EPBC	Low. Although this species is likely to occasionally fly over the site on a seasonal basis, there is no suitable terrestrial habitat onsite.
Monarcha melanopsis	Black-faced Monarch	M		Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp gullies in rainforest, eucalypt forest and in more open woodland when migrating (Pizzey and Knight 2007).	EPBC	**Moderate.** Subject site represents seasonal breeding habitat.
Monarcha trivirgatus	Spectacled Monarch	M		Occurs in the understorey of mountain/lowland rainforests, thickly wooded gullies and waterside vegetation. Migrates to NE NSW in summer to breed (Pizzey and Knight 2007).	EPBC	Low. May rarely occur as a passage or dispersing migrant.
Motacilla flava	Yellow Wagtail	M		This species occurs in a range of habitats including estuarine habitats such as sand dunes, mangrove forests and coastal saltmarshes. This species also occurs in open grassy areas including disturbed sites such as sports grounds and has been recorded on the edges of wetlands, swamps, lakes and farm dams. This species migrates from Asia to Australia in spring-summer. It has been recorded in the estuarine areas of the Hunter River in Newcastle NSW and in QLD and the north of NT and WA (Higgins, Peter et al. 2006).	EPBC	Low. No suitable habitat in the subject site.
Myiagra cyanoleuca	Satin Flycatcher	M		Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey and Knight 2007).	EPBC	Low. May rarely occur as a passage or dispersing migrant.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Neophema chrysogaster	Orange-bellied Parrot	ZM	E1	Orange-bellied Parrot breeds in the south-west of Tasmania and migrates in autumn to spend the winter on the mainland coast of south-eastern South Australia and southern Victoria. Typical winter habitat is saltmarsh and strandline/foredune vegetation communities either on coastlines or coastal lagoons. Spits and islands are favoured but they will turn up anywhere within these coastal regions. The species can be found foraging in weedy areas associated with these coastal habitats or even in totally modified landscapes such as pastures, seed crops and golf courses. Diet mainly comprises seeds and fruits of sedges and salt-tolerant coastal and saltmarsh plants. Occasionally, flowers and stems are eaten. Orange-bellied Parrots are known to forage among flocks of Blue-winged Parrots (Higgins 1999). It is expected that NSW habitats may be being more frequently utilised than observations suggest (Department of Environment and Conservation 2005).	EPBC	Low. No suitable habitat in the subject site.
Ninox connivens	Barking Owl		V	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett and Crowley 2000).	Bionet	Low. No suitable habitat in the subject site.
Ninox strenua	Powerful Owl		V	A sedentary species with a home range of approximately 1000 hectares it occurs within open eucalypt, Casuarina or Callitris pine forest and woodland. It often roosts in denser vegetation including rainforest of exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands (Garnett and Crowley 2000).	Bionet	**High.** Suitable foraging and nesting habitat suggest the subject site is likely to represent part of the home range of local individuals.
Numenius madagascariensis	Eastern Curlew	CEM		Inhabits coastal estuaries, mangroves, mud flats and sand pits. It is a migratory shorebird which generally inhabits sea and lake shore mud flats, deltas and similar areas, where it forages for crabs and other crustaceans, clam worms and other annelids, molluscs, insects and other invertebrates. Its migration route ranges from its wintering grounds in Australia to its breeding grounds in northern China, Korea and Russia (Pizzey and Knight 2007).	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Numenius minutus	Little Curlew	M		On passage the species shows a preference for foraging and resting in swampy meadows near lakes and along river valleys. It overwinters on dry inland grassland, bare cultivation, dry mudflats and coastal plains of black soil with scattered shallow pools of freshwater, swamps, lakes or flooded ground. It shows a preference for short grass swards of less than 20 cm tall, and occasionally occurs in dry saltmarshes, coastal swamps, mudflats or sandflats in estuaries, or on the beaches of sheltered coasts (BirdLife International 2009).	Bionet	Low. No suitable habitat in the subject site.
Numenius phaeopus	Whimbrel	M		Migrates to Taiwan, Philippines, PNG, and a race breeding in NE Siberia is found on the north and south-eastern coastlines of Australia. Juveniles arrive to Australia from spring to early summer. Usually only juveniles remain in Australia but very occasionally adults in breeding plumage may be seen in Australian winters (Pizzey and Knight 2007).	EPBC	Low. No suitable habitat in the subject site.
Pachyptila turtur	Fairy Prion	V			EPBC	Low. No suitable habitat in the subject site.
Pandion cristatus (syn. P. haliaetus)	Eastern Osprey	M	V	Generally a coastal species, occurring in estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks. Sometimes ascends larger rivers to far inland. Builds nests high in tree, on pylon or on ground on islands. Feeds on fish (Pizzey and Knight 2007).	EPBC	Low. Although this species is likely to occasionally fly over the site, there is no suitable terrestrial habitat onsite.
Philomachus pugnax	Ruff	M		The Ruff is found on generally fresh, brackish or saline wetlands with exposed mudflats at the edges. It is found in terrestrial wetlands including lakes, swamps, pools, lagoons, tidal rivers, swampy fields and floodlands and occasionally on sheltered coasts, in harbours, estuaries, seashores, sewage farms and saltworks. It is also sometimes found on wetlands surrounded by dense vegetation including grass, sedges, saltmarsh and reeds and has been observed on sand spits and other sandy habitats including shingles. It forages on mudflats, in shallow water and occasionally on dry mud, dry waterside plants and in swampy areas in sewage farms. It prefers to roost amongst shorter vegetation (Higgins and Davies 1996).	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Pluvialis fulva	Pacific Golden Plover	M		Prefers sandy, muddy or rocky shores, estuaries and lagoons, reefs, saltmarsh, and or short grass in paddocks and crops. The species is usually coastal, including offshore islands; rarely far inland. Often observed on beaches and mudflats, sandflats and occasionally rock shelves, or where these substrates intermingle; harbours, estuaries and lagoons (Marchant and Higgins 1993).	EPBC	Low. No suitable habitat in the subject site.
Pterodroma leucoptera	Gould's Petrel	EM	V	A marine species, it nests on islands among rocks and debris of Cabbage Tree Palms. It feeds on fish, cephalapods and other marine animals (Garnett and Crowley 2000).	Bionet, EPBC	Low. No suitable habitat in the subject site.
Pterodroma neglecta	Kermadec Petrel	V		An oceanic species that forages in the tropical and subtropical pacific ocean (Garnett and Crowley 2000).	EPBC	Low. No suitable habitat in the subject site.
Ptilinopus superbus	Superb Fruit-Dove		V	Occurs in rainforests and fringes, scrubs, mangroves and wooded stream-margins, lantana thickets, isolated figs, pittosporums, lily pillies and blackberries (Pizzey and Knight 2007).	Bionet	**Moderate**. Although this species is likely to occasionally fly over the site on a seasonal basis, and utilise fruiting figs onsite.
Rhipidura rufifrons	Rufous Fantail	M		Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range (Pizzey and Knight 2007).	EPBC	**Moderate.** Subject site represents seasonal breeding habitat.
Rostratula australis (syn. R. benghalensis)	Australian Painted Snipe (Painted Snipe)	VM	E1	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as Eucalyptus camaldulensis (River Red Gum), E. populnea (Poplar Box) or shrubs such as Muehlenbeckia florulenta (Lignum) or Sarcocornia quinqueflora (Samphire). Feeds at the water's edge and on mudlflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett and Crowley 2000).	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Stagonopleura guttata	Diamond Firetail		V	Distributed through central and eastern NSW, extending north into southern and central Queensland and south through Victoria to the Eyre Peninsula, South Australia. In NSW, the species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas (Blakers, Davies et al. 1984, Schodde and Mason 1999). Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range (Garnett and Crowley 2000). Firetails nest in trees and bushes, and forage on the ground, largely for grass seeds and other plant material, but also for insects (Blakers, Davies et al. 1984, Read 1994).	Bionet	Low. No suitable habitat in the subject site.
Sterna albifrons	Little Tern	M	E1	Little Terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets. They nest on sand-spits, sandbanks, ridges or islets in these habitats or gently sloping sandy ocean beaches and occasionally in sand-dunes (Garnett and Crowley 2000).	Bionet	Low. No suitable habitat in the subject site.
Sterna fuscata	Sooty Tern		V	Occurs in tropical and subtropical seas, islands and cays. Nests in scrape in sand or coral debris, often in large colonies (Simpson and Day 1996).	Bionet	Low. No suitable habitat in the subject site.
Sterna hirundo	Common Tern	M		A non-breeding migrant to Australia, occurring mainly on the east coast and inhabiting marine, pelagic and coastal habitats. Mostly oceanic but often recorded in bays, harbours and estuaries and occasionally in coastal wetlands. Roosting occurs on unvegetated intertidal sandy ocean beaches, shores of estuaries, lagoons and sand bars (Higgins and Davies 1996).	Bionet	Low. Although this species is likely to occasionally fly over the site on a seasonal basis, there is no suitable terrestrial habitat onsite.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Sternula nereis nereis	Fairy Tern (Australian)	V		Fairy Terns utilise a variety of habitats including offshore, estuarine or lacustrine (lake islands, wetlands, beaches and spits. The subspecies may migrate within southern Western Australia and Tasmania, where they are seen less frequently during the winter months. They are more sedentary in the north of Western Australia, and in South Australia and Victoria (Hill 1988). Fairy Terns nest in small colonies on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries, and on open sandy beaches (Hill 1988, Higgins and Davies 1996). They nest above the high water mark often in clear view of the water and on sites where the substrate is sandy and the vegetation low and sparse. Colonies tend to occupy areas rather than specific sites, and nest sites are often abandoned after one year, even if they have been successful (Saunders 1985).	EPBC	Low. No suitable habitat in the subject site.
Thalassarche bullei	Buller's Albatross	VM		Breeds on Snares and Solander Islands, New Zealand, foraging locally, but also foraging widely enough to cross the Tasman (Garnett and Crowley 2000). An oceanic species uncommon in inshore habitats and avoiding encolsed waters.	EPBC	Low. No suitable habitat in the subject site.
