

Biodiversity Assessment Report in support of Request for Planning Proposal

**251, 260R, 278, and 280-282 Captain Cook Drive,
Kurnell**

Urbis Pty Ltd on behalf of Besmaw Pty Ltd

13 December 2023

Final



Report No. 17213RP4

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or commendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology.

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Glossary

Term Abbreviation	Definition
APZ	Asset Protection Zone
BAM	Biodiversity Assessment Method 2020
BAR	Biodiversity Assessment Report
BC Act	NSW Biodiversity Conservation Act 2016
BC Regulation	NSW Biodiversity Conservation Regulation 2017
BCD	Biodiversity Conservation Division
BDAR	Biodiversity Development Assessment Report
BMP	Biodiversity Management Plan
BOS	Biodiversity Offset Scheme
CEMP	Construction Environmental Management Plan
Council	Sutherland Shire Council
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DPE	NSW Department of Planning and Environment (formerly DPIE)
DPIE	NSW Department of Primary Industries
DPIE	NSW Department of Planning, Industry and Environment (now DPE)
ECMS	Ecological and Cultural Management Strategy prepared for the site by Besmaw
EEC	Endangered Ecological Community
EHG	Environment and Heritage Group, a division of the NSW Department of Planning and Environment
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
GGBF	Green and Golden Bell Frog
GIS	Geographic Information System
GPS	Global Positioning System
ha	Hectares
KPI	Key Performance Indicator
Kurnell Peninsula	The subject land and land that surrounds the subject land, with potential to be directly or indirectly impacted by the Project (See Figure 1)
LGA	Local Government Area
NPW Act	National Parks and Wildlife Act 1974
NPWS	National Parks and Wildlife Service
NSW	New South Wales
m	metres

m²	Square metres
MNES	Matters of National Environmental Significance
OEH	the former NSW Office of Environment and Heritage
PCT	Plant Community Type
Project	Planning Proposal (See Figure 9)
Resilience and Hazards SEPP	State Environmental Planning Policy (Resilience and Hazards) 2021
ROW	Right of Way
SEPP	State Environmental Planning Policy
SEPP Precincts	State Environmental Planning Policy (Precincts—Central River City) 2021
SSLEP	Sutherland Shire Local Environment Plan 2015
STVM	State Type Vegetation Mapping
Subject land	The land subject of the SEPP Kurnell amendment (see Figure 1)
TEC	Threatened Ecological Community
VENM	Virgin Excavated Natural Material
WSUD	Water Sensitive Urban Design

1. Introduction

1.1. Purpose

Cumberland Ecology Pty Ltd (Cumberland Ecology) has been commissioned by Urbis Pty Ltd (Urbis) on behalf of Besmaw Pty Ltd (Besmaw) to prepare a Biodiversity Assessment Report (BAR) of land within the Sutherland Shire Local Government Area (LGA) (hereafter referred to as the 'subject land') (**Figures 1-3**). The subject land is located at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell and is owned by Besmaw. The subject land and the surrounding environments that could be indirectly impacted by development of the subject land are collectively defined as the Kurnell Peninsula.

The BAR has been prepared by Cumberland Ecology to accompany a proponent-initiated Planning Proposal (the Planning Proposal) in support of a proposed amendment to *State Environmental Planning Policy (Precincts—Central River City) 2021* (SEPP Precincts) and *Sutherland Shire Local Environmental Plan 2015* (SSLEP 2015).

The Planning Proposal aims to translate and amend current land use zones to be consistent with the standard instrument local environmental plan (LEP) zones and enable additional uses to accommodate a diverse range of land uses at the subject land. The Planning Proposal will establish a new mixed-use community encompassing residential, employment, tourism, education, cultural facilities, ecological regenerative zones and public open space areas.

The objectives of the BAR are to:

- Describe the vegetation communities and fauna habitat characteristics of the subject land;
- Identify any threatened species, populations or ecological communities existing on the subject land (as listed under the schedules of the New South Wales (NSW) *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Assess the likelihood of occurrence of threatened species, populations or ecological communities in the Kurnell Peninsula;
- Assess the potential direct and indirect impacts of future development on threatened flora and fauna, and terrestrial, aquatic, and groundwater communities;
- Recommend avoidance, minimisation, and mitigation measures to reduce the potential impacts on flora, fauna and aquatic community values; and
- Ensure delivery of conservation outcomes in the long term and ultimately an overall improvement or maintenance of biodiversity values of the Kurnell Peninsula.

This report was prepared with reference to requirements provided by State Government Agencies and Sutherland Shire Council (Council). The agencies included Department of Planning and Environment (DPE), Environment and Heritage Group (EHG) & Biodiversity Conservation Division (BCD), Fisheries and National Parks and Wildlife Service (NPWS).

The tables in **Appendix A** reproduce Council and agency requirements related to biodiversity and indicate how they are dealt with in this report.

1.2. Background

In March 2023 the proponent submitted a Scoping Proposal to Council to commence the formal Planning Proposal process, in accordance with the LEP Making Guidelines 2022. The Scoping Proposal provided a comprehensive ‘status update,’ outlining the concept master plan, the intended development outcome, the proposed planning controls and the environmental considerations which were to be further resolved.

As part of the Scoping Proposal process, Council referred the Scoping Proposal package to DPE, State agencies, and several internal Council teams for review and comment. The advice received from these stakeholders has provided clear directives on the necessary updates and key focus areas within the technical documentation accompanying the Planning Proposal.

Separate to the Scoping Proposal package, extensive and ongoing engagement with relevant State agencies has occurred since November 2022, with the objective of clarifying and resolving any of the outstanding considerations.

1.2.1. Location

The subject land has a total area of 210.5 ha and comprises lots fronting Captain Cook Drive on the Kurnell Peninsula within the Sutherland Shire LGA. The land to which the Planning Proposal relates (the subject land) comprises 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell. The key features of the subject land are summarised in **Table 1** and shown within **Photographs 1-4**.

Table 1 Site description

Feature	Lot 2 North	Lot 2 South	Lot 8	Lot 9
Street Address	251 Captain Cook Drive	280-282 Captain Cook Drive	278 Captain Cook Drive	260R Captain Cook Drive Kurnell
Legal Description	Lot 2 in DP1030269	Lot 2 in DP559922	Lot 8 in DP586986	Lot 9 DP 586986
Site Area	16 ha	160 ha	34.5 ha	82 m ²
	Total Area: Approximately 210.5 hectares			
Local Government Area	Sutherland Shire			

Lot 2 North has an area of 16 ha and is bound by Quibray Bay to the north and north-east, Towra Point Nature Reserve to the west, and Captain Cook Drive to the south. Lot 2 North contains a small area of Coastal Wetlands identified in Chapter 2 (Coastal Management) of the State Environmental Planning Policy (Resilience and Hazards) 2021 (hereafter referred to as the Resilience and Hazards SEPP). The remainder of the lot does not contain any areas of significant vegetation.

Lot 2 South has an area of approximately 160 hectares (ha) and is bound by Captain Cook Drive to the north, industrial zoned land to the northeast (including the Sydney Water Desalination Plant), Kurnell Village and the Ampol fuel terminal, Kamay Botany Bay National Park to the east, Bate Bay to the south, and Wanda Reserve

to the west. Lot 2 South is used for sand quarrying for the Sydney construction market as well as for management of dunes and vegetation. A collection of dwellings to the north of Boat Harbour, known as the “Boat Harbour Cabins”, are used for permanent and vacation accommodation.

Photograph 1 Looking north across Lot 2 South, towards Quibray Bay with Boat Harbour in the foreground.



Photograph 2 Looking towards Bate Bay over Lot 2 South and Lot 8 (left).



Photograph 3 Bate Bay looking south west, illustrating the revegetated dune in Lot 2 South.



Photograph 4 Looking north to Quibray Bay over Lot 2 North and Captain Cook Drive in the foreground.



1.2.2. Proposed Project

The Planning Proposal aims to translate and amend current land uses zones under the applicable controls to be consistent with the standard instrument zones and enable additional uses at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell (the subject land). The Planning Proposal will establish a new mixed-use community at Bidhiinja Beach, encompassing residential, employment, tourism, education, cultural facilities, ecological regenerative zones and public open space areas.

The Planning Proposal is supported by a Master Plan (Group GSA 2023a) and a Landscape and Open Space Strategy (Group GSA 2023b), with the intended outcomes seeking to deliver:

- 4,333 new dwellings
- 4 new hotels and low scale cabins
- 9,800m² of retail GFA
- a cultural trail which includes cultural enterprise activities
- a 2.5 hectare school site
- 3 district parks and 8 local parks
- 2km of public beach front
- public car parking, associated community facilities and surf life saving club
- the restoration and regeneration of ecology, providing 141 hectares of landscaped open space.

Incorporated into this project is the dedication of the Boat Harbour Bate Bay foreshore and frontal dunes owned by the proponent to become a public open space area, zoned C2 – Environment Protection, as shown in the Site Plan (Group GSA 2023a).

The wetland area on Lot 2 North and those in Lot 8 are identified as Coastal Wetlands in Chapter 2 of the Resilience and Hazards SEPP and are proposed to be zoned C2 – Environment Protection as well and will remain excluded from the development footprint.

1.2.3. Ecological and Cultural Management Strategy

Consistent with the Landscape and Open Space Strategy (Group GSA 2023b), Besmaw has developed an Ecological and Cultural Management Strategy (ECMS) to provide a framework and principles to ensure the cultural and ecological values of the proposal can be delivered and managed in the future, capturing the vision and intent of the proposal.

It will embed the Connecting with Country principles and outcomes into the planning framework, it will provide a framework for delivery and management of ecological values on the site and will propose a governance structure to ensure collaboration and alignment for stakeholders.

1.2.3.1. Relationship to other documents

The ECMS provides a framework that embeds the Designing with Country processes undertaken to date into the statutory planning for the site. It provides a mechanism that will guide future cultural, social and ecological outcomes on the site, which prioritise Aboriginal ways of connecting to Country.

The strategy is designed to ensure the future co-design and collaboration with Aboriginal stakeholders to achieve the best ecological, cultural, land management and design outcomes.

The ECMS sets out the vision, guiding principles, governance structure and the framework for the future management of the cultural and ecological elements of the subject land.

The following detailed reports will be prepared at the relevant stage, to guide the future development outcomes, cultural activities and ecological practices on the subject land:

- Cultural Management Plan;
- Biodiversity Management Plan; and
- Operational Management Plan.

Further details are provided in **Chapter 7: Mitigation and Compensation Measures**.

1.2.4. Zoning

The subject land is divided into multiple zonings (see the Planning Proposal) and is separated by Captain Cook Drive between Lot 2 North and Lot 2 South.

Lot 2 North is zoned 6© Private Recreation. The north east corner of Lot 2 North contains an area nominated as Coastal Wetlands under Chapter 2 of the Resilience and Hazards SEPP.

Lot 2 South contains the following zones:

- Part 4(a) - General Industrial over the eastern access corridor from Captain Cook Drive into the body of the lot.
- Part 6(b) - Public Recreation along the Bate Bay foreshore.
- Part 7(b) - Special Development
- Part 9(a) - Regional Open Space over the Boat Harbour land

The predominant zone applying to Lot 2 South is 7(b) - Special Development.

Lots 8 and 9 are zoned General Industrial under the SSLEP 2015.

1.2.5. Previous Development Approval

Sand quarrying activities on Lot 2 South are permissible to the proponent under interim development order – Sand Mining (1965).

In 1989, DA155/89 was submitted and approved for a Sydney Destination Resort located on the subject land. This was amended with DA 542/92 for Stage 1 of the resort, including construction of the hotels, condominiums, a hospital, recreational and sporting facilities, a retail centre, and associated infrastructure.

An area containing Lot 1 DP 1030269 lies between the Lot 2 North boundary and the edge of the Quibray Bay. This Lot was previously owned by the proponent and handed over to National Parks as part of the Development Application lodged and approved in 1989. The proponent maintains rights to a 100 metre (m) wide Right of Way (ROW) through this Lot for to access the shoreline for specified activities.

1.2.6. Historical Land Use

The Holt family have owned the land for ~150yrs, with Besmaw as the landholding company. The subject land has undergone a variety of land uses in this time, with Kurnell Boarding Stables occupying and operating on Lot 2 North since 1960 and sand quarrying extraction activities occupying Lot 2 South from 1965 onwards.