Thalassarche cauta cauta	Shy Albatross	VM	V	An Australian territory endemic, which breeds on three islands off southern Tasmania; Albatross, Bass and Pedra Branca Islands (Marchant and Higgins 1990). Genetic data studies on shy-type albastross collected off New Zealand, Australia and South Africa, strongly suggest that most Shy Albatross remain close to the breeding grounds throughout the year, with few birds moving north beyond the southern NSW coast (Abbott 2006).	EPBC	Low. No suitable habitat in the subject site.
Thalassarche eremita	Chatham Albatross	EM		Very restricted breeding on Pyramid Rock, Chatham Island (Garnett and Crowley 2000). Many disperse eastwards as far as South America, but it is occasionally encountered off eastern Australia's southern coasts (Garnett and Crowley 2000).	EPBC	Low. No suitable habitat in the subject site.
Thalassarche impavida	Campbell Albatross	VM		Recently separated from the closely related Black-browed Albatross and only separable from this species in individuals of sufficient age to develop the distinctive amber iris. Breeds on Campbell Island New Zealand foraging locally during this period (Garnett and Crowley 2000). Outside the breeding season forages around New Zealand, the Central Pacific and Australia (Garnett and Crowley 2000).	EPBC	Low. No suitable habitat in the subject site.
Thalassarche melanophris	Black-browed Albatross	VM	V	Nomadic marine species that breeds on subantarctic island outside Australian waters, but moves northwards in non-breeding seasons. The waters off southern Australia between Brisbane and Perth are the principal feeding area of birds (Garnett and Crowley 2000). Black-browed-type albatross are more regularly observed from shore than more pelagic albatross species.	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Thalassarche salvini	Salvin's Albatross	VM		An oceanic species that breeds on Bounty, Snares and Chatham Islands, south of New Zealand, and Crozet Island in the southern Indian Ocean (Garnett and Crowley 2000). Most individuals disperse east to the eastern Pacific Ocean from the breeding grounds, but a few individuals visit Australian waters, although few reach north of southern NSW.	EPBC	Low. No suitable habitat in the subject site.
Thalassarche steadi	White-capped Albatross	VM		An oceanic species that breeds on Adams, Auckland, Bollons, Disappointment and Chatham Islands south of New Zealand (Garnett and Crowley 2000). Global population between 70,000 and 80,000 pairs the majority of which breed on Disapointment Island (Garnett and Crowley 2000). During the breeding season most birds remain around the breeding islands and into the Tasman Sea (Garnett and Crowley 2000). Outside of the breeding season genetic data from bycatch studies strongly indicates that White-capped Albatross wonder widely in Australasian waters and west as far as South Africa (Abbott 2006).	EPBC	Low. No suitable habitat in the subject site.
Tringa brevipes (syn. Heteroscelus brevipes)	Grey-tailed Tattler	M		It is often found on sheltered coasts with reefs, rock platforms or with intertidal mudflats. It is also found at intertidal rocky, coral or stony reefs, platforms and islets that are exposed at low tide. It has also been found in embayments, estuaries and coastal lagoons, especially fringed with mangroves. It is rarely seen on open beaches and occasionally found around near-coastal wetlands, such as lagoons, lakes and ponds in sewage farms and saltworks. Inland records for the species are rare (Higgins and Davies 1996). The species forages in shallow water, hard intertidal substrates, rock pools, intertidal mudflats, mangroves, banks of seaweed and among rocks and coral rubble, over which water may surge. The species roosts in mangroves, dense stands of shrubs, snags, rocks, beaches, reefs, artificial structures (sea walls, oyster racks), occasionally in near-coastal saltworks and sewage ponds and rarely on sandy beaches or sand banks (Higgins and Davies 1996, Rogers 1999).	EPBC	Low. No suitable habitat in the subject site.
Tringa nebularia	Common Greenshank	M		Occurs in a range of inland and coastal environments. Inland, it occurs in both permanent and temporary wetlands, billabongs, swamps, lakes floodplains, sewage farms, saltworks ponds, flooded irrigated crops. On the coast, it occurs in sheltered estuaries and bays with extensive mudflats, mangrove swamps, muddy shallows of harbours and lagoons, occasionally rocky tidal ledges. It generally prefers wet and flooded mud and clay rather than sand (Morcombe 2003).	Bionet, EPBC	Low. No suitable habitat in the subject site.
Tringa stagnatilis	Marsh Sandpiper			Occurs in coastal and inland wetlands (salt or fresh water), estuarine and mangrove mudflats, beaches, shallow or swamps, lakes, billabongs, temporary floodwaters, sewage farms and saltworks ponds (Morcombe 2003).	Bionet, EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Tyto tenebricosa	Sooty Owl		V	Occurs in wet eucalypt forest and rainforest on fertile soils with tall emergent trees. Typically found in old growth forest with a dense understorey but also occurs in younger forests if nesting trees are present nearby. It nests in large hollows within eucalypts and occasionally caves. It hunts in open and closed forest for a range of arboreal and terrestrial mammals including introduced species and sometimes birds (Garnett and Crowley 2000).	Bionet	Low. No suitable habitat in the subject site.
Cercartetus nanus	Eastern Pygmy-possum		V	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and bark of a tree, abandoned birds' nests and shredded bark in the fork of trees (Turner and Ward 1995).	Bionet	Low. No suitable habitat in the subject site.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs in moderately wooded habitats, mainly in areas with extensive cliffs and caves and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins (Churchill 1998, Office of Environment and Heritage 2011). Breeding habitat (maternity roosts) is located in roof domes in sandstone caves (Office of Environment and Heritage 2011). Thought to forage below the forest canopy for small flying insects (Churchill 1998).	EPBC	Low. No suitable habitat in the subject site.
Dasyurus maculatus maculatus	Spotted-Tailed Quoll (Southern Subspecies)	E	V	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service 1999). Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service 1999, NSW National Parks and Wildlife Service 1999).	Bionet, EPBC	Low. No suitable habitat in the subject site.
Isoodon obesulus	Southern Brown Bandicoot	E	E1	Occurs in a variety of habitats in south-eastern Australia, including heathland, shrubland, dry sclerophyll forest with heathy understorey, sedgeland and woodland. Many of the habitats are prone to fire (NSW National Parks and Wildlife Service 1999).	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Miniopterus australis	Little Bent-wing Bat		V	Feeds on small insects beneath the canopy of well timbered habitats including rainforest, Melaleuca swamps and dry sclerophyll forests. Roosts in caves and tunnels and has specific requirements for nursery sites. Distribution becomes coastal towards the southern limit of its range in NSW. Nesting sites are in areas where limestone mining is preferred (Strahan 1995).	Bionet	**Moderate.** Potential foraging habitat within subject site, so may visit site on an intermittent basis.
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat		V	Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Hunt in rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands.	Bionet	**High.** Potential foraging and roosting habitat within subject site, so may visit site on regular basis.
Mormopterus (Micronomus) norfolkensis	Eastern Freetail Bat		V	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (Churchill 2008).	Bionet	**Moderate.** Potential foraging habitat within subject site, so may visit site on an intermittent basis.
Myotis macropus	Southern Myotis, Large-footed Myotis		V	Found in most habitat types in association with streams and permanent waterways usually at low elevations in flat or undulating landscapes from northern areas of Western Australia, and the Northern Territory, down the entire east coast and the southern coast of Australia to just west of the Victoria/South Australia border and inland along the Murray River. Roosts in caves, tree hollows, in clumps of dense vegetation (e.g. Pandanus), mines, tunnels, under bridges, road culverts and stormwater drains often in abandoned, intact Fairy Martin nests. Roost sites are strongly associated with bodies of water where this species commonly feeds on aquatic insects, shrimp and small fish at the water surface, however, aerial foraging for other insects is also known(Churchill 2008). Breeding habitat likely to coincide with roosting habitat (Office of Environment and Heritage 2011).	Bionet	**High.** Potential foraging and roosting habitat within subject site, so may visit site on regular basis.
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or "colonies" each usually separated by hundreds of metres (NSW National Parks and Wildlife Service 2003).	EPBC	Low. No suitable habitat in the subject site.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	HABITAT	DATA SOURCE[3]	LIKELIHOOD OF OCCURRENCE
Phascolarctos cinereus	Koala (NSW, ACT & QLD - excluding SE QLD)	V	V	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum Eucalyptus tereticornis, Grey Gum E. punctata, Monkey Gum E. cypellocarpa and Ribbon Gum E. viminalis. In coastal areas, Tallowwood E. microcorys and Swamp Mahogany E. robusta are important food species, while in inland areas White Box E. albens, Bimble Box E. populnea and River Red Gum E. camaldulensis are favoured (NSW National Parks and Wildlife Service 1999, NSW National Parks and Wildlife Service 2003). Hawks Nest and Tea Gardens Population and population in the Pittwater LGA listed as Endangered under the NSW TSC Act.	EPBC	Low. No suitable habitat in the subject site.
Pseudomys novaehollandiae	New Holland Mouse	V		The New Holland Mouse is a small, burrowing native rodent. The species is similar in size and appearance to the introduced house mouse (Mus musculus), although it can be distinguished by its slightly larger ears and eyes, the absence of a notch on the upper incisors and the absence of a distinctive 'mousy' odour. Known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes (Threatened Species Scientific Committee 2010).	EPBC	Low. No suitable habitat in the subject site.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lily pillies. It roosts in the branches of large trees in forests or mangroves (NSW National Parks and Wildlife Service 2001, Churchill 2008)	Bionet, EPBC	**High.** Likely that local individuals visit the subject site regularly when site trees flower/fruit.
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb and Shine 1994, Webb and Shine 1998).	EPBC	Low. No suitable habitat in the subject site.

1. Listed as vulnerable (V), endangered (E), critically endangered (CE) under the EPBC Act.
2. Listed as an endangered population (E2), vulnerable (V), endangered (E1) or critically endangered (CE) under the BC Act.
3. EPBC Search = EPBC Act Protected Matters Search Tool Report, PlantNet = Royal Botanical Gardens, Sydney – 5 km buffer of subject site subject site, Bionet = Office of Environment and Heritage Bionet Atlas – 5 km buffer of subject site subject site

APPENDIX C

ASSESSMENTS OF SIGNIFICANCE

1 POWERFUL OWL

Status

The Powerful Owl (*Ninox strenua)* is listed as Vulnerable under to BC Act.

Habitat and ecology

The Powerful Owl is the largest owl in Australasia. It is a typical hawk-owl, with staring yellow eyes and no facial-disc (Garnett and Crowley 2000). It is a sedentary species with a home range of approximately 1000 hectares and occurs within open eucalypt, *Casuarina* or *Callitris* pine forest and woodland. It often roosts in denser vegetation including rainforest or exotic pine plantations. It generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling or arboreal dwelling which often require a shrub layer, these are important habitat components for owls. Often Powerful Owls are found in areas with more old trees and hollows than average stands (Garnett and Crowley 2000).

Threats

The OEH Threatened species profile (Office of Environment and Heritage 2015) lists the following threats to the species:

- Fragmentation and loss of suitable woodland habitat.
- Loss of hollow-bearing trees and changes in forest structure.
- Disturbance during the breeding period.
- High fire frequency.
- Road kills.
- Secondary poisoning
- Predation of fledglings by foxes, dogs and cats.

Specific impacts

Powerful Owl were not recorded in the subject site during field surveys informing this report. The Powerful Owl is however known to occur within the Botanic Gardens and Domain and potential, albeit minor, foraging habitat was identified in the subject site, comprising of horticultural plantings. The proposed development will necessitate the removal of 141 trees, majority of which have low ecological value and are previous horticultural plantings.

1.1 BC ACT SIGNIFICANCE ASSESSMENT

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

Powerful Owl was not recorded in the subject site during field surveys informing this report. A small amount of potentially suitable foraging habitat (141 horticultural planting trees) is likely to be affected by the project.

Due to their mobility, large home range and the small extent of habitat in the subject site, potential habitat occurring within the subject site would likely marginal habitat opportunities within the home range for individuals. Furthermore, essential microhabitat elements, such as diversity of hollow-bearing trees and complex ground layer, necessary for their prey was generally not abundant in the subject site. Locally occurring Powerful Owls are unlikely to be restricted to habitat within the construction area, as similar and higher quality habitat occurs widely in the locality. Potential foraging habitat within the subject site is considered of marginal quality and such habitat would at best represent a small component of locally occurring resources accessible to this species. Therefore it is not likely to constitute important habitat for local Powerful Owls. The action proposed is unlikely lead to an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

— **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

Not applicable.

— **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

— **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

The project is likely to affect a relatively small area of horticultural plantings that may provide marginal foraging habitat for this species.

— **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action**

Habitat connectivity is not likely to be affected by the project. The majority of the subject site occurs on previously disturbed or recreational areas. Vegetation removal will largely be limited to removal of semi-mature planted native trees. As the construction is largely confined to previously disturbed areas, the project would not further fragment or isolate any previously undisturbed patches of habitat. In addition, post construction landscape plantings will ensure similar habitat is maintained over the medium to long term. Furthermore, given these species' high mobility (some using home ranges up to 1500 ha) and that similar and likely more significant habitat occurs in the wider locality, it is not considered likely that habitat would become further isolated or fragmented significantly beyond that currently existing in the subject site and wider locality.