The Boat Harbour Cabins lie on the north east corner of Lot 2 South, adjoining the Kamay Botany Bay National Park, and are currently leased as residential or holiday lettings on behalf of the landholder.

The Boat Harbour beach area and Bate Bay Beach are utilised as public recreation and open space areas allowing 4WD vehicle access and leisure activities along the foreshore.

1.2.7. Wetlands and Waterways

The subject land is adjoined by, and includes, a range of freshwater, estuarine and marine habitats.

Lot 2 North is bound by Quibray Bay to the west, which lies adjacent to Towra Point Nature Reserve, a wetland listed under the Ramsar Convention on Wetlands of International Importance. Towra Point is one of 65 Australian RAMSAR Sites (DoE 2016).

Towra Point Estuarine Wetland is also listed as a Nationally Important Wetland under the Directory of Important Wetlands of Australia, published by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2023a).

Lot 2 North coastal wetland area adjoins the Kurnell Boarding stables; however, access is restricted to the wetland by a barrier of planted Swamp she-oak (*Casuarina glauca*).

Lot 2 South is bound to the south west by Boat Harbour and to the south east by Bate Bay. The Boat Harbour rock platform known as Pimweli Rocks is bordered by the Boat Harbour Aquatic Reserve, extending out to encompass Merries Reef (DPI). The proponent owns the rock platform along with up to the mean high water mark of the Bate Bay foreshore. This area is private land, with access made available to the public through the purchase of access passes. 4WD access is permitted.

Historical and present land use of Lot 2 South as a sand quarry for the Sydney construction market has exposed a natural freshwater aquifer that occupies a large area in the centre of Lot 2 South. Backfilling and compaction using Virgin Excavated Natural Material (VENM) is occurring on the site moving from west to east following the direction of the sandquarrying process. The aquifer is fresh water and regular monitoring conducted for over 20 years by Coffey Pty Ltd (2018) on behalf of the proponent, shows the aquifer is isolated and unaffected by saltwater intrusion from the beach or Quibray Bay.

Lot 8 has not been developed and retains some areas significant ecological and cultural values, and some areas of Bitou Bush infestation. It still contains some areas of significant native vegetation, including wetlands that are threatened ecological communities (TECs) as described in **Chapter 3**. It also has a midden within it.

1.2.8. Opportunities Under the Planning Proposal for Flora and Fauna

The Planning Proposal provides a major opportunity to restore and extend flora and fauna habitats on site and create linkages to other conservation sites, consistent with the Kurnell 2020: Corridor Delineation (DECC 2009).

Remaining native vegetation will be retained and restored through active management. The quarry will be remediated and replanted with a range of local native species. In total this will create a major network of open space corridors totalling 141 ha (~67%) of the subject land.

Under the Landscape and Open Space Strategy (Group GSA 2023b) corridors will be established throughout the site with varying widths of up to 460m. The corridors will support the site's regeneration, strengthen the biodiversity values, allowing for the reintroduction of native flora and the movement of fauna across the subject land. The new habitat corridors can be revegetated to link north-south, and east-west across the site. These will form habitat linkages with, and buffers to adjoining conservation areas include Towra Point Nature Reserve and Kamay Botany Bay National Park, Wanda Reserve.

Revegetation of open space corridors within the subject land will also help to improve water quality and so improve water flowing into Quibray Bay, Bate Bay and Boat Harbour, which have significant marine environments of high conservation value.

1.2.8.1. Native Vegetation

A high proportion of the subject land has been cleared for sand extraction. However, a number of native plant communities were identified and these include Coastal Fore-dune Wattle Scrub in the southern extent of the subject land and throughout Lot 8, Estuarine Swamp Oak Twig-rush Forest in Lot 8, and Sydney Coastal Sand Swamp Scrub, Sapphire Saltmarsh and *Sporobolus virginicus* Saltmarsh in the north of the subject land.

As explained later in this report, native vegetation will be retained and conserved and will be augmented by substantial revegetation that will aim to regenerate ecological communities at risk elsewhere on the peninsular, including the threatened ecological communities of Littoral Rainforest, Kurnell Dune Forest, Bangalay Sand Forest and Freshwater Wetlands.

1.2.8.2. Dune Management

The coastal sand dune along Boat Harbour and Bate Bay has been historically denuded of native vegetation by erosion. Besmaw has rebuilt and rehabilitated the frontal sand dune and continues to manage this coastal vegetation, providing a stable dune covered by a native vegetation community, with only a low density of weeds (See **Section 3.3**).

A native plant nursery has been maintained on the subject land and is used to propagate local native plant species for the rehabilitation of the fore-dune and other areas on site. The nursery has used seeds and other propagules collected from original vegetation occupying the frontal dunes.

Under the Landscape and Open Space Strategy (Group GSA 2023b) this will be remediated and managed for conservation, forming a major east west corridor along Bate Bay.

1.2.8.3. Regional Vegetation Mapping

The most recent regional vegetation mapping available for the Kurnell Peninsula is the State Type Vegetation Mapping (STVM) which identifies the vegetation as comprising various plant community types (PCTs) (DPE 2023b). That mapping recognised that most of the site is vegetation free, having been cleared for sand extraction. However, a number of native PCTs were identified and these include: Southern Sydney Rockplate

Heath, Sydney Creekflat Wetland, Estuarine Swamp Oak Twing-rush Forest and Coastal Sands Littoral Scrub-Forest in the southern extent of the subject land, and Samphire Saltmarsh in the north of the subject land.

As explained later in this report, Cumberland Ecology has sampled and verified the nature and extent of such vegetation on the subject land.

1.2.8.4. Green and Golden Bell Frog

The Green and Golden Bell Frog (GGBF) is listed as an Endangered species under the NSW BC Act (OEH 2017b), and as Vulnerable under the EPBC Act (DoEE 2017). It has and is known to occur on the Kurnell Peninsula. However, as explained later in the report, it has not been found on the subject land.

Under the Landscape and Open Space Strategy (Group GSA 2023b) and consistent with the draft recovery plan for the species (DEC (NSW) 2005a), substantial areas of potential new habitat will be created within the open space corridors. Such habitats will include potential foraging, breeding and dispersal areas.

1.2.8.5. Migratory Waders and Shorebirds

Towra Point wetland is categorised as an area “Highest Fauna Values” due to it supporting important habitat for migratory shorebirds, waterbirds, and other avian species. In the adjacent saltmarsh and bushland, GGBF, Masked Owls and one of only two remaining populations of the White-fronted Chat exist in the region (OEH, 2013).

Boat Harbour Aquatic Reserve is recognised by the NSW Department of Primary Industries (DPI) as an important feeding ground for a number of shorebirds, including threatened species such as Sooty Oystercatchers and migratory waders.

The subject land and adjacent wetland also fall within the East Asian Australasian Flyway, one of eight recognised international flyways. Flyways are broad corridors used by migratory species in their annual migration routes, and the site is regularly surveyed for migratory species presence by the Australasian Wader Study Group (AWSG) (AWSG 2015).

Revegetation of open space corridors within the site will also help to improve water quality and so improve water flowing into Quibray Bay, Bate Bay and Boat Harbour, which are significant habitats for migratory waders and shorebirds. Management of areas of open space on site, such as the dune areas and future wetlands, may also provide opportunities for migratory waders and shorebirds.

1.3. Relevant Legislation

Relevant State and Commonwealth Acts and Policies for the proposed development are listed in **Table 2**.

Table 2 : Relevant Legislation

Legislation	Relevant Objectives	How it applies to this Project
NSW and Commonwealth Legislation		

Legislation	Relevant Objectives	How it applies to this Project
<p>NSW Fisheries Management Act 1994 (FM Act)</p>	<p>Provides for the protection, conservation and recovery of threatened species as well as management of threats to threatened species, populations and ecological communities defined under the Act. In particular, the FM Act has mechanisms for the protection of fish, fish habitats, mangroves, seagrasses and seaweeds on public water land and foreshores.</p>	<p>The proposal adjoins areas of Key Fish Habitats, which are listed as Protected under the FM Act. Threatened fish species listed under the FM Act have potential to occur.</p>
<p>Environmental Planning and Assessment Act 1979 (EP&A Act)</p>	<p>To encourage the proper management, development and conservation of natural and artificial resources for the purpose of promoting the social and economic welfare of the community and a better environment.</p>	<p>This Act is the principal planning instrument in NSW and as such dictates the assessment approach for the Proposal, including flora and fauna impact assessment and consideration of other Acts and planning policies.</p>
<p>Water Management Act 2000 (WM Act)</p>	<p>Provides for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations</p>	<p>The proposal is located within land that is classified as 'waterfront land' under the WM Act, defined as 'the bed of any river, lake or estuary, and the land within 40 metres of the river banks, lake shore or estuary mean high water mark. Works on waterfront land are subject to a Controlled Activity Approval under the WM Act.</p>
<p>Biodiversity Conservation Act 2016 (BC Act)</p>	<p>Provides for the conservation of threatened species, populations and ecological communities and sets out a number of specific objectives relating to the conservation of biological diversity and the promotion of ecologically sustainable development.</p>	<p>The BC Act establishes that a person must not, by an act or an omission, do anything that causes damage to any habitat of a threatened species, an endangered population or an endangered ecological community.</p>
<p>Coastal Management Act 2016 (CM Act)</p>	<p>The objects of this Act are to manage the coastal environment of NSW in a manner consistent with the principles of ecologically sustainable development for the social, cultural and economic well-being of the people of the State.</p>	<p>The subject land is located adjacent to the coast and within the coastal zone and therefore this Act applies.</p>

Legislation	Relevant Objectives	How it applies to this Project
<p>Marine Estate Management Act 2014 (MEM Act)</p>	<p>The primary objects of this Act are to provide for the management of the marine estate of NSW consistent with the principles of ecologically sustainable development in a manner that promotes a biologically diverse, healthy and productive marine estate, and facilitates economic opportunities for the people of NSW,</p>	<p>The project triggers this Act as the subject land is in close proximity to the Towra Point Aquatic Reserve and therefore future development applications will be required to address section 56 of the Marine Estate Management Act 2014 and the relevant marine estate Ministers will need to be consulted.</p>
<p>National Parks and Wildlife Act 1974 (NPW Act)</p>	<p>The objects of this Act include the conservation of nature, including, habitat, ecosystems and ecosystem processes, biological diversity, and landforms of significance, including geological features and processes, and landscapes and natural features of significance including wilderness and wild rivers</p>	<p>The Planning Proposal proposes an easement over a portion of Towra Point Nature Reserve and any use of it must comply with the legislative framework applicable to the land, including the NPW Act and its regulations. Any conduct that would be permissible under the terms of the easement, but not the NPW Act, cannot be carried out on the easement in the absence of a specific authorisation under the NPW Act.</p>
<p>Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</p>	<p>To provide for the protection of the environment, particularly, Matters of National Environmental Significance (NES) which include nationally listed threatened species and ecological communities, and migratory species.</p>	<p>Impacts to MNES and migratory species listed under the EPBC Act with the potential to occur on the site need to be assessed. This includes the adjoining RAMSAR listed wetland in the Kurnell Peninsula.</p>
<p>Regulations and Policies</p>		
<p>State Environmental Planning Policy (Precincts – Central River City) 2021</p>	<p>Chapter 5 of the SEPP relate to development of the Kurnell Peninsula. The general aims of Chapter 5 of the SEPP are to conserve the natural environment of the Kurnell Peninsula and ensure that development is managed having regard to the environmental, cultural and economic significance of the area to the nation, State, region and locality</p>	<p>The subject land is located on the Kurnell Peninsula and this SEPP needs to be taken into consideration. The intended outcome of the Planning Proposal is to translate the site from the SEPP to the Sutherland LEP. Once gazetted, the SEPP will no longer apply to the land.</p>

Legislation	Relevant Objectives	How it applies to this Project
Sutherland Shire Council Local Environment Plan 2015	The purpose of the LEP is to guide development in the Sutherland Shire.	The site is located within close proximity to mapped wetlands as nominated under the Sutherland Shire Council Local Environment Plan 2015.
Sutherland Shire Council Development Control Plan 2015	The Development Control Plan provides detailed planning and design guidelines to support the planning controls in Council's LEP.	Chapter 39 of the DCP "Natural Resources Management" provides details of appropriate buffers to wetlands that need to be implemented in the subject land due to the presence of adjacent wetlands
Policy and guidelines for fish habitat conservation and management (update 2013)	This document outlines policies and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species, in marine, estuarine and freshwater environments. The document aims to help developers, their consultants and government and non-government organisations to ensure compliance with legislation, policies and guidelines as they relate to fish habitat conservation and management.	This policy needs to be considered due to the presence of wetlands, aquatic reserves and marine habitat in close proximity to the subject land.
Draft National Recovery Plan for the Grey-headed Flying-fox, (DECCW 2009)	The purpose of this plan is to set out the management and research actions necessary to stop the decline of, and support the recovery of the Grey-headed Flying-fox	A roosting camp of the Grey-headed Flying-fox occurs adjacent to the subject land and therefore a range of management measures are required including a 300 m buffer.
Draft National Recovery Plan for the Green and Golden Bell Frog (DEC 2005)	The purpose of this plan is to set out a comprehensive strategy to manage and arrest the decline of Key (important) populations of the species (GGBF). Implement relevant strategies to reduce the impacts of threats to the species at important population level.	Kurnell was identified as a Key population of the GGBF. A Key Population Management Plan for the GGBF population was developed. A best practice habitat guide for the GGBF was also developed. The of these plans and guides was viewed as being the best strategy for recovery of the species by stakeholders at Kurnell.