— **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality**

A small area of potential foraging habitat (141 horticulture planted trees) is likely to be affected by the project. Foraging opportunities will continue to exist and an abundance of similar and better quality foraging opportunities are found in wider locality. Owing to the small extent of potential foraging habitat to be affected and the high mobility of these species, the project is not likely to significantly affect their long-term survival.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Director General of the Office of Environment and Heritage. No critical habitat has been listed for large forest owls.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has been prepared for Large Forest Owls (Department of Environment and Conservation 2005), in which a number of recovery actions are listed (refer to Table 1). The plan covers the Powerful Owl. The overall objective of the NSW Large Forest Owl Recovery Plan is to ensure that large forest owls persist in the wild in NSW in each region where they presently occur.

Table 1: Recovery actions for Large Forest Owls

OBJECTIVE	RECOVERY ACTION	LIKELY TO BE AFFECTED BY PROJECT
Recovery action 1: To assess the Distribution and amount of high quality habitat for each owl species across public and private lands to get an estimate of the number and proportion of occupied territories of each species that are, and are not, protected.	Update and refine existing owl habitat models using the best available information.	No
	Map the amount of modelled habitat across forested land in NSW.	No
	Design a sampling strategy to test the modelled habitat for the presence of owls and locate identified sites.	No
	Field validation of modelled habitat for the presence of owls.	No
	Estimate the areal amount of mapped modelled habitat for each owl species that is occupied (based on the proportion of sample sites with owls in them) and use this estimate to further estimate the number of owl territories present within different land tenures (based on home range data).	No
Recovery action 2: To monitor trends in population parameters (numbers, Distribution, territory fidelity and breeding success) across the range of the three species and across different land tenures and disturbance histories.	Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.	No
	Seek cooperative involvement of other agencies, researchers and the community in the implementation of the regional monitoring program.	No
	Implement a regional monitoring program.	No
Recovery action 3: To assess the implementation and effectiveness of forest management prescriptions designed to mitigate the impact of timber-harvesting operations on the three owl species and, (if necessary), to use this information to refine the prescriptions so that forestry activities on state forests are not resulting in adverse changes in species abundance and breeding success.	Investigate the implementation by DPI (Forests NSW) of the forestry TSL owl prescriptions by carrying out proactive audits targeting these prescriptions (DEC) and through IFOA monitoring and reporting DPI (Forests NSW).	No
	Carry out post-harvest surveys in locations where owls were detected prior to logging to determine if they are continuing to occupy the habitat.	No
	Encourage student radio tracking projects examining the use of logged and unlogged forest by the three owl species.	No
	Make an assessment of the implementation and effectiveness of forestry owl prescriptions using data collected in this action.	No
	If necessary, refine the prescriptions and negotiate changes to the forestry TSLs.	No

OBJECTIVE	RECOVERY ACTION	LIKELY TO BE AFFECTED BY PROJECT
Recovery action 4: Ensure the impacts on large forest owls and their habitats are adequately assessed during planning and environmental assessment processes	Prepare environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess impacts of developments on the large forest owls.	No
	Monitor and report on the effectiveness of concurrence and licence conditions that have previously been applied to reduce the impacts of developments on the three large forest owl species or their habitats. This will involve keeping a record of such conditions, selecting case studies and then checking for the presence of owls at long intervals post development.	No
	Use this information to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the three large forest owls.	No
	Provide up to date and accurate large forest owl and habitat information in the 'PVP Developer Threatened Species Tool', ensuring that broad-scale clearing is only approved under the NV Act if 'improve or maintain' test is met.	No
	Facilitate the adequate consideration of large forest owls during biodiversity certification of environmental planning instruments.	No
	Provide up to date information and data for the Bio Banking assessment methodology	No
Recovery action 5: Minimise further loss and fragmentation of habitat by protection and informed management of significant owl habitat (including protection of individual nest sites)	Prepare guidelines addressing issues associated with habitat protection and management, and survey assessment. Guidelines would provide detailed information on identification of significant owl habitat, appropriate strategies for its protection and for habitat creation as part of revegetation programs.	No
	Encourage CMAs to invest in actions that actively manage and/o or conserve large forest owl habitat and promote owl conservation on private lands.	No
	Encourage private landholders to undertake management options to conserve and/ or actively manage large forest owl habitat (and particularly nest sites) through incentive property management plans, voluntary conservation agreements and management incentives.	No

OBJECTIVE	RECOVERY ACTION	LIKELY TO BE AFFECTED BY PROJECT
Recovery action 6: To improve the recovery and management of the three large forest owls based an improved understanding of key areas of their biology and ecology	Promote awareness and involvement of the research and management needs of the three large forest owls among scientific and academic community.	No
	Seek an Australian Research Council Linkage grant or other joint funding opportunity to initiate research into identified key areas of the biology and ecology of large forest owls.	No
	Seek scholarship funds for an aboriginal student to investigate the cultural and historic significance of the three species.	No
Recovery action 7: To raise awareness of the conservation requirements of the three large forest owls amongst the broader community, to involve the community in owl conservation efforts and in so doing increase the information base about owl habitats and biology.	Encourage and coordinate the involvement of community-based groups (e.g. the Australian Bird and Bat Study Association) and animal care groups (e.g. WIRES) in the implementation of recovery actions.	No
	Set up a website linked to the DEC internet site and targeted specifically at the community that will serve to provide information on owl identification (including photographs and samples of calls), habitat identification and protection, any current activities that they can be involved in as well as information on how and where to report sightings and other relevant information. Ensure this site has links to other key internet sites such as the Australasian Raptor Association.	No
Recovery action 8: To coordinate the implementation of the recovery plan and continually seek to integrate actions in this plan with actions in other recovery plans or conservation initiatives	Coordination of implementation of actions.	No
	Review of plan and rewrite in final year.	No
	Convene a threatened owl workshop with relevant experts and stakeholders to reassess the State conservation Status of the three large forest owls. This action will be undertaken upon Conclusion of the implementation of all of the above actions.	No

The project is not likely to significantly affect any of these recovery actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

With respect to threatened forest owls, the project does not consist of any key threatening processes under the BC Act, as all occurring vegetation within the subject site contains native horticultural plantings.

The extent of vegetation clearing and habitat removal associated with the project is considered small and will be replaced as part of proposed post construction landscaping. Although the project will represent the loss of marginal foraging habitat, this small area is a small component of locally occurring resources accessible to these species. In addition onsite native vegetation does not form part of any remnant native vegetation, as all identified vegetation is part of horticultural plantings.

Conclusion

Powerful Owls are threatened forest owls considered likely to occur within the subject site. While native plantings occur in the subject site, the young age class of onsite vegetation is generally unsuitable for arboreal mammals, which are the favoured prey of Powerful Owls. Whilst marginal foraging habitat exists in the subject site, it is considered unlikely to represent an important part of the foraging range of local individuals. An abundance of similar and potentially more significant habitat for this species occurs in the wider locality. The subject site does not contain any native remnant vegetation but consists of semi-mature native horticultural plantings that would provide only marginal foraging habitat and do not have large hollows to provide nesting habitat. Therefore, the project is considered to represent an incremental loss of marginal foraging habitat, which will be replaced in the medium to long term, and is unlikely to have a significant impact upon this species locally.

2 MICROCHIROPTERAN BATS

Microchiropteran bats fall into two broad groups based on their roosting requirements, cave-dwelling species and hollow-dwelling species. Each group will be dealt with separately within the following test of significance, due to their different roosting habitat preferences.

2.1 HOLLOW DEPENDANT MICROCHIROPTERAN BATS

Threatened hollow-dependent species of microchiropteran bat have been assessed together as they generally share similar habitat requirements, threats that affect their recovery, and potential impacts as result of the project. Hollow-dependent microchiropteran bats considered for this impact assessment are:

— Eastern Freetail-bat (*Micronomus norfolkensis* (syn. *Mormopterus norfolkensis*))

Table 2 Details of Threatened species of hollow-dwelling microchiropteran bat

HOLLOW-DWELLING MICROCHIROPTERAN BATS				
Common name (Scientific name)	**BC Act[1]**	**EPBC Act**	**Habitat and distribution**	**Threats**
East-coast Free-tail Bat *(Micronomus norfolkensis)*	V	-	Thought to live in Sclerophyll forest and woodland. Small colonies have been found in tree hollows or under loose bark. It feeds on insects above the forest canopy or in clearings at the forest edge (Churchill 2008).	Vulnerable to loss of tree hollows and loss of feeding grounds by forestry activities, clearing for agriculture and housing. Its population is suspected to have been reduced. It is an ecological specialist and depends on particular types of diet or habitat (Churchill 2008).

Key: 1: V = Vulnerable under the BC Act.

Specific Impacts

The project would remove 141 horticultural planted trees within the subject site. The removed native horticultural plantings are considered likely to provide foraging resources for local microchiropteran bats including the East-coast Free-tail Bat.

2.1.1 BC ACT SIGNIFICANCE ASSESSMENT

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The subject site contains predominantly horticultural plantings and managed exotic grasslands. Approximately 141 horticultural planted trees are to be removed, these trees provides foraging and minor potential roosting (decorticating bark) for microchiropteran bats, no hollow-bearing trees will be removed as part of the project.

Whilst 141 trees, which provide mainly foraging habitat will be removed as part of the project, an abundance of similar or high quality foraging opportunities occur in the wider locality.

While vegetation to be removed represents foraging opportunities for hollow-dwelling microchiropteran bats, due to the abundance of similar and higher quality habitat in the locality, it is considered unlikely that the removal of a relatively small amount of vegetation will significantly affect locally occurring microchiropteran bat populations.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

— **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

Not applicable.

— **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

— **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

Potential foraging habitat (141 horticultural planted trees) in the subject site represents only a small part of a much greater area of potential habitat accessible to locally occurring species. Vegetation to be removed is not considered to be of importance to these species, due to the abundance of retained habitat of similar or higher quality in the greater locality.

— **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action**

The subject site occurs in a highly disturbed area with no remnant native vegetation. The removal of vegetation is will not fragment or isolate other areas of habitat. In addition given the species high mobility, the project is unlikely to represent significant increases to habitat isolation and or fragmentation.

— **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality**

The subject site provides a relatively small amount of suitable foraging habitat for these species, and as a result a small amount of habitat will be affected. Foraging opportunities occurring in the subject site, will continue to exist with similar and higher quality foraging opportunities in the adjacent Botanic gardens and the Domain. The project would not impact habitat considered important to the long-term survival of populations in the locality and is unlikely to increase barriers to local movements for this species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Director General of Department of Environment, Climate Change and Water. No critical habitat has been listed for any microchiropteran bat to date. Furthermore, it is considered that only marginal quality habitat would be affected by the project, and as such, is not considered critical to the survival of these species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for any microchiropteran bat under the BC Act. The Office of Environment and Heritage has however; identified 25 priorities action statements within 11 recovery strategies to help recover these species (refer Table 3).

Table 3 Priorities action statements for microchiropteran bats

RECOVERY STRATEGY	PRIORITY ACTION	LIKELY TO BE AFFECTED BY THE PROJECT
Recovery strategy 1: Community and land-holder liaison/ awareness and/or education	Promote bats throughout the rural community as ecologically interesting and important, but sensitive to disturbance at caves/disused mine tunnels.	No
Recovery strategy 2: Data recording and storage	Compile register of all known roost sites in natural and artificial structures including current and historical data and identify significance of roost, e.g. maternity, hibernation, transient roost.	No
Recovery strategy 3: Habitat management: Feral control	Control foxes and feral cats around roosting sites, particularly maternity caves and hibernation sites.	No
	Control goats around roosting sites, particularly maternity caves and hibernation sites.	No

RECOVERY STRATEGY	PRIORITY ACTION	LIKELY TO BE AFFECTED BY THE PROJECT
Recovery strategy 4: Habitat management: Fire	Exclude prescription burns from 100 m from cave entrance; ensure smoke/flames of fires do not enter caves/roosts in artificial structures.	No
	Prepare fire management plans for significant roost caves, disused mines, culverts, especially maternity and winter roosts.	No
Recovery strategy 5: Habitat management: Other	Prepare management plans for significant bat roosts especially all known maternity colonies and winter colonies.	No
Recovery strategy 6: Habitat management: Site protection (e.g. fencing/signage)	Protect significant roosts and forest habitat within 10 km of roosts in PVP assessments (offsets should include nearby remnants in high productivity) and other environmental planning instruments.	No
	Identify and protect significant roost habitat in artificial structures (e.g. culverts, old buildings and derelict mines).	No
	Restrict access where possible to known maternity sites (e.g. signs).	No
	Restrict caving activity during critical times of year in important roosts used by species, particularly maternity and hibernation roosts.	No
	Search for significant roost sites and restrict access where possible e.g. gateing of caves). Significant includes maternity, hibernation and transient sites including in artificial structures.	No
Recovery strategy 7: Habitat management: Weed control	Undertake non-chemical removal of weeds (e.g. lantana, blackberry) to prevent obstruction of cave entrances.	No
Recovery strategy 8: Habitat protection (inc critical habitat nomination etc.)	Promote the conservation of these significant roost areas using measures such as incentive funding to landholders, offsetting and BioBanking, acquisition for reserve establishment or other means.	No
Recovery strategy 9: Monitoring	Monitor the breeding success of maternity colonies in cave roosts over a number of years to determine the viability of regional populations.	No
	For roost caves vulnerable to human disturbance, monitor their visitation by people, particularly during winter and spring/summer maternity season and in school holidays.	No
Recovery strategy 10: Research	Identify types of winter roosts used by species. Winter roosts suspected to be banana palms and tree hollows.	No
	Determine the effectiveness of PVP assessment, offsets and actions for bats.	No
	Establish a gateing design for disused mines across species range that will not adversely impact species.	No
	Identify important foraging range and key habitat components around significant roosts.	No
	Identify the susceptibility of the species to pesticides.	No

RECOVERY STRATEGY	PRIORITY ACTION	LIKELY TO BE AFFECTED BY THE PROJECT
	Measure genetic population structure among cave roosts of maternity colonies to estimate dispersal and genetic isolation, and vulnerability to regional population extinction.	No
	Study the ecological requirements of maternity colonies and their environs and migratory patterns.	No
	Study the effect of different burning regimes on cave disturbance and surrounding foraging habitat.	No
Recovery strategy 11: Survey/mapping and habitat assessment	Undertake a regular census of maternity colonies (e.g. Willi Willi) and other key roosts in network, especially where there are population estimates from banding in the 1960s.	No

Note: priorities action statements taken from Little Bent-wing Bat threatened species profile (Busnel and Fletcher 1978).

The project is not likely to significantly adversely affect any of these recovery actions with the possible except of vegetation removal around possible marginal (non-breeding) roost sites (i.e. small fissures or decorticating bark in trees). This impact is unlikely to significantly affect the recovery of any local population of the species.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

With respect to hollow-dwelling microchiropteran bats, the project is not consistent with any key threatening processes under the BC Act, as the onsite vegetation is part of past horticultural plants and will be replaced in the medium to long-term – no native remnant vegetation exists within the subject site.

The extent of vegetation clearing and habitat removal associated with the project is considered relatively small. Although the project will represent the loss of potential foraging, such habitat would only be a small component of locally occurring resources accessible to these species.

Conclusion

Whilst a small area of potential foraging habitat for hollow-dwelling microchiropteran bats may be impacted by the project (141 native planted horticultural trees), microhabitat foraging opportunities that occur in the subject site will continue to exist and an abundance of similar and higher quality foraging habitat will remain available in the Botanic gardens, Domain and the wider locality. The project is not likely to further fragment or isolate potential habitat for this species. Therefore, the proposed development is not likely to have a significant adverse effect on this species.