Legislation	Relevant Objectives	How it applies to this Project
National Light Pollution Guidelines for Wildlife DCEW (2023)	These guidelines provide users with the theoretical, technical and practical information required to assess whether artificial lighting is likely to affect wildlife, and the management tools to minimise and mitigate that effect	Due to the potential lighting impacts of the project and the ecologically sensitive environments in vicinity to the subject land, these guidelines need to be considered.
Convention on Wetlands (Ramsar Convention)	<p>The Ramsar Convention's broad aims are to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. In designating a wetland as a Ramsar site, countries agree to establish and oversee a management framework aimed at conserving the wetland and maintaining its ecological character.</p> <p>Under the Ramsar Convention, contracting parties are required to use the 'wise use' approach and consider wetland conservation when planning development or activities in surrounding areas</p>	Towra Point Nature reserve is located in direct proximity to the subject land and has been listed as a Ramsar Wetland. Accordingly, the proposal must demonstrate that the ecological character of the nature reserve can be maintained.
The Towra Point Nature Reserve Ramsar site: Ecological character description (DECCW 2010).	Describing the ecological character of a wetland ecosystem is central to effective management, as the description forms the baseline against which management planning and actions are determined.	Due to the presence of Towra Point Nature reserve in direct proximity to the subject land, the Planning Proposal needs to be assessed against this document
Towra Point Reserve Plan of Management	The primary management objectives of this plan of management are to: actively conserve and enhance the viability of the reserve as a sanctuary for protected, threatened and migratory species, and to retain and protect the existing landforms and other natural values for the long term under the terms of international agreements or conventions to which Australia is a signatory.	Towra Point Nature reserve is located in direct proximity to the subject land and therefore the plan of management needs to be taken into consideration
Migratory Bird Agreements (JAMBA, CAMBA, ROKAMBA and Bonn)	Each of these agreements provides for the protection and conservation of migratory birds and their important habitats, protection from take or trade except under limited circumstances, the exchange of information, and building cooperative relationships	Towra Point Nature reserve is located in direct proximity to the subject land, and birds listed under these agreements have been recorded there. This nature reserve is a listed Ramsar Wetland

Legislation	Relevant Objectives	How it applies to this Project
Local Planning Directions	These are a list of Directions issued by the Minister for Planning to relevant planning authorities under the EP&A Act and apply to planning proposals lodged with the DPE	As the project is a planning proposal, Local Planning Directions apply

1.3.1. Sutherland Shire Local Environment Plan 2015

The *Sutherland Shire Council Local Environment Plan 2015* (SSLEP) applies to part of the subject land. It will apply following gazettal. The purpose of the SSLEP is to guide development in the Sutherland Shire and the aims of the SSLEP are as follows:

- a. to protect and promote the use and development of land for arts and cultural activity, including music and other performance arts,
 - b. to deliver the community’s vision for Sutherland Shire by achieving an appropriate balance between development and management of the environment that will be ecologically sustainable, socially equitable and economically viable,
 - c. to establish a broad planning framework for controlling development, minimising adverse impacts of development, protecting areas from inappropriate development and promoting a high standard of urban design,
 - d. to protect and enhance the amenity of residents, workers and visitors in all localities throughout Sutherland Shire,
 - e. to minimise risk to life, property and the environment from hazards, particularly bush fires, flooding and climate change,
 - f. to concentrate development in localities with adequate infrastructure that is accessible to transport and centres,
 - g. to protect and enhance the natural environment and scenic quality of the Sutherland Shire through the retention and rehabilitation of wildlife habitats, wildlife corridors, bushland, foreshores and waterways,
 - h. to conserve, protect and enhance the environmental and cultural heritage of Sutherland Shire,
 - i. to provide leisure and recreation opportunities to suit the needs of the changing population,
 - j. to meet the future housing needs of the population of Sutherland Shire
- As per the Planning Proposal Report, the subject land is to be transitioned from the State Environmental Planning Policy (Precincts—Central River City) 2021 (see **Section 1.3.2** below) to the SS LEP 2015.

1.3.2. State Environmental Planning Policy – (Precincts – Central River City) 2021

State Environmental Planning Policy (Precincts – Central River City) 2021 contains planning provisions for precincts within the Central River City. This SEPP has consolidated and repealed the provisions from:

- SEPP (State Significant Precincts) 2005;
- SEPP (Sydney Region Growth Centre) 2006;
- Sydney Regional Environmental Plan 24 – Homebush Bay Area;
- SEPP (Kurnell Peninsula) 1989; and
- SEPP (Urban Renewal) 2010

Chapter 5 of the SEPP relate to development of the Kurnell Peninsula. The general aims of Chapter 5 of the SEPP are:

- a. to conserve the natural environment of the Kurnell Peninsula and ensure that development is managed having regard to the environmental, cultural and economic significance of the area to the nation, State, region and locality,
- b. to apply environmental performance criteria which will ensure that the environment is not adversely affected by development,
- c. to promote, encourage and facilitate opportunities for commercial, industrial and tourist development consistent with the conservation of the unique ecological and landscape attributes of the Kurnell Peninsula,
- d. to ensure that development is co-ordinated to allow the economic and efficient provision of public services and amenities having regard to the environment,
- e. to promote the sharing of responsibility for environmental planning on the Kurnell Peninsula between the Council, the Department of Planning, the Department of Environment, Climate Change and Water, the Department of Industry and Investment and Sydney Water Corporation,
- f. to protect, enhance and utilise the tourism, leisure and recreation potential of the Kurnell Peninsula so far as it is consistent with the conservation of its ecological and heritage value.

The particular environmental planning aims and objectives of Chapter 5 of the SEPP are:

- a. to preserve and protect the wetland areas of the Kurnell Peninsula in the environmental and economic interest of the State, region and locality,
- b. to identify lands having high value and strategic importance as local or regional open space and national park or nature reserve areas and to facilitate bringing these lands into public ownership,
- c. to protect the health, well-being and safety of the local community,

- d. to identify and conserve areas, sites and features of natural, ecological, historic or cultural significance,
- e. to conserve and manage the aquatic environment and its resources in the interests of the community and the oyster, prawn and fishing industries,
- f. to identify and protect lands having regional and international significance as wildlife habitats,
- g. to ensure that the recommendations of any relevant risk assessment or transportation studies are implemented,
- h. to control and progressively phase out sand quarrying and to facilitate the rehabilitation of degraded lands, and
- i. to conserve the environmental heritage of the Kurnell Peninsula.

1.3.3. Coastal Management Act 2016

The *Coastal Management Act 2016* is relevant to the subject land as it is located within the coastal zone and therefore this Act applies.

The NSW coastal zone is made up of the following 4 coastal management areas:

- Coastal wetlands and littoral rainforests area– areas that display the characteristics of coastal wetlands or littoral rainforests;
- Coastal vulnerability area– areas subject to coastal hazards such as coastal erosion and tidal inundation;
- Coastal environment area– areas with natural coastal features such as beaches, rock platforms, coastal lakes and lagoons, and undeveloped headlands. Marine and estuarine waters are also included; and
- Coastal use area– land next to coastal waters, estuaries and coastal lakes and lagoons, and where urban coastal development may be found.

The *Coastal Management Act 2016* specifies management objectives for each area that reflect their different values and threats, and which may overlap.

State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP) maps the four coastal management areas making up the coastal zone for the purposes of both the *Coastal Management Act 2016* and the *Environmental Planning and Assessment Act 1979*.

Details of the Resilience and Hazards SEPP are provided below, including a discussion of how it is relevant to the subject land.

1.3.4. State Environmental Planning Policy (Resilience and Hazards) 2021

State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP) came into force on 1 March 2022, replacing State Environmental Planning Policy (Coastal Management) 2018. The Coastal Management SEPP 2018 is now Chapter 2 (Coastal Management) of the Resilience and Hazards SEPP 2021.

Other than the savings and transitional provisions of the 2018 policy (which have since lapsed), Chapter 2 replicates the 2018 policy.

The following zones identified in Chapter 2 (Coastal Management) of the Resilience and Hazards SEPP occur within the Kurnell Peninsula:

- Coastal Wetlands;
- Proximity Area for Coastal Wetlands;
- Coastal Environment Area; and
- Coastal Use Area.

The objectives of each zone are outlined below, whilst potential impacts on matters mapped under the Resilience and Hazards SEPP are further discussed in **Chapter 5**.

i. Coastal Wetland Zone

Under Chapter 2 (Coastal Management) of the Resilience and Hazards SEPP, development can be carried out in areas mapped as Coastal Wetlands (as Designated Development) if the consent authority is satisfied that sufficient measures have been, or will be, taken to protect, and where possible enhance, the biophysical, hydrological and ecological integrity of the coastal wetland.

Mapped Coastal Wetlands surround the subject land, within the Towra Point Nature Reserve to the north of Lot 2 North, and wetlands on Lot 8 to the north east of Lot 2 South. The areas within the subject land mapped as Coastal Wetland correspond to the wetland vegetation associated with Lot 2 North. The Coastal Wetlands mapped on Lot 2 North are located outside of the proposed development area. A portion of Lot 2 North, and a very small portion of Lot 2 South which has been mapped as 'Proximity Area to Coastal Wetlands' will be partially developed as part of the proposal.

ii. Proximity to Coastal Wetland Zone

Under Chapter 2 (Coastal Management) of the Resilience and Hazards SEPP, development can be carried out in areas mapped "Proximity Area for Coastal Wetlands" if the consent authority is satisfied that the proposed development will not significantly impact on the biophysical, hydrological and ecological integrity of the Coastal Wetlands or the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland.

The areas mapped as 'Proximity to Coastal Wetland' surrounds the Coastal Wetlands on Lot 2 North and Coastal Wetlands in the adjoining Lot 8 (outside of the subject land) extends over a small portion of Lot 2 South development site, and the Boat Harbour Drive access road.

iii. Coastal Environment Area

Under Chapter 2 (Coastal Management) of the Resilience and Hazards SEPP, development can be carried out in areas mapped within the Coastal Environment Area if the consent authority is satisfied that the proposed development will not significantly impact on the following:

- the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,
- coastal environmental values and natural coastal processes,
- the water quality of the marine estate (within the meaning of the *Marine Estate Management Act 2014*), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,
- marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,
- existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,
- Aboriginal cultural heritage, practices and places, or
- the use of the surf zone.

Areas mapped as 'Coastal Environment Area' occur in the Kurnell Peninsula, in association with the marine environment of Quibray Bay and Bate Bay, and the mapping extends in to the northern portion of Lot 2 North and the southern foredune of Lot 2 South.

1.3.5. State Environmental Planning Policy (Biodiversity and Conservation) 2021

State Environmental Planning Policy (Biodiversity and Conservation) 2021 (BC SEPP) came into force on the 1 March 2022. This transferred 7 SEPPs unchanged into chapters 6 to 12 of the BC SEPP and relocated relevant provisions from the 7 SEPPs into local environmental plans (LEPs) and Ministerial Directions (see **Section 1.3.5**).

1.3.6. Local Planning Directions

Local Planning Directions (also known as Ministerial Directions) are a list of Directions issued by the Minister for Planning to relevant planning authorities under section 9.1(2) of the EP&A Act and apply to planning proposals lodged with the DPE.