2.2 CAVE-DEPENDENT MICROCHIROPTERAN BATS

The following cave-dwelling microchiropteran bats were considered to be limited to foraging potential only within the subject site, due to the lack of suitable cave roosting opportunities:

— Little Bent-wing Bat (*Miniopterus australis*)

— Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)

These species have been assessed as a guild because of their similarity in habitat usage and habits, which are described in Table .

Table 4 Details of Threatened species of cave-dwelling microchiropteran bat

COMMON NAME (SCIENTIFIC NAME)	BC ACT	EPBC ACT	DISTRIBUTION AND ECOLOGY	THREATS (OFFICE OF ENVIRONMENT AND HERITAGE 2015B)
Little Bent-wing Bat (*Miniopterus australis*)	V	-	Feeds on small insects beneath the canopy of well-timbered habitats including rainforest, Melaleuca swamps and dry Sclerophyll forests. Roosts in caves and tunnels and has specific requirements for nursery sites. Distribution becomes coastal towards the southern limit of its range in NSW. Nesting sites are in areas where limestone mining is preferred (Strahan 1995).	— Disturbance of colonies, especially in nursery or hibernating caves, may be catastrophic. — Destruction of caves that provide seasonal or potential roosting sites. — Changes to habitat, especially surrounding maternity/nursery caves and winter roosts. — Pesticides on insects and in water consumed by bats bio accumulates, resulting in poisoning of individuals. — Predation from foxes, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges. — Predation from feral cats, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges — Introduction of exotic pathogens such as the White-nosed fungus. — Hazard reduction and wildfire fires during the breeding season. — Large scale wildfire or hazard reduction can impact on foraging resources. — Poor knowledge of reproductive success and population dynamics.
Eastern Bent-wing Bat *(Miniopterus schreibersii oceanensis)*	V		Distributed across the east coast of Australia, rests in caves, old mines, stormwater channels and comparable structures including occasional buildings (Dwyer 1998). Typically found in well-timbered valleys where it forages, above tree canopy on small insects (Churchill 2008).	— Disturbance by recreational cavers and general public accessing caves and adjacent areas particularly during winter or breeding. — Loss of high productivity foraging habitat. — Introduction of exotic pathogens, particularly white-nose fungus. — Cave entrances being blocked for human health and safety reasons, or vegetation (particularly blackberries) encroaching on and blocking cave entrances. — Hazard reduction and wildfire fires during the breeding season.

Key: 1: V = Vulnerable under the BC Act.

Specific Impacts

The subject site does not contain roosting habitat (culverts/bridges) for cave-dwelling microchiropteran bats, although it provides suitable foraging habitat in the form of native horticultural vegetation community. The project will remove 141 native planted horticultural trees, which represents foraging habitat for cave-dwelling bats. The Little Bent-wing Bat and Eastern Bent-wing Bat have previously been recorded in proximity to the study site.

2.2.1 BC ACT SIGNIFICANCE ASSESSMENT

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

There is no roosting opportunity within the study site for cave-dwelling microchiropteran bat species.

There are foraging opportunities for these species associated with the canopies of native horticultural vegetation, throughout the subject site and in the wider locality. Only a relatively small area of foraging habitat would be affected by the project (141 native planted horticultural trees). These species often prefer to forage along the ecotonal edges between open and wooded habitats and these types of foraging opportunities will continue to exist throughout the subject site.

Therefore, the project is unlikely to cause significantly adverse effects upon cave-dwelling microchiropteran bat species, due to the relatively small area of vegetation removal, which contained no cave-roosting microhabitat elements. Further, foraging areas will remain within and adjacent to the subject site post project construction and replacement plantings will provide foraging habitat in the medium to long-term. Given this, the action proposed is unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

— **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

Not applicable.

— **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

— **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

Potential foraging habitat for cave-dwelling microchiropteran bat species was recorded within the subject site during field surveys, in the form of canopies associated with native planted horticultural trees. A small area of foraging habitat is likely to be affected by the project (141 native planted horticultural trees). Potential foraging habitat within the subject site likely represents only a small part of a greater home range for local species in the locality.

— **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action**

While the subject site occurs in predominantly disturbed land, proposed vegetation removal will consist of horticultural plantings (141 trees), as no remnant native vegetation occurs onsite. As the project will remove a relatively small amount of foraging habitat in a locality that provides an abundance of similar or greater quality habitat, which is easily accessed due to the species high mobility, the project is unlikely to represent significant increases to habitat isolation and or fragmentation.

— **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality**

The subject site provided a relatively small amount of potential foraging habitat for these species. Foraging opportunities occurring within the subject site will continue to exist and similar and higher quality foraging opportunities will remain available within the Botanic Gardens, Domain and the wider locality. The project would not impact habitat considered important to the long-term survival of populations in the locality and is unlikely to further create a barrier to movement for these species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Director General of Department of Environment and Heritage. No critical habitat has been listed for any microchiropteran bat to date.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Not all cave-dwelling microchiropteran bats under the BC Act have approved recovery plan or threat abatement approved. However, the Office of Environment and Heritage has identified 25 priorities action statements within 11 recovery strategies to help recover these species (refer Table).

Table 5 Priorities action statements for microchiropteran bat

RECOVERY STRATEGY	PRIORITY ACTION	LIKELY TO BE AFFECTED BY THE PROJECT
Recovery strategy 1: Community and land-holder liaison/ awareness and/or education	Promote bats throughout the rural community as ecologically interesting and important, but sensitive to disturbance at caves/disused mine tunnels.	No
Recovery strategy 2: Data recording and storage	Compile register of all known roost sites in natural and artificial structures including current and historical data and identify significance of roost, e.g. maternity, hibernation, transient roost.	No
Recovery strategy 3: Habitat management: Feral control	Control foxes and feral cats around roosting sites, particularly maternity caves and hibernation sites.	No
	Control goats around roosting sites, particularly maternity caves and hibernation sites.	No
Recovery strategy 4: Habitat management: Fire	Exclude prescription burns from 100 m from cave entrance; ensure smoke/flames of fires do not enter caves/roosts in artificial structures.	No
	Prepare fire management plans for significant roost caves, disused mines, culverts, especially maternity and winter roosts.	No
Recovery strategy 5: Habitat management: Other	Prepare management plans for significant bat roosts especially all known maternity colonies and winter colonies.	No
Recovery strategy 6: Habitat management: Site protection (e.g. fencing/signage)	Protect significant roosts and forest habitat within 10 km of roosts in PVP assessments (offsets should include nearby remnants in high productivity) and other environmental planning instruments.	No
	Identify and protect significant roost habitat in artificial structures (e.g. culverts, old buildings and derelict mines).	No
	Restrict access where possible to known maternity sites. (e.g. signs).	No
	Restrict caving activity during critical times of year in important roosts used by species, particularly maternity and hibernation roosts.	No

RECOVERY STRATEGY	PRIORITY ACTION	LIKELY TO BE AFFECTED BY THE PROJECT
	Search for significant roost sites and restrict access where possible (e.g. gateing of caves). Significant includes maternity, hibernation and transient sites including in artificial structures.	No
Recovery strategy 7: Habitat management: Weed control	Undertake non-chemical removal of weeds (e.g. lantana, blackberry) to prevent obstruction of cave entrances.	No
Recovery strategy 8: Habitat protection (inc critical habitat nomination etc.)	Promote the conservation of these significant roost areas using measures such as incentive funding to landholders, offsetting and BioBanking, acquisition for reserve establishment or other means.	No
Recovery strategy 9: Monitoring	Monitor the breeding success of maternity colonies in cave roosts over a number of years to determine the viability of regional populations.	No
	For roost caves vulnerable to human disturbance, monitor their visitation by people, particularly during winter and spring/summer maternity season and in school holidays.	
Recovery strategy 10: Research	Identify types of winter roosts used by species. Winter roosts suspected to be banana palms and tree hollows.	No
	Determine the effectiveness of PVP assessment, offsets and actions for bats.	No
	Establish a gateing design for disused mines across species range that will not adversely impact species.	No
	Identify important foraging range and key habitat components around significant roosts.	No
	Identify the susceptibility of the species to pesticides.	No
	Measure genetic population structure among cave roosts of maternity colonies to estimate dispersal and genetic isolation, and vulnerability to regional population extinction.	No
	Study the ecological requirements of maternity colonies and their environs and migratory patterns.	No
	Study the effect of different burning regimes on cave disturbance and surrounding foraging habitat.	No
Recovery strategy 11: Survey/mapping and Habitat assessment	Undertake a regular census of maternity colonies (e.g. Willi Willi) and other key roosts in network, especially where there are population estimates from banding in the 1960s.	No

Note: priorities action statements taken from Little Bent-wing Bat threatened species profile (Department of Environment and Climate Change 2005).

The project is not likely to adversely affect any of these recovery actions, as the subject site does not provide vital foraging or roosting habitat for any of the mentioned species.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

With respect to cave-dwelling microchiropteran bats, the project is not consistent with any key threatening processes under the BC Act, as onsite native vegetation is part of past horticultural plants – no native remnant vegetation exists within the subject site.

The extent of native vegetation clearing and habitat removal associated with the project is considered relatively small (141 native planted horticultural trees). Although the project will represent an incremental loss of potential foraging, such habitat would only be a small component of an abundance of locally occurring resources accessible to these species.

Conclusion

While the subject site provides potential foraging resources for cave-dwelling microbat species the majority of the subject site has been previously disturbed and fragmented for recreational and urban development activities. Vegetation clearance will be small in size, with 141 native planted horticultural trees likely to be affected.

Microhabitat foraging opportunities, such as ecotonal edges, that occur within the subject site will continue to exist and an abundance of similar quality foraging habitat will be retained within the subject site and in the wider locality.

The proposed development will be generally restricted to existing disturbed areas and vegetation removal will be a relatively small extent. The project is not likely to further fragment or isolate potential habitat for these species and project landscape plantings will offset short-term vegetation losses in the medium to long-term. Therefore, the project is not likely to have a significant adverse effect on these species.

3 GREY-HEADED FLYING-FOX

Status

The Grey-headed Flying-fox is listed as Vulnerable under both the BC Act and EPBC Act.

Distribution

The Grey-headed Flying is endemic to Australia and presently occurs along the east coast from Maryborough in Queensland to Melbourne, Victoria (Department of the Environment and Heritage 2003). This species is also occasionally found west of the Great Dividing Range to the western slopes of NSW and QLD. At any one time, the majority of animals only occupy a small proportion of this entire range (NSW National Parks and Wildlife Service 2001b).

Habitat

The Grey-headed Flying-fox utilises subtropical and temperate rainforests, tall sclerophyll forests, woodlands, heaths, swamps and mangroves, as well as urban gardens and fruit crops for foraging (Churchill 2008; NSW National Parks and Wildlife Service 2001b).

Ecology

This species is considered an important pollinator and seed disperser of native trees, as they forage on the nectar and pollen of eucalypts, angophoras, melaleucas and banksias, as well as fruit of rainforest trees and vines (NSW National Parks and Wildlife Service 2001b; Van Dyck & Strahan 2008). While the majority of foraging events occur within 20 km of their day roost, some individuals will disperse and commute up to 50 km (Van Dyck & Strahan 2008).

Grey-headed Flying-foxes are highly mobile and as the availability of native fruits, nectar and pollen varies over time and throughout their range, they respond to this by migrating between camps up and down the east coast, sometimes travelling hundreds of kilometres (NSW National Parks and Wildlife Service 2001b). When migration occurs they do not move as a colony, but as individuals or small groups resulting in the intermixing of sub-populations (Churchill 2008). The population concentrates in May and June in northern NSW and Queensland where animals exploit winter-flowering trees such as Swamp Mahogany, Forest Red Gum and Paperbark, dispersing south during the summer (Department of the Environment and Heritage 2003).

Grey-headed Flying-fox roost in large colonies of up to tens of thousands and may be shared with Little Red Flying-fox and Black Flying-fox(Churchill 2008). Camps are generally located in gullies with dense vegetation (such as mangrove, rainforest, Melaleuca and Casuarina), close to water and generally located within 20 km of a regular food source (NSW National Parks and Wildlife Service 2001b). Site fidelity to camps is high with some camps in NSW used for over a century (NSW National Parks and Wildlife Service 2001b).These bats usually return annually to particular camps for rearing young (NSW National Parks and Wildlife Service 2001b).

Threats

Threats to Grey-headed Flying-fox include:

— loss of foraging habitat

— disturbance of roosting sites

— unregulated shooting

— electrocution on powerlines.

Specific impacts

The subject site provides suitable foraging habitat in the form of native horticultural plantings. Approximately 141 native planted horticultural trees, representing foraging habitat will be removed as part of the project, however this represents only a small component of locally occurring resources that are accessible to this species in the adjacent Botanical Gardens, the Domain and wider locality.

3.1 BC ACT SIGNIFICANCE ASSESSMENT

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The majority of the subject site contains planted horticultural native vegetation, with majority of native tree species are of a semi-mature age class. Due to the relatively small amount of Grey-headed Flying-fox foraging habitat to be removed from within the subject site and the abundance of similar and greater quality habitat elsewhere in the locality, the action proposed is unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

— **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

Not applicable.

— **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

— **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

A relatively small patch of horticultural plantings (141 native planted horticultural trees) representing a small amount of foraging habitat would be affected by the project. However, the Grey-headed Flying-fox would not be restricted to habitat resources within the study site as this species is likely to use similar habitat resources within the adjacent Botanical Gardens, the Domain and wider locality.

— **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action**

Habitat connectivity is not likely to be affected by the project. The majority of the study site occurs on previously disturbed land and is dominated by horticultural plantings and exotic grasslands. Given that the Grey-headed Flying-fox is highly mobile, regularly foraging up to 50 km from camp sites, and that similar or greater quality foraging resources occur widely in the locality, it is considered unlikely that habitat would become further isolated or fragmented significantly beyond that currently existing within the subject site.

— **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality**

While potential foraging habitat was observed in the study site, no camps were recorded therein, however, a camp does occur in Centennial Park (3km) in close proximity to the subject site. Grey-headed Flying-foxes regularly forage up to 50 km from roost sites (NSW National Parks and Wildlife Service 2001b). An abundance of similar or greater quality habitat is available in the adjacent Botanical Gardens, the Domain and in the wider locality. Therefore the removal of a relatively small amount of suitable foraging habitat (141 native planted horticultural trees), in the short-term, is not considered likely to significantly affect the availability of quality habitat for this species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Director General of Department of Environment, Climate Change and Water. No critical habitat has been listed for Grey-headed Flying-fox.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for Grey-headed Flying-fox under the BC Act. The department of Environment, Climate Change and Water has however; identified 31 priority actions in 10 recovery strategies to help recover these species (refer Table 6).