Feedback from the DPE on the Scoping Proposal identified that the planning proposal must demonstrate consistency with all relevant Directions, and any inconsistency must be specifically explained and justified in the proposal, including relevant technical analysis and studies. Those relevant to the BAR include:

- Direction 3.1 Conservation Zones;
- Direction 3.7 Public Bushland; and
- Direction 4.2 Coastal Management

2. Methodology

2.1. Introduction

The current biodiversity values of the subject land are limited due to extensive historical land clearing and the current land use as a sand quarrying site and a horse stabling facility. The areas of vegetation that remain include the wetlands area in Lot 2 North and Lot 8, which will be retained under the Master Plan, and the vegetated coastal dunes of Lot 2 South that, although it comprises only planted native vegetation, will also be retained and expanded on under the Master Plan to provide a significant corridor between the Kamay Botany National Park to the east and Wanda Reserve to the west.

A comprehensive desktop review was conducted as part of this assessment and considered the extensive ecological data available in relation to the Kurnell Peninsula, and in particular, for the Kurnell Peninsula. Existing ecological data has been utilised in the development of the survey requirements for the current assessment, and used to supplement the findings, where appropriate. The overall values of the Kurnell Peninsula have been considered in determining the ecological constraints to future development, and the potential indirect impacts resulting from changes to land use in the future (See **Chapter 5**).

It should be noted that for consistency with the biodiversity scope of works, surveys across the entire subject land have been described, as they were conducted in 2018.

Field surveys were undertaken predominantly in 2018 to inform the first iteration of this BAR, and since this time little has changed in terms of vegetation extent or habitat availability throughout the subject land.

Vegetation data collected in 2018 was checked in 2023 by revisiting sites where BAM plots were previously completed and checking condition of vegetation. Some plots that were collected along the edges of the sand quarrying operation in 2018 have since been quarried, as shown in **Figure 12**.

As Lot 8 has now been added to the subject land, a further three BAM plots were completed in this area in November 2023 within each of the major vegetation types present.

Mr Ross Wellington, accredited expert for the Green and Golden Bell Frog, visited the subject land and conducted habitat assessments and targeted surveys for the species in October 2023. He focussed on wetlands to the north of Captain Cook Drive, and also on wetlands within Lot 8 (**Figure 12**).

The surveys completed in 2018, along with the recent targeted Green and Golden Bell Frog surveys conducted by Biodiversity Assessment Method (BAM) biodiversity expert Ross Wellington in 2023, are considered sufficient to describe the ecological values present and inform the Master Plan and in accordance with requirements for Planning Proposals.

Field surveys were undertaken in the subject land, including baseline terrestrial flora and fauna surveys, aquatic surveys, and wetland habitat assessments. The focus of the terrestrial field surveys was to identify and map existing biodiversity values, in particular any TECs and areas of habitat for threatened fauna and flora within and adjoining the site. Large areas of the subject land have been heavily degraded through sand quarrying; however, part of Lot 2 North contains an area nominated under Chapter 2 (Coastal Management) of the Resilience and Hazards SEPP as coastal wetland and it is likely to constitute a TEC. Other significant vegetation

that has potential to occur in near-shore environments such as the subject land includes Coastal Saltmarsh and Mangroves.

The field surveys also aimed to identify any major ecological factors impacting on the site such as coastal processes, erosion, feral animal populations, fire regime and priority weeds. Habitats on the subject land were assessed for their significance for threatened, regionally and locally significant fauna and flora species. The recovery potential of cleared and rehabilitated land within the subject land was assessed to enable further consideration of linkages that could be made as part of the development and assessment of priorities for the improvement in the condition of remnant vegetation on site.

The methodology for terrestrial baseline ecological surveys was based around methods outlined in the BAM and as approved by DPIE prior to the 2018 surveys being conducted. The survey work then, and the updated work in 2023, is also consistent with the requirements of the scoping proposal.

Aquatic field surveys were conducted in the subject land to identify the existing aquatic habitat present in and adjacent to the subject land, as well as any species, populations or ecological communities listed under the BC Act or the EPBC Act or the Fisheries Act. The aquatic field surveys also aimed to identify any groundwater dependent ecosystems and any Priority aquatic weed species listed under the NSW *Biosecurity Act 2015*.

The subject land on Lot 2 North was first studied by Cumberland Ecology in 2013 (Letter to Luke Walker, Minter Ellison Lawyers, dated 20 February 2013) as part of an investigation into the vegetation communities present on site. A detailed flora and fauna investigation was later completed in 2018. This current assessment utilises the information in the 2013 and 2018 reports by Cumberland Ecology, supplementing that information with additional flora survey work in 2023 and the investigations about Green and Golden Bell Frog by Mr Ross Wellington in 2023.

2.2. Database Analysis

Database analysis was conducted for the locality of the subject land using the EHG Threatened Biodiversity Data Collection (BioNet) (2023b) and the Commonwealth Protected Matters Search Tool (DCCEEW 2023b). Additionally, for the aquatic assessment, the NSW DPI website was consulted, and distribution maps of all potential threatened aquatic species reviewed.

The locality is defined as the area within a 10 km radius of the centre of the subject land. The BioNet Atlas search facility was used to generate records of threatened flora and fauna species and populations listed under the BC Act within the locality of the subject land.

A number of databases were utilised during the preparation of this BAR, including:

- EHG BioNet Atlas database;
- EHG Threatened Biodiversity Data Collection database;
- EHG BioNet Vegetation Classification database;
- Commonwealth Species Profile and Threat Database; and

- DPI webpage, including Freshwater threatened species distribution maps and Primefact sheets for threatened marine species.

The abundance, distribution and age of records generated within the search areas provided supplementary information for the assessment of likelihood of occurrence of those threatened species within the subject land. The Commonwealth Protected Matters Search Tool generated a list of potentially occurring Matters of National Environmental Significance (MNES) listed under the EPBC Act within the locality of the subject land.

The likelihood of occurrence assessment for species and populations listed under the BC Act and/or EPBC Act is included in **Appendix B**.

2.3. Literature Review

A large number of ecological reports were utilised and/or reviewed during the preparation of this assessment. The flora and fauna survey data recorded as part of the extensive surveys of the Kurnell Peninsula in preparation of these ecological reports, has been utilised in this assessment to supplement the results of the surveys for the subject land, where appropriate. These ecological reports include but are not limited to:

- The Vertebrate Fauna of Towra Point Nature Reserve (OEH 2013);
- Kurnell GGBF Management Plan: Sydney Metropolitan Catchment Authority (DECC 2007);
- Green and Golden Bell Frog *Litoria aurea* Draft Recovery Plan (DEC (NSW) 2005a);
- Protecting and Restoring Green and Golden Bell Frog Habitat (DECC (NSW) 2008b);
- Best Practice Guidelines: Green and Golden Bell Frog Habitat (DECC (NSW) 2008a);
- Kurnell Green and Golden Bell Frog Key Population Management Plan (DECC 2007)
- Towra Point Nature Reserve Ramsar Site: Ecological Character Description (DECCW 2010);
- Biosis: An Independent Assessment of the Ecological Values at Kurnell Peninsula (Biosis 2002);
- Bate Bay Management Plan: Natural and Cultural Heritage (Biosis 2001);
- Biosis, 238 – 258 Captain Cook Drive, Kurnell: Flora and Fauna Assessment (Biosis 2015a);
- Biosis, 238 – 258 Captain Cook Drive, Kurnell: Vegetation Management Plan (Biosis 2015b);
- Kurnell 2020: Corridor Delineation (DECC 2009);
- Kurnell Peninsula: A guide to the plants, animals, ecology and landscapes (SMCMA 2010);
- HWR Kurnell Sand Extraction Proposal: Flora Assessment (2002);
- Gunninah Environmental Consultants, Kurnell Sand Extraction Proposal: Fauna Assessment (2002);
- Biosphere Environmental Consultants, Kurnell Sand Extraction Proposal: Green and Golden Bell Frog and Wallum Froglet Assessment (2002);

- The Ecology Lab, Kurnell Sand Extraction Proposal: Aquatic Ecology Assessment (2002);
- R.W Corkery & Co., Kurnell Sand Extraction Proposal: Species Impact Statement (2002); and
- Travers Morgan/The Ecology Lab, Sydney Destination Resort Development: Ecological Studies (1988).

Additionally, the review of existing ecological data has been used to identify any gaps in ecological information that are of relevance to the Planning Proposal for the subject land, and implications for the Kurnell Peninsula.

Consideration of the ecological values of the Kurnell Peninsula, as presented in the ecological reports listed above and identified as part of the assessments for the subject land, has been utilised in the detailed assessments of ecological constraints and opportunities, including identification of existing and potential future corridors (outlined in **Section 5.1.7**). The potential indirect impacts as a result of the proposed future landuse for the subject land has been determined, to the extent that this is known at the rezoning stage of the project, with regard to the ecological values of the Kurnell Peninsula.

2.4. Consultation with BCD

The scope of this work was informed by consultation with Biodiversity and Conservation Division (BCD), as summarised within compliance tables in **Appendix A**. Based on this, further flora work was done in 2023 and all PCT names were updated for the earlier work in 2018 to fit with the current terms for PCTs. Additional flora survey works was also done across Lot 8, which was not surveyed by Cumberland Ecology in 2018. Updated BioNet Atlas species data searches have been run and the results included in this BAR.

Due to ongoing requests for information about the species, new targeted Green and Golden Bell Frog surveys have been completed in 2023 by Ross Wellington to expand on the original 2018 survey effort undertaken by Cumberland Ecology.

2.5. Flora Survey

Flora surveys were conducted in the subject land to verify existing vegetation present, with particular reference to TECs, as listed under the BC Act and/or EPBC Act. Flora surveys were conducted in accordance with the BAM (OEH 2017a, DPIE 2020a).

During the flora survey, the vegetation was ground-truthed and the plant species recorded using the following methods:

- Recording of the flora species present within 20 x 20 m plots, including stratum, life-form, cover and abundance rating;
- Random meander transects to compile detailed lists of flora species present within each ecological community type and vegetation patch; and
- Targeted surveys for threatened flora species considered likely to occur, based on database analysis.

Any weed species noted were recorded, with particular emphasis on Weeds of National Significance (WoNS) or Priority Weeds listed under the NSW *Biosecurity Act 2015*. Any large infestations of weeds were mapped, and the numbers estimated.

2.5.1. Review of Existing Data

The following primary sources of information were consulted as part of a desktop assessment of the native vegetation within the Project Boundary:

- BioNet Vegetation Classification (EHG 2023b); and
- Cumberland Ecology (2013): Investigation of Vegetation Communities within Lot 2 DP 1030269 on the Kurnell Peninsula.

Information obtained during the review of existing data was utilised in conjunction with recent field data collected by Cumberland Ecology to assess native vegetation within the subject land. Existing vegetation mapping was subsequently refined within the Project Boundary using collected field survey data. The updated vegetation mapping has been utilised within this assessment.

2.5.2. Vegetation Mapping

In January and February 2018, the subject land and immediate surrounds were surveyed and detailed vegetation mapping was completed.

At the time of survey, the most recent vegetation mapping of the subject land available was the Native Vegetation Mapping of the Sydney Metro Area from OEH (2016). This was reviewed and subject land vegetation within the subject land was then ground-truthed to examine and verify the mapping of the condition and extent of the different vegetation communities. Where vegetation community boundaries were found to differ from the OEH mapping, records were made of proposed new boundaries using a hand-held Global Positioning System (GPS) and mark-up of aerial photographs.

The resultant information was synthesised using a Geographic Information System (GIS) to create a spatial database that was used to interpret and interpolate the data to produce a vegetation map of the subject land.

Vegetation Communities were previously named according to Native Vegetation Mapping of the Sydney Metro Area (OEH 2016). However, these have now all been updated to the Revised East Coast PCT Classification and the vegetation communities are now referred to by their PCT names throughout. The PCTs have been determined based on analysis of the dominant species, landscape position, and mapping held within the State Vegetation Type Mapping (DPE 2023b).

2.5.3. Vegetation Sampling

Vegetation sampling was conducted in 2018 using a total of 12 BAM flora plots across the subject land. Vegetation data collected in 2018 was checked in 2023 by revisiting sites where BAM plots were previously completed and checking condition of vegetation. Some plots that were collected along the edges of the sand quarrying operation in 2018 have since been quarried, as shown in **Figure 12**.

, of which three occurred on Lot 2 North and nine were set in Lot 2 South. subject land. Based on Table 3 of the BAM, seven plots were required to adequately assess the vegetation communities of the subject land. The additional five plots were undertaken at the discretion of Cumberland Ecology to ensure the vegetation survey intensity addressed the expected environmental variation between stratified environmental units, and were targeted to fill gaps in existing mapping of the site.

The locations of flora plots are shown in **Figure 12**. The locations of these plots were stratified by marking waypoints on a handheld GPS prior to site access based on existing OEH (2016) and Cumberland Ecology mapping, so that sampling was conducted in all of the major vegetation types discernible across the subject land. The following data was collected within each of the plots:

- Composition for each growth form group by counting the number of native plant species recorded for each growth form group within a 20 m x 20 m floristic plot;
- Structure of each growth form group as the sum of all the individual projected foliage cover estimates of all native plant species recorded within each growth form group within a 20 m x 20 m floristic plot;
- Cover of 'High Threat Exotic' weed species within a 20 m x 20 m floristic plot;
- Assessment of function attributes within a 20 x 50 m plot, including:
 - Count of number of large trees;
 - Tree stem size classes, measured as 'diameter at breast height over bark' (DBH);
 - Regeneration based on the presence of living trees with stems <5 cm DBH;
 - The total length in metres of fallen logs over 10 cm in diameter;
- Assessment of litter cover within five 1 m x 1 m plots evenly spread within the 20 x 50 m plot; and
- Number of trees with hollows that are visible from the ground within the 20 x 50 m plot.

PCTs were then determined based on quantitative analysis of the collected survey data and using the PCT information provided in the BioNet Vegetation Classification (EHG 2023b).

'Random meanders' were undertaken within the subject land in order to maximise the census of vascular plant species. Additional species not recorded during plot sampling were noted during the random meanders to assist in the compilation of a species list for the subject land.

Survey of the subject land included searches for threatened flora species, including targeted searches within suitable habitat of threatened flora species known from the locality. The locations of threatened flora specimens observed during surveys were recorded using a hand-held GPS. The location of the threatened species searches undertaken on 16 January 2018 are shown in **Figure 12**.

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (1990-1993). Recent name changes to plant names have been incorporated into this report, and the names are derived from PlantNET (Botanic Gardens Trust 2020).

A full list of species recorded in each plot is included in **Appendix C**.

2.5.4. Survey Effort

Flora survey method and survey effort for the subject land are summarised in **Table 3**.

Table 3 : Flora survey effort

Survey Method	Dates	Effort
Vegetation mapping	16/01/2018	1 day for two people
Plot sampling	17/01/2018, 09/01/2018	12 plots
Plot sampling	29/11/2023	3 plots
Random meanders	16/01/2018, 17/01/2018, 09/01/2018	n/a
Threatened species searches	17/01/2018 and throughout survey period	4 hours for two people (minimum)

2.6. Fauna Survey

2.6.1. Habitat Assessment

A fauna habitat assessment was conducted in the subject land on 17 January 2018 to identify fauna habitat likely to be of local, regional or state significance (including habitat of threatened species, populations, ecological communities or critical habitat listed under the BC Act). The fauna habitat assessment was further supported by the review of existing ecological documentation for the Kurnell Peninsula (as listed in **Section 2.5.1**).

Fauna habitat assessments included recording of indicators of habitat condition and complexity such as the occurrence of microhabitats, tree hollows, fallen logs, and bush rock. An assessment of the structural complexity of vegetation, the age structure of the vegetation and the nature and extent of human disturbance throughout the subject land was undertaken. Indirect indicators of fauna use of the subject land such as droppings, diggings, footprints, scratches, nests, burrows, paths and runways were also recorded. Specific habitat present on the subject land for threatened fauna species known to occur in the locality was targeted during the fauna habitat assessment and recorded if present.

2.6.2. Microchiropteran Bat Surveys

Surveys for microchiropteran bats were undertaken in January 2018 using several "Songmeter" call detection units. Each location was surveyed for a minimum of three nights within the subject land (see **Figure 12**). The Songmeter units were positioned in suitable habitat along tracks or wetland areas which would be most likely used as flyways for bat species. The Songmeter units were set to activate before dusk each evening and switch off after dawn. Ultrasonic calls collected from the Songmeter units were sent to Greg Ford of Balance Environmental for identification.

2.6.3. Green and Golden Bell Frog Surveys

Green and Golden Bell Frog targeted surveys were conducted over four nights in January 2018. Survey methods used followed the species specific Survey Guidelines for Australia's Threatened Frogs (DSEWPaC 2010) and were approved by DPIE prior to being undertaken.

The environmental impact assessment guidelines for the species (NSW NPWS 2003), recognises that spaced surveys over several activity breeding seasons is ideal, but is not mandatory and with its intent being to spatially spread survey efforts across potential activity periods to improve the chance of detection where present, (Ross Wellington pers comm.). In order to supplement the lack of repeated surveys over additional activity seasons, the survey results were supported by detailed habitat assessment, and consideration of existing data.

A combination of call detection, call playback, spotlight surveys and habitat assessment were conducted at four locations within the subject land, occurring over a period of four nights. At each site, the survey process involved five minutes of call detection, followed by five minutes of call playback and five minutes of quiet listening; then spotlighting for 15 minutes in the immediate vicinity. Surveys were timed to align with optimum weather conditions of warm and windless nights following rainfall within the previous seven days. Survey times were between 7.30pm and 9.30pm each survey night, with sunset at approximately 8pm. Visiting times to each site were staggered so all sites included a diurnal survey, and a survey during each of the half hour periods thereafter.

A reference site of a known GGBF population at Sydney Olympic Park was used to establish calling presence compared to the subject land. The reference population of Green and Golden Bell Frog was selected based on the most reliable call records and largest population that is regularly monitored, within an area of similar climatic conditions. Although a closer known population occurs at the Green Hills Australand site, it is not monitored as regularly and the population is thought to be declining.

The survey methods utilised were determined as suitable at the time of being performed and while they did not precisely follow the current guidelines NSW Survey Guide for Threatened Frogs (DPIE 2020b) this is only due to the guidelines not being released until several years after the DPIE consultation and when the subject land surveys were conducted.

Notwithstanding the Cumberland Ecology survey findings in 2018 it was decided to supplement these null survey results with an additional, more recent evaluation for presence with a further evaluation of habitat. An accredited biodiversity expert with the species, Ross Wellington who prepared both the national recovery plan for the species and developed the GGBF Key Population management plan at Kurnell, consequently undertook two further diurnal and nocturnal targeted surveys for the Green and Golden Bell Frog throughout the subject site during 14 and 15 November 2023. Ross Wellington who is a Green and Golden Bell Frog Biodiversity Expert under the BAM, and recognised as having the specialised knowledge and experience for consideration in the preparation of BARs or in provision of expert reports when required carried out 16 hours of specific survey effort. This was conducted to assess whether the species credit species, the Green and Golden Bell Frog in this instance, was present within the site, to identify species habitat polygons where/if present and/or whether further assessment is required. The surveys undertaken by Ross Wellington in 2023 have been detailed in his

report for the project (AES 2023) and hence provide a further or additional updating to the targeted survey efforts already undertaken by Cumberland Ecology. The additional targeted survey efforts undertaken by Ross Wellington (AES 2023) are provided in **Appendix E**.

2.6.4. Diurnal Bird Surveys

Visual observation and call identification of diurnal birds was carried out within the subject land in February 2018. Four (4) sites associated with water bodies were surveyed for at least an hour each using point and area search methods. Opportunistic sightings observed throughout the duration of all surveys were also recorded. The location of the diurnal bird census point is shown in (**Figure 12**).

2.6.5. Reptile Surveys

Reptile searches were undertaken within the subject land during the general habitat assessment on 16 January 2018. Searches of suitable reptile habitat involved lifting of bark, fallen logs, bushrock and scraping of top soil. Nocturnal searches for reptiles were undertaken as part of the Green and Golden Bell Frog targeted surveys.

2.6.6. Camera traps

Several unbaited camera traps were set up around the subject land at locations deemed conducive as fauna thoroughfares from 17 January 2018 for a total of seven nights each. Traps were set at approximately 50cm height from the ground and angled to pointing down to best observe the traversing fauna. The locations of the camera traps are shown in **Figure 12**.

2.6.7. Incidental Observations

Any vertebrate fauna species observed, detected on the basis of calls, tracks, scats, scratch markings or otherwise, were recorded and listed in the total species list for the subject land. The presence or evidence of any feral animals was also recorded throughout the survey period.

2.6.8. Survey Effort

Fauna survey method and survey effort for the subject land are summarised in **Table 4**.

Table 4 : Fauna survey effort

Survey Method	Dates	Effort
General habitat assessment (as part of vegetation and flora surveys)	16/01/2018, 17/01/2018	32 person hours
Microchiropteran bat surveys	18/01/2018 – 24/01/2018	3 sites, 6 nights
Green and Golden Bell Frog Surveys – Cumberland Ecology	17/01/2018, 18/01/2018, 24/01/2018, 25/01/2018	4 nights, 8 person hours per night spread over 4 sites. Each site totals 4 person hours over the survey period.
Green and Golden Bell Frog Surveys – Ross Wellington	14/11/2023 – 15/11/2023	See Appendix E

Survey Method	Dates	Effort
Diurnal bird surveys	09/02/2018, throughout fauna survey period	4 sites
Aquatic surveys	09/02/2018	20 person hours over 4 sites
Reptile surveys	Throughout fauna survey period	n/a
Incidental observations	Throughout fauna survey period	n/a

2.6.8.1. Requirements for Additional Seasonal Surveys

As identified by the BAM, seasonal surveys are required for Species Credit Species identified as having potential to occur on the development site. The development site (footprint) is used as a basis for the assessment of direct and indirect impacts to Species Credit Species. It is therefore acknowledged that additional seasonal surveys are required for some species that would not be likely to be readily recorded during the summer survey season as conducted on the subject land and that updated surveys should be completed at the DA stage.

Surveys were considered adequate in order to identify the potential species present and suitable habitat for all threatened and migratory species with potential to occur on the subject land. The survey results were supplemented with existing data for the subject land and the Kurnell Peninsula and detailed habitat assessments.

For these reasons, it is considered that additional seasonal surveys are appropriate at the DA stage, when they can be done as per the requirements of BAM. Nonetheless, the results of any additional seasonal surveys are not expected to alter the findings of the report, which identifies the highly degraded condition of habitats for threatened and migratory species present on the subject land.

2.7. Aquatic Surveys

Areas of aquatic habitat in the subject land comprise the aquifer, and the large body of water that is the Boat Harbour. Adjacent to the subject land to the north is Quibray Bay, and the Pacific Ocean is adjacent to the subject land to the south. Accordingly, there is potential for impacts to occur to the aquatic and marine environment.

No detailed marine ecology surveys were undertaken in areas outside of the subject land. Marine ecology surveys were limited to snorkelling surveys around Boat Harbour to determine presence/absence of seagrasses. Surveys for marine birds were incorporated into the diurnal bird surveys described in **Section 2.6.4**. In order to supplement the marine surveys, consideration of the existing aquatic data and mapping of aquatic habitats has been incorporated into the findings of this assessment. Consideration of constraints, and assessment of potential indirect impacts, of the potential future land use for the subject land has utilised the existing aquatic data and mapping, including mapping of the known endangered population of *Posidonia australis* (Seagrass) (See **Section 4.1.2** and **Figure 20**).

Aquatic field surveys were undertaken in the subject land utilising the field methods of the NSW AusRivAS Sampling and Processing Manual. Although AusRivAS analyses cannot be applied to the waterbodies within the subject land as the models are designed for perennial, flowing streams, the field sampling methodologies

and invertebrate identification requirements provide a nationally recognised standards and were utilised to for the field surveys.

This field approach involves undertaking habitat assessments and macro-invertebrate samples to provide an indication of the current condition of the aquatic survey locations. Sampling for fish and turtles was limited to visual observations and by-catch during the macro-invertebrate sampling.

2.7.1. Survey Sites

Initial desktop assessments were conducted to determine potential locations for monitoring surveys. Indicative monitoring locations comprised:

- Sites located within Lot 2 North coastal wetland area; and
- Sites located within and around the aquifer on Lot 2 South.

Site selection was restricted to areas located within the subject land and under the proponent's ownership.

Three sites (Site 1 – Site 3.) were established within the subject land.

The locations of these survey sites are provided in **Figure 12**.

2.7.2. Survey Timing and Conditions

The aquatic ecology surveys were conducted on 9 February 2018. The weather conditions during the February 2018 survey period were characterised by clear, hot days and moderately warm nights. Although some rainfall occurred in the weeks prior to the survey period, no rain was recorded during the survey period.

2.7.3. Habitat Assessment

The following visual assessments were conducted at each survey site:

- Water levels;
- Riparian vegetation composition, if present;
- Substrate composition;
- Water quality (where present); and
- Anthropogenic disturbance.

Photographs were also taken at each sampling location to provide a visual indication of the habitat at each location, and to form a baseline record of current conditions.

2.7.4. Water Quality

Water quality measurements were conducted at Site 1 and Site 3. No water quality measurements were taken Site 2 as it was densely vegetated and lacked any remnant pools or visible water.

A range of water quality measurements were recorded *in situ* using an Aquaread Water Quality Meter. These included:

- Electrical Conductivity (EC) ($\mu\text{S}/\text{cm}$);
- Dissolved Oxygen (DO) (% saturation);
- Temperature ($^{\circ}\text{C}$);
- pH; and
- Turbidity (NTU).

In addition to the above parameters, Alkalinity was measured *in situ* using a LaMotte P & T Alkalinity Titrator Test Kit – 3467.

2.7.5. Macroinvertebrate Sampling

Macroinvertebrate samples were collected at each of the two sites where water quality measurements were conducted.

For the purposes of AusRivAS, a habitat is an instream environment within a sampling site that supports a distinct macroinvertebrate fauna. In NSW, the two main habitats that are sampled are riffle and edge habitats. The riffle habitat is an area of broken water with rapid current that has some cobble or boulder substratum while the edge habitat is an area along the banks with little or no flow.

Edge habitat samples were collected at Site 1 and Site 3. As distinct riffle habitats were largely absent, bed samples were collected in lieu of riffle habitat samples in order to establish baseline macroinvertebrate composition at these sites.

Bed samples were collected by disturbing the sediment and sweeping a standard macroinvertebrate sampling net, with a 250 micron mesh, through the water. Edge samples were collected by agitating plant matter and debris within the water column and vigorously sweeping the net through any suspended material.

Site 2 had no discernible water or bed to sample from, and was not surveyed in this scope.

The collected material was emptied into sorting trays and macroinvertebrate samples were live-picked in the field. Collected organisms were stored in a solution of 70% ethanol for transport to the laboratory for identification.

2.7.6. Field Survey Summary

Table 5 below summarises the specific surveys conducted at each site for the February 2018 aquatic ecology surveys.

Table 5 : Aquatic ecology survey summary – February 2018

Location	Survey Site	Date	Visual Assessments	Water Quality Measurements	Macroinvertebrate Sampling
Lot 2 South	Site 1	9 Feb 18	Photographic Records, Vegetation condition, Disturbance Assessment,	+	Edge and bed habitats
Lot 2 North	Site 2	9 Feb 18	Photographic Records, Vegetation condition, Disturbance Assessment	n/a	n/a
Lot 2 South	Site 3	9 Feb 18	Photographic Records, Vegetation condition, Disturbance Assessment,	+	Edge and bed habitats

2.8. Data Analysis

2.8.1. Macroinvertebrate Identification

Macroinvertebrate analysis involved identification using taxonomic keys and aquatic invertebrate guides. As required under AusRivAS, most taxa were identified to family level with the exception of Oligochaeta (to class) and Chironomidae (to subfamily) in accordance with AusRivAS requirements.

2.8.2. Data Analysis

The macroinvertebrate data collected from each site was analysed using Stream Invertebrate Grade Number – Average Level (SIGNAL) analyses and species richness analyses, including PET analyses. These analysis methods are described in the following sections.

2.8.2.1. PET Taxa Richness

The “PET” group of macroinvertebrates are three orders of insects that are known to be especially sensitive to disturbance and are typically found in very low numbers in degraded water bodies or water bodies with naturally high stressors (e.g. low oxygen content or acidic waters). The three orders are: Plecoptera (stoneflies), Ephemeroptera (mayflies) and Trichoptera (caddisflies). These particular macroinvertebrate orders are known to be sensitive to changes within their environment and therefore the species richness and numbers of species found at a site are considered good indicators of disturbance and/or stressors. A PET ratio is derived as the percentage of PET taxa representation within the whole invertebrate community at each site. Low PET ratios indicate a greater prevalence of taxa that are tolerant to disturbance (and can reflect lower habitat values).

2.8.2.2. SIGNAL Analysis

The SIGNAL index was initially developed by Chessman (1995) to assist in the bioassessment of water quality in Australia. Chessman (1995) determined sensitivity grade numbers (between 1 and 10) for most freshwater macroinvertebrate families in Australia based on how sensitive each was to various pollutants and other physical and chemical factors.

The SIGNAL scoring was conducted in accordance with Version 2 of the scoring system (SIGNAL 2) which allows for identification at family level as well as order-class-phylum level. The SIGNAL 2 scoring was conducted at the family level for most taxa (sub-family level for Chironomids). However, for taxa such as the oligochaetes, the order-class-phylum grades were used consistently across the samples (Chessman 2003). As the AusRivAS method for macroinvertebrate collection in NSW is based on presence/absence of taxa, SIGNAL scores for taxa were used directly and were not weighted based on the abundance of the respective taxa.

Relatively pristine sites would be expected to have high macroinvertebrate diversity, including taxa that are sensitive to pollution, and therefore a high SIGNAL score. A Site SIGNAL score >6 generally indicates a healthy habitat, and scores <4 indicate severe pollution.

2.9. Wetland Habitats

2.9.1. Wetland Habitat Assessment

Wetland habitat assessment was conducted for three wetlands within the subject land, as shown in **Figure 12**. The purpose of the wetland habitat assessment was to classify the habitat value for terrestrial and semi-aquatic species, in particular for amphibians and wading birds.

Assessment of foraging, breeding, and shelter habitat involved an assessment of each dam or water body and noting the presence of the following features important to the species:

- Cover of fringing vegetation (low (<10%) = 1, moderate (10-39%) = 2, high (40- 100%) = 3);
- Cover of emergent vegetation (low (<10%) = 1, moderate (10-39%) = 2, high (40- 100%) = 3);
- Grassland or woodland around the dam (grassland = 1, woodland = 2, grassland and woodland mosaic = 3);
- Varying water depth (absent = 0, present = 1);
- Submerged rocks and logs (absent = 0, present = 1);
- Rocks and/or logs for basking/shelter on dam edge (absent = 0, present = 1);
- Presence of *Gambusia holbrooki* (absent = 1, present = 0); and
- Turbid water (turbid = 0, clear = 1).

Each variable was allocated a score as shown above and each water body was allocated a score out of 15. Habitat was then assessed to a quality category as shown below:

- Score < 8 = Low quality habitat;
- Score 8-12 = Moderate quality habitat; and
- Score > 12 = High quality habitat.

2.10. Constraints Mapping

Consideration of the findings of the surveys of the subject land and the supporting ecological information for the Kurnell Peninsula, have been utilised in the development of constraints mapping to support the development of the proposed Concept Master Plan for the subject land (as shown in **Figure 8**). The constraints mapping identified ecological values of low, moderate and high conservation significance on the subject land, potential existing and future links to areas of high biodiversity value in the Kurnell Peninsula, and potential areas of restoration to develop habitat corridors from east to west and north to south. The constraints mapping considered the scope of works identified by the PCG and the South District Plan (Greater Sydney Commission 2020). Constraints mapping has been utilised in the development of a suite of potential mitigation and compensation measures that are proposed as part of future development proposals, such as biodiversity management, establishment of buffers and corridors, construction and operational environmental controls, including water cycle management.

Constraints mapping has also considered the relevant international migratory species agreements, and implications for habitat conservation and restoration for species with potential to utilise the subject land now, and in the future.

2.11. Limitations

Due to past sand extraction, and other historic land use, the subject land has been highly modified, leaving only limited opportunities for native flora and fauna. Therefore, although the field work for this project was of limited duration, adequate information was obtained for the purpose and objectives of this report. Despite the surveys being completed predominantly in 2018, little has changed throughout the subject since this time and the existing survey data provides a sound background of the current biodiversity values of the subject land for the purposes of informing this BAR. Furthermore, vegetation sample plots for 2018 have been checked in 2023, and three more plots have been added for Lot 8 vegetation.

Vertebrate fauna and vascular flora of the locality are well known based upon a sizeable database of past records and various published reports. The surveys by Cumberland Ecology added to the existing database and helped to provide a clear indication of the likelihood that various species occur, or are likely to occur within the subject land. The data obtained from database assessment and surveys of the subject land furnished an appropriate level of information to support this assessment.

The weather conditions at the time of the flora surveys were generally favourable for plant growth and production of features required for identification of most species. Shrubs, grasses, herbs and creepers were readily identifiable in most instances. It is expected that not all flora species present would have been recorded during surveys. Despite this, it is considered that sufficient information has been collected to assess issues including conservation significance of the flora, condition and viability of bushland and likely impact on native vegetation.

The fauna surveys, while undertaken in accordance with NSW government guidelines, have limitation in that they are a "snapshot" investigation in time and illustrate a view of the fauna that were active during the time of the surveys. The data produced by the surveys is intended to be indicative of the types of species that could occur and not an absolute census of all vertebrate fauna species occurring within the subject land. The fauna

surveys undertaken for this ecological assessment are limited in that they have not been undertaken during different seasonal conditions and a new suite of surveys will be required at the DA stage when the final development outcome is known. As a result, the opportunities to maximise the detection of a variety of species is reduced.

Due to the highly mobile and seasonal nature of the migratory waders and avian species frequenting the site, the bird surveys undertaken provide a representation of the species present at the time of survey only, and do not encompass the full diversity which may utilise the subject land.

Aquatic Site 3 comprised a dam with steep sides and deep water. Due to the safety hazards, sampling of the bed was limited to accessible areas from the banks and may not encompass the full diversity of macroinvertebrates within the sediments.

The majority of Aquatic Site 4 (K-Aq4 in **Figure 12**) was outside the property and was not accessible, and therefore assessments for this site were limited to visual observations from the client's property.

3. Terrestrial Ecology Results

3.1. Introduction

This chapter provides a description of the flora and fauna found on site during the field investigations for the BAR. It provides a description of the vegetation that originally occurred on or near the site, and also of habitat for threatened flora and fauna that occur.

Due to past sand extraction, and other historic land use, the subject land has been highly modified and much of the original habitats have been cleared. As per the methodology approved previously by DPIE (now DPE), it is acknowledged that the 'base case' for assessment is post-rehabilitation.

At the conclusion of the sand extraction and land rehabilitation, Lot 2 South will be a brownfield site with finished levels consistent with the development consent that applies to the land. The landform will be one engineered exclusively from Virgin Excavated Natural Material (VENM) such as sandstone, clay and sand and will exhibit the characteristics envisaged by the DPE, when consent was issued to undertake these activities. The majority of Lot 2 South will have an altered land form following sand extraction and the placement of VENM, graded so that surface runoff and stormwater is collected within the site and directed and discharged into Botany Bay or directed into the sand environment within the site infiltrating to recharge the freshwater aquifer. Elements of native vegetation such as the frontal dune which has been the subject of an ongoing program of planting of native species propagated on site and are considered to be in their rehabilitated form. All surfaces not planted with native vegetation will be seeded with native grasses to stabilise the land surface. Existing biodiversity values on Lot 2 South are not considered further in this assessment.

3.2. Vegetation Communities at the Time of European Settlement

The sand dunes of the Kurnell Peninsula, and the sands that are being quarried in the subject land, give the impression that the original pre-European landscape was comprised of simple vegetation, lacking trees. However, this was not the case. On 29 April 1770, Captain James Cook, on board the HM Bark Endeavour, landed in Botany Bay, stepping ashore near Silver Beach. Shortly after, James Cook looked down from the sand hills at what is now known as Cronulla Beach. The sand dunes were completely covered in vegetation, including woodland and forest, and so Cook made no mention of any bare sand dunes during his visit to the Kurnell peninsula (Benson and Howell 1990).

A range of forests occurred on the Kurnell Peninsula. However, to promote grass growth for their livestock the early European settlers destroyed the oldest trees and by 1868 forests of that included Bangalley, Swamp Mahogany, Sydney Red Gum, Tuckeroo and other trees were ringbarked or simply cut down. Within 100 years after Cook's landing, most of the original vegetation had been cleared or massively changed (Benson and Howell 1990).

The original vegetation originally comprised a complex mosaic that included forests, forested wetlands, wetlands, saltmarsh, mangroves and heathland. Some of the original vegetation that occurred on or near the site originally include threatened ecological communities of Littoral Rainforest, Kurnell Dune Forest, Bangalay Sand Forest and Freshwater Wetlands.

Other than mangroves, the original forest and wetland communities of the subject land and surrounds will be replanted in the remediated areas of the proposed open space corridors as explained in **Section 5.1.7**.

3.3. Vegetation Communities

Natural or semi-natural plant communities occurring in the Kurnell Peninsula are shown in **Figure 13** and the vegetation communities of the subject land have been recognised and these are shown within **Table 6** and **Figure 14**. A number of these communities are consistent with Threatened Ecological Communities (TECs) listed under the BC Act or the EPBC Act, as mapped in **Figure 14**.

A description for each vegetation community is provided within **Sections 3.3.1 to 3.3.5**. The areas of vegetation present on the subject land are summarised in **Table 6**. Lot 2 North has been extensively cleared and modified through past and current land uses, including as a horse stabling facility. Consequently, approximately 90% of the area consists of exotic dominated grassland, with some scattered occurrences of native canopy trees. However, the lot retains some saltmarsh and reedland vegetation located in the eastern corner, constituting approximately 9% of Lot 2 North. The wetland areas within the low-lying areas of this area are fed from the west by a freshwater aquifer and from the east by saltwater. This has created a saltwater gradient and, despite being weed infested, this is illustrated in the native flora present – with the prevalence of salt-tolerant species increasing toward the east.

Beyond the boundary of Lot 2 North, within NPWS reserved land directly to the north of the subject land, extensive exotic vegetation dominated by *Chrysanthemoides monilifera* (Bitou Bush) occurs. Vegetation to the north east and north west also include smaller areas of mangroves, and other wetland communities, in association with Weeny Bay and Towra Point nature Reserve, as shown in **Figure 13**.

Table 6 : Vegetation present on the subject land

Vegetation Community	Area (ha)
Estuarine Saltmarsh Complex	0.24
Sporobolus virginicus Saltmarsh	0.67
Sydney Coastal Sand Swamp Scrub	1.12
Estuarine Swamp Oak Twing-rush Forest	6.75
Coastal Foredune Wattle Scrub	35.14
Coastal Sands Littoral Scrub-Forest	0.18
Exotic Vegetation	9.62
Exotic Grassland and Cleared Land	88.33
Dune/Foreshore	18.99
Water	49.17
Total	210.21

The PCTs within this version of the BAR have been updated to align with the new Eastern NSW PCTs released in April 2023. This PCT update is necessary as any future DAs will include the preparation of Biodiversity Development Assessment Reports that will be required to utilise the PCTs to assess existing vegetation.

The existing PCTs and the selection and justification of the new PCTs is provided below in **Table 7**.

Table 7 PCT justification

Previous Community	PCT	PCT Name	TEC	Lineage PCTs	SVTM PCTs	New PCT	Reason for Selection
Estuarine Saltmarsh	1746	Estuarine Saltmarsh Complex	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions	4097, 4103	4097	4097	PCT 4097 is a better fit than PCT 4103 due to the higher coverage of <i>Sarcocornia quinqueflora</i> versus <i>Sporobolus virginicus</i>
Estuarine Reedland	1808	Estuarine Reedland	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions	3963, 4028	3963	4103	PCT 4103 aligns with the recorded plot data and is a Saltmarsh PCT that is dominated by <i>Sporobolus virginicus</i> and <i>Juncus kraussii</i> , and contains occurrences of other species such as <i>Machaerina juncea</i> and <i>Ficinia nodosa</i> .
Coastal Freshwater Wetlands	781	Coastal Freshwater Lagoons of the Sydney Basin and South East Corner	-	3958, 3959, 3962, 3972, 3975, 3976, 3985, 4050	3972, 3922	3922	PCT 3922 has been mapped in the locality, is mentioned as occurring in dune swales, and the description of the PCT as often highly disturbed due to long history of disturbance based on proximity to urban environments fits. Species matches with the few natives in plot and include <i>Acacia longifolia</i> , <i>Typha orientalis</i> , <i>Machaerina juncea</i> , and <i>Imperata cylindrica</i>

Previous Community	PCT	PCT Name	TEC	Lineage PCTs	SVTM PCTs	New PCT	Reason for PCT Selection
Coastal Swamp Paperbark-Swamp Oak Tall Shrubland on Estuarine Flats, Sydney Basin and South East Corner	1236	Swamp Paperbark -Swamp Oak Tall Shrubland on Estuarine Flats, Sydney Basin and South East Corner	Swamp Oak Floodplain Forest of the New South Wales Coast, Sydney Basin and South East Corner	4000, 4028, 4056	4028, 4027	4028	PCT 4028 chosen as this is the dominant Swamp Oak community mapped surrounding Kurnell. Although this community usually is dominated in the ground layer of <i>Machaerina juncea</i> , which is common elsewhere in the site, the occurrence within this site appears to be at the periphery of the natural habitat, and thus is a drier occurrence potentially with some spread of <i>Casuarina glauca</i> into formerly drier areas. Despite this, most of the few native species recorded match the PCT and these are <i>Casuarina glauca</i> , <i>Dianella caerulea</i> , <i>Gahnia clarkei</i> , <i>Homalanthus populifolius</i> , <i>Phragmites australis</i> , <i>Stephania japonia</i> , and <i>Typha orientalis</i> .
Coastal Fore dune Wattle Scrub	772	Coast Banksia Coast Wattle Dune Scrub Sydney Basin and South East Corner	-	3640, 3788	3410, 3810, 3546	3788	Although this is planted revegetation, PCT 3788 is the best fit for an <i>Acacia longifolia</i> subsp. <i>sophorae</i> dominated community on sand dunes.

Previous Community	PCT	PCT Name	TEC	Lineage PCTs	SVTM PCTs	New PCT	Reason for Selection
Coastal Sands Littoral Scrub-forest	0	Coastal Sands Littoral Scrub-Forest	Kurnell Dune Forest of the Sutherland Shire and City of Rockdale	3546	-	3546	Based on EcoPlanning roadside vegetation mapping, see report.

3.3.1. Samphire Saltmarsh

PCT: 4097 – Samphire Saltmarsh

Status under EPBC Act: Vulnerable Ecological Community

Status under BC Act: Endangered Ecological Community

A small patch of Samphire Saltmarsh occurs in the north east of the subject land, within Lot 2 north, as shown in **Photograph 5**. The Samphire Saltmarsh adjoins a Mangrove community that occurs within Towra Point Nature Reserve to the north and north east, and includes sparse occurrences of *Avicennia marina* (Grey Mangrove) and *Aegiceras corniculatum* (River Mangrove) trees in the canopy and shrub stratum. The understorey is dominated by *Sarcocornia quinqueflora subsp. quinqueflora* (Samphire), *Samolus repens* (Creeping Brookweed), *Sporobolus virginicus*, *Baumea juncea* and *Juncus kraussii subsp. australis* (Sea Rush) with occurrences of exotic species, including; *Cenchrus clandestinus* (Kikuyu Grass), *Chrysanthemoides monilifera* (Bitou Bush) and *Hydrocotyle bonariensis*. We determined the distributional extent of the community by the occurrence of saltwater species *Sarcocornia quinqueflora* (Samphire) and *Samolus repens* (Creeping Brookweed).

Samphire Saltmarsh on the subject land conforms to Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community (EEC) listed under the BC Act, due to its landscape position and the presence of characteristic species (NSW Scientific Committee 2011a). The occurrence of Coastal Saltmarsh present on the subject land also meets the minimum patch size (>0.1 ha) and inclusion of characteristic species for listing as Subtropical and Temperate Coastal Saltmarsh vulnerable ecological community under the EPBC Act (DoEE 2013).

Photograph 5 : Samphire Saltmarsh in the north east of the subject land



3.3.2. Sporobolus virginicus Saltmarsh

PCT: 4103 – Sporobolus virginicus Saltmarsh

Status under EPBC Act: Vulnerable Ecological Community

Status under BC Act: Endangered Ecological Community

Sporobolus virginicus Saltmarsh occurs in the eastern part of Lot 2 North, and is periodically inundated, as shown in **Photograph 6**. The occurrence on site is a degraded community, with low species diversity, dominated by reeds; *Juncus kraussii* subsp. *australiensis* (Sea Rush), *Ficinia nodosa* (Knobby Club-rush) and *Juncus acutus* subsp. *acutus* (Sharp Rush), with *Baumea juncea* occurring in the brackish areas at the margins of the saltmarsh. The understorey includes sparse shrubs, including; *Chrysanthemoides monilifera* (Bitou Bush) and *Acacia longifolia* subsp. *sophorae* (Coastal Wattle) and groundcovers; *Sporobolus virginicus* and *Juncus kraussii* subsp. *australis* (Sea Rush).

The distributional extent of this community was determined by the scattered occurrence of salt-tolerant species such as *Aegiceras corniculatum* (River Mangrove) and *Sporobolus virginicus*. The brackish area of Sporobolus virginicus Saltmarsh is typified by the prevalence of *Juncus kraussii*, *Baumea juncea* with the occasional *Casuarina glauca* sapling.

Sporobolus virginicus Saltmarsh is included in the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC listed under the BC Act based on the dominance of *Juncus kraussii* and *Baumea juncea* which are upper saltmarsh species.

Photograph 6 : *Sporobolus virginicus* Saltmarsh present in the north east of subject land



3.3.3. Sydney Coastal Sand Swamp Scrub

PCT: 3922 – Sydney Coastal Sand Swamp Scrub

Status under EPBC Act: Not listed

Status under BC Act: Not listed

Sydney Coastal Sand Swamp Scrub occurs across the eastern side of the low-lying area of Lot 2 North, as shown in **Photograph 7**, and as a small patch to the east of Lot 8. This community is a degraded form, with low species diversity, dominated by *Hydrocotyle bonariensis* (Largeleaf Pennywort), *Ageratina adenophora* (Crofton Weed), *Juncus kraussii* subsp. *australiensis* (Sea Rush) and, to a lesser extent, by *Typha orientalis* (Broad-leaved cumbungi).

The Sydney Coastal Sand Swamp Scrub community does not constitute 'Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions endangered ecological community' as defined under the BC Act, due to lack sufficient diagnostic species (DECCW (NSW) 2009) (NSW Scientific Committee 2011b) and are presently highly degraded due to cover and abundance of exotic weeds such as *Hydrocotyle bonariensis* (see **Appendix C**). This is especially apparent in Lot 2 North where exotic weeds have established due to water dispersal by run-off from higher lying areas surrounding the wetlands. The species composition of this wetland lacks diagnostic species of the Freshwater Wetland TEC and the prevalence of weeds has degraded the community significantly. This community is associated with re-worked aeolian sands, unlike the naturally occurring TEC.

Photograph 7 : Degraded Sydney Coastal Sand Swamp Scrub (foreground) in Lot 2 North



3.3.4. Estuarine Swamp Oak Twig-rush Forest

PCT: 4028 – Estuarine Swamp Oak Twig-rush Forest

Status under EPBC Act: Endangered Ecological Community

Status under BC Act: Endangered Ecological Community

Much of Lot 8 comprises Estuarine Swamp Oak Twig-rush Forest on the eastern boundary of the subject land, shown in **Photograph 8**, along with some smaller patches appearing on the southern side of Captain Cook Drive. The canopy and midstorey occurs as a monoculture of *Casuarina glauca* (Swamp Oak), with an

understorey dominated by *Ageratina adenophora* (Crofton Weed), *Asparagus aethiopicus* (Asparagus Fern), *Conyza bonariensis* (Flaxleaf Fleabane) and vines such as *Araujia sericifera* (Moth Vine) and *Cuscuta campestris* (Golden Dodder).

The Estuarine Swamp Oak Twig-rush Forest conforms to 'Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions' EEC under the BC Act (NSW Scientific Committee 2011). c

Photograph 8 : Estuarine Swamp Oak Twig-rush Forest on the eastern edge of the subject land



3.3.5. Coastal Sands Littoral Scrub-Forest

PCT: 3546 – Coastal Sands Littoral Scrub-Forest

Status under EPBC Act: Not listed

Status under BC Act: Endangered Ecological Community

A small area of Coastal Sands Littoral Scrub Forest was mapped by EcoPlanning as part of their roadside vegetation assessment and where this mapping encroached into the subject land it has been incorporated, such as this small occurrence at the start of the access track to the east. See the EcoPlanning report for further details.

This vegetation has the potential to conform to the BC Act listed EEC Kurnell Dune Forest in the Sutherland Shire and City of Rockdale.

3.3.6. Exotic and Planted Vegetation Types

Following previous current advice from EHG, the best-fit PCT is applied to planted native vegetation, although it is understood that this may be assessed under the Streamlined Assessment Module – Planted Native Vegetation of the BAM in future DAs if it meets the set criteria. Nevertheless, PCTs have been allocated for each of the variations of planted vegetation types, as below.

A number of communities have been mapped in **Figure 14** which are represented by planted endemic native species, non-endemic native species, or exotic species. These communities are described below.

3.3.6.1. Coastal Fore-dune Wattle Scrub

PCT: 3788 – Coastal Fore-dune Wattle Scrub

Status under EPBC Act: Not listed

Status under BC Act: Not listed

Coastal Fore-dune Wattle Scrub has been planted on historically cleared fore-dunes, as shown in **Photograph 9**. It also occurs extensively on Lot 8.

The occurrence on the dunes has been entirely planted (by the Proponent) as part of fore-dune stabilisation and restoration works. Despite being a planted community, it can be associated with a native plant community type, due to the assemblage of native species present and its landscape context.

This community is simplified, with a shrub and midstorey dominated by *Acacia longifolia subsp. sophorae* (Coastal Wattle) and *Leptospermum laevigatum* (Coast Teatree), and a groundcover dominated by *Lomandra longifolia* (Spiny-headed Mat-rush), *Spinifex sericeus* (Hairy Spinifex), *Dianella caerulea var. producta* and *Asparagus aethiopicus* (Asparagus Fern).

This community is consistent with PCT 3788 – Coastal Fore-dune Wattle Scrub. It is of variable condition and in the area of Lot 8 is extensively dominated by weeds such as Bitou Bush (*Chrysanthemoides monilifera*).

Photograph 9 : Coastal Foredune Wattle Scrub on the fores dune of the subject land



3.3.6.2. Exotic

Exotic vegetation occurs in a narrow strip behind the coastal dune that have been revegetated with Coastal Foredune Wattle Scrub in the south of the subject land. This vegetation comprises predominantly sown *Cynodon dactylon* (Couch), along with occurrences of *Chrysanthemoides monilifera*, *Gamochaeta americana* (Purple Cudweed), *Hydrocotyle bonariensis*, *Plantago lanceolata* (Lamb's Tongue) and *Taraxacum officinale* (Dandelion). The minor occurrence of the native *Pelargonium australe* (Native Storksbill) was also recorded.

This area does not conform to any PCTs or TECs listed under the BC Act or EPBC Act.

3.3.6.3. Exotic Grassland and Cleared Land

Exotic grassland occurs in much of the subject land, including much of the horse stables facilities. The grassland is dominated by exotic grasses; *Cynodon dactylon* (Couch), *Conyza bonariensis* (Fleabane), and exotic herbs, including; *Chrysanthemoides monilifera*, *Plantago lanceolata* (Lamb's Tongues), *Taraxacum officinale* (Dandelion) and *Hydrocotyle bonariensis*, with sparse occurrences of native *Pelargonium australe* (Native Storksbill).

Within Lot 2 North, Exotic Grassland and Cleared Land occurs as shown in **Photograph 10**.

Photograph 10 : Exotic Grassland and Cleared Land (foreground) in the centre of Lot 2 North



3.3.6.4. Dune/Foreshore

Dune/Foreshore occur along the southern boundary of Lot 2 South and covers areas that do not include any significant coverage of vegetation and are predominantly sand and the rocky exposed areas of Pimweli Rocks.

This area does not conform to any PCTs or TECs listed under the BC Act or EPBC Act.

3.4. Flora

3.4.1. Flora Species

Due to historic clearance and modification of the subject land, there is low plant species diversity. Only 74 flora species were recorded across the subject land during the 2018 surveys, of which 42% are native and 58% are exotic species.

Overall, the most numerous species on site are herbaceous plants from the Asteraceae, Poaceae, Apiaceae and Juncaceae families.

3.4.2. Weeds

Exotic species dominate most areas of vegetation on the subject land, with the exception of Samphire Saltmarsh, *Sporobolus virginicus* Saltmarsh and a patch of Sydney Coastal Sand Swamp Scrub.

In NSW all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

A number of the exotic species recorded from the subject land are listed as 'Priority Weeds' within the Greater Sydney management area under the *NSW Biosecurity Act 2015*, including: *Asparagus asparagoides* (Bridal Creeper) and *Senecio madagascariensis* (Fireweed) have a 'Prohibition on Dealing', whereby the plant must not be imported into the State or sold. *Cortaderia species* (Pampas Grass) and *Olea europaea subsp. cuspidata* (African Olive) have a listed 'Regional Recommended Measure', preventing the spread of the species outside of the core area of occupancy.

Chrysanthemoides monilifera subsp. rotundata (Bitou Bush), which is the dominant weed species present throughout the subject land, is listed within a 'Biosecurity Zone', where it must be eradicated throughout the state; however, this excludes coastal land within 10 km of the mean high tide and would include the subject land. Other dominant weed species include: *Hydrocotyle bonariensis* throughout the subject land, and *Juncus acutus subsp. acutus* (Sharp Rush) in wetland and saltmarsh areas, which are not listed as Priority Weeds under the Biosecurity Act.

Under the National Weeds Strategy, 32 introduced plants have been identified as Weeds of National Significance (WONS). These weeds are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts. Weeds of National Significance recorded in the subject land include: *Chrysanthemoides monilifera subsp. rotundata*, *Asparagus asparagoides* and *Senecio madagascariensis*.

All weeds are listed in the flora species list in **Appendix C**.

3.4.3. Threatened Species

No threatened flora species were recorded, and no potential habitat was identified for the species recorded from the locality, as identified in the likelihood of occurrence assessment (**Appendix B**).

3.5. Fauna

3.5.1. Fauna Habitats of the Kurnell Peninsula

3.5.1.1. Terrestrial Habitats

The Kurnell Peninsula provides habitat for a range of fauna species, with terrestrial vegetation including coastal vegetation communities, woodland, sand forest, heathland, swamp forest, dune forest and scrub, located primarily in Botany Bay National Park to the east of the subject land, as shown in **Figure 13**. These coastal habitats provide structured and floristically diverse vegetation, which provides habitat for a range of birds, mammals, reptiles and some amphibians.

3.5.1.2. Wetland Habitats

The Kurnell Peninsula includes a diversity of aquatic environments. Quibray Bay to the west, which lies adjacent to Towra Point Nature Reserve, is a wetland listed under the Ramsar Convention on Wetlands of International Importance. Towra Point is one of 65 Australian Ramsar sites (DoE 2016).

Towra Point was first listed as a Ramsar Site in 1984, at which time it met Ramsar criterion 1, 2, 3 and 6. In 2009 the listing was re-evaluated and the site is now listed as meeting criteria 2, 3, 4 and 8. The criterion classifications are:

1. Representative, rare, or a unique example of a natural or near-natural wetland type found within the appropriate biogeographic region: Towra Point no longer meets this criterion as the biogeographic classification has been changed from the Biogeographic Regionalisation for Australia (IBRA) to Australian Drainage Divisions, which locates Towra Point in the much larger Southeast Coast Drainage Division as opposed to the Sydney Basin bioregion. There are more extensive areas of mangroves and salt marsh wetlands similar to Towra Point in the Southeast Coast Drainage Division, disqualifying it from listing as a rare or unique wetland (DECCW 2010).
2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities: Towra Point meets this criterion as it supports three species listed under the EPBC Act, and 23 threatened species and five endangered ecological communities listed under the BC Act (DoE 2016)
3. Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region: Towra point is recognised as one of the four most important migratory wading birds sites in NSW and Towra Spit Island as the second most important breeding area in NSW for the Little Tern (*Sterna albifrons*). It supports a diversity of flora and fauna specific to the region and for this reason meets the criterion for listing (DoE 2016).
4. Critical life cycle stages for plants or animal species: Towra Point meets this criterion due to its significance as an area for migratory species, Little Tern breeding and fish habitat (DoE 2016).
5. Supports 1% or more of the population of a waterbird species: Towra Point no longer meets this criterion as the international population of the Eastern Curlew (on which this was based) has increased (DECCW 2010).
6. Provides an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks depend: Towra Point meets this criterion due to its significance as an area for supporting fish habitat (DoE 2016).

Towra Point Estuarine Wetland is also listed as a Nationally Important Wetland under the Directory of Important Wetlands of Australia, published by the Commonwealth Department of Environment and Energy (DotE 2014).

The wetland is recognised for its significant saltmarsh and seagrass communities, and as a critical roosting and foraging habitat for diversity of migratory species; including three nationally threatened species, 24 threatened species and five endangered ecological communities protected under NSW legislation (DECCW 2010).

3.5.1.3. Shore Habitats

Bate Bay includes extensive beach habitat and rocky intertidal habitats, suitable for shorebirds and other marine and oceanic species. The Boat Harbour rock platform known as Pimweli Rocks is bordered by the Boat Harbour Aquatic Reserve, extends out to encompass Merries Reef (DPI).

3.5.2. Fauna Habitats on the Subject land

3.5.2.1. Terrestrial Habitats

Terrestrial fauna habitats are limited on the subject land, due to the lack of intact native vegetation. The habitats present have been significantly modified from what would have originally occurred, prior to the commencement of sand quarrying. Analysis of historical aerial imagery indicates that the subject land was completely cleared prior to 1950 and therefore prior to the commencement of sand quarrying, and areas of native vegetation present today have either regrown, or are established as artificial habitats either through planting, or alterations to drainage (discussed further in *Section ii* below).

Limiting resources are generally absent for a large range of species, due to the lack of structural complexity of vegetation (for cover, prey abundance, foraging resources), hollow-bearing trees, and a high diversity of fruiting and flowering plant species. Resources that are present include a low abundance of flowering Acacias, and fruiting Casuarinas, which provide foraging habitat for a range of birds and some mammal species.

3.5.2.2. Wetland Habitat

Wetland habitats are present on the south eastern boundary of Lot 2 North, adjoining the north eastern boundary of Lot 2 South on Boat Harbour Drive, and occur in Lot 8. These areas are characterised as Coastal Wetlands under the Resilience and Hazards SEPP, as shown in **Figure 17**. Wetlands provide important aquatic and semi-aquatic habitats for amphibians and wading birds, as described above. Within the subject land, the wetland habitats have been characterised as Moderate quality, based on a range of factors that determine the suitability for amphibians (focusing in particular on the habitat requirements of threatened species) and BC Act and EPBC Act list wading birds. **Table 8** shows the assessment of each wetland area, as represented by the aquatic survey locations in **Figure 12**.

Table 8 : Wetland Habitat Assessment Results

Wetland Area	Final Score	Assessed Quality
K-AQ2	9	Moderate
K-AQ4	11	Moderate

* Habitat assessment based on final score, where <8 = Low quality, 8-12 = Moderate quality, >12 = High quality habitat.

The habitat assessment was based on the cumulative score for eight determining factors, each measured during the survey.

- Fringing vegetation cover;
- Emergent vegetation cover;

- Vegetation around dam;
- Shallow dam edges;
- Varying water depth;
- Submerged rocks/logs;
- Plague minnow presence; and
- Turbidity.

Vegetation cover was given a percentage cover score correlating to a low (<10%), moderate (10-39%), or high (40-100%) cover abundance; providing a score of 1, 2 or 3 respectively. The remaining factors were scored as 0 or 1 based on presence/absence, with the final numbers totalled to give a score out of a possible 15.

3.5.2.3. Shore Habitats

As described for the Kurnell Peninsula, the subject land includes some shore habitats, in association with Bate Bay and Boat Harbour. The sand dunes and sand flats are known to be utilised by shorebirds, and provide foraging and potential nesting habitat for a range of species. However, the