Table 6 Recovery actions for Grey-headed Flying-fox

RECOVERY ACTION	PRIORITY ACTION	LIKELY TO BE AFFECTED BY THE PROJECT
Recovery Strategy 1: Community and land-holder liaison/ awareness and/or education	Provide educational resources to improve public attitudes toward Grey-headed Flying-foxes.	No
	Develop materials for public education & provide them to land managers & local community groups working with controversial flying-fox camps, highlighting species Status, reasons for being in urban areas, reasons for decline etc.	No
	Monitor public attitudes towards flying-foxes.	No
	Review & evaluate camp site management activities, summarising outcomes of past experiences at controversial camps. Noise impacts on neighbours of camps to be considered. For use in managing future conflicts with humans at flying-fox camps.	No
	Conduct periodic range-wide assessments of the population size of Grey-headed Flying-foxes to monitor population trends.	No
Recovery Strategy 2: Coordinate the recovery and/or threat abatement program	Grey-headed Flying-fox National Recovery Team to undertake an annual review of the national recovery plan's implementation.	No
Recovery Strategy 3: Habitat management: Other	Enhance and sustain the vegetation of camps critical to the survival of Grey-headed Flying-foxes.	No
Recovery Strategy 4: Habitat Protection (inc vca/jma/ critical habitat nomination etc.)	Protect and enhance priority foraging habitat for Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.	No
	Protect roosting habitat critical to the survival of Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.	No
Recovery Strategy 5: Habitat Rehabilitation/Restoration and/or Regeneration	Increase the extent and viability of foraging habitat for Grey-headed Flying-foxes that is productive during winter and spring (generally times of food shortage), including habitat restoration/rehabilitation works.	No
Recovery Strategy 6: Monitoring	Develop and implement a grower-based program to monitor trends in damage to commercial fruit crops by flying-foxes, and use the results to monitor the performance of actions to reduce crop damage.	No

RECOVERY ACTION	PRIORITY ACTION	LIKELY TO BE AFFECTED BY THE PROJECT
	Systematically document the levels of flying-fox damage to the horticulture industry within the range of the Grey-headed Flying-fox.	No
Recovery Strategy 7: Other Action	Develop guidelines to assist land managers dealing with controversial flying-fox camps.	No
Recovery Strategy 8: Recovery Plan Preparation: Single species	Complete national recovery plan in 2007.	No
Recovery Strategy 9: Research	Develop and promote incentives to reduce killing of flying-foxes in commercial fruit crops.	No
	Develop methods for rapid estimates of flying-fox damage on commercial crops, allowing the long-term monitoring of industry-wide levels and patterns of flying-fox damage.	No
	Review and improve methods used to assess population size of Grey-headed Flying-foxes.	No
	Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts.	No
	Describe the species, age structure & demographics of flying-foxes killed in fruit crops to improve the understanding of the impact by assessing trends in the species, sex, age & reproductive Status of animals killed on crops.	No
	Determine characteristics of roosting habitat for Grey-headed Flying-foxes, exploring the roles of floristic composition, vegetation structure, microclimate and landscape features, and assess the Status of camps.	No
	Investigate the age structure and longevity of Grey-headed Flying-foxes.	No
	Assess the impacts Grey-headed Flying-fox camps have on water quality, and publish results in a peer-reviewed journal.	No
	Develop methods to monitor landscape scale nectar availability trends, to explain/potentially predict crop damage trends where crop protection is absent, & promote importance of foraging habitat productive in seasons critical to the horticulture industry.	No
	Investigate between-year fidelity of Grey-headed Flying-fox individuals to seasonal camps.	No
	Investigate the differences in genetic relatedness, sex, age etc. between sedentary and transient Grey-headed Flying-foxes.	No

RECOVERY ACTION	PRIORITY ACTION	LIKELY TO BE AFFECTED BY THE PROJECT
	Investigate the genetic structure within Grey-headed Flying-fox camps, including levels of relatedness within and between members of adult groups, occupants of individual trees etc.	No
	Investigate the patterns of juvenile Grey-headed Flying-fox dispersal and mortality, allowing identification of the specific habitat requirements of juveniles.	No
Recovery Strategy 10: Survey/Mapping and Habitat assessment	Identify the commercial fruit industries that are impacted by Grey-headed Flying-foxes, to provide an information base for use by the various stakeholders.	No
	Set priorities for protecting foraging habitat critical to the survival of Grey-headed Flying-foxes and generate maps of priority foraging habitat.	No
	Establish & maintain a range-wide database of Grey-headed Flying-fox camps, including information on location, tenure, zoning & history of use, for Distribution to land management/planning authorities, researchers & interested public.	No
	Improve knowledge of Grey-headed Flying-fox camp locations, targeting regional areas and seasons where information is notably incomplete, such as inland areas during spring and summer.	No

The project is not likely to adversely affect any of these recovery actions, as the subject site does not provide vital foraging or roosting habitat for Grey-headed Flying-fox.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project is unlikely to result in the operation or increase any NSW listed key threatening process.

Conclusion

The project will remove an area of horticultural plantings that do not represent remnant native vegetation, and will be replaced by project landscape plantings in the medium to long-term. As an abundance of similar and higher quality habitat occurs nearby and in the wider locality, the action proposed is unlikely to lead to a significant impact on the Grey Grey-headed Flying-fox or its habitat.

3.2 EPBC ACT SIGNIFICANCE ASSESSMENT

The Grey-headed Flying-fox is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of Environment 2013). Under the Act, important populations are:

- likely to be key source populations either for breeding or dispersal
- likely to be necessary for maintaining genetic diversity, and/or
- at or near the limit of the species range.

Is this part of an important population?

Grey-headed Flying-foxes occur across a range of wooded habitats where their favoured food, eucalypt blossom occurs. They set up roosting camps in association with blossom and fruiting availability, which are usually situated in dense vegetation and associated with water. Grey-headed Flying-foxes can migrate up to 75 km north during the winter and during this time young flying-foxes establish camps.

The study site does not contain suitable habitat for roosting camps and such habitat does not occur within its close vicinity, however a roost camp does occur in Centennial Park (3km). Therefore, a population of Grey-headed Flying-fox in the study site is not considered to be important, as no roost sites would be affected by the project.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will result in one or more of the following:

Lead to a long-term decrease in the size of an important population of a species

Not applicable. Grey-headed Flying-fox in the subject site is not part of an important population (refer to above) and onsite habitats are not considered important for the maintenance of local flying-foxes.

Reduce the area of occupancy of an important population of the species

Not applicable. Grey-headed Flying-fox in the subject site is not part of an important population (refer to above) and onsite habitats are not considered important for the maintenance of local flying-foxes.

Fragment an existing important population into two or more populations

Not applicable. Grey-headed Flying-fox in the subject site is not part of an important population (refer to above) and the removal of onsite habitat will not represent barriers to local flying-fox movements.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act.

Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long-term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community (Department of Environment 2013).

The project will not adversely affect habitat considered critical to this species.

Disrupt the breeding cycle of an important population

Not applicable. Grey-headed Flying-fox in the subject site is not part of an important population (refer to above) and onsite habitats are not considered important for the breeding cycle of local flying-foxes.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

No. The project would only affect a small area of suitable foraging habitat for this species (141 native planted horticultural trees). As this species is known to forage up to 50 km from roost sites, the project is not likely to significantly affect the availability of quality habitat for this species to the extent that the species is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species´ habitat

It is unlikely that invasive species (such as introduced predators) that are harmful to the Grey-headed Flying-fox would become further established as a result of the project.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the project.

Interfere with the recovery of the species

Due to the limited foraging habitat likely to be affect by the project (141 native planted horticultural trees) and as no roost camps are located in the close vicinity of the subject site, the project is not likely to interfere with the recovery of this species.

Conclusion

While the proposed action will removal of 141 planted trees, their loss is considered unlikely to have a significant impact on the Grey-headed Flying-fox, due to the abundance of similar and higher quality habitat locally and the offset of vegetation in the medium to long-term by project landscape plantings.

ABOUT US

WSP is one of the world's leading engineering professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors, environmental specialists, as well as other design, program and construction management professionals. We design lasting Property & Buildings, Transportation & Infrastructure, Resources (including Mining and Industry), Water, Power and Environmental solutions, as well as provide project delivery and strategic consulting services. With 36,000 talented people in more than 500 offices across 40 countries, we engineer projects that will help societies grow for lifetimes to come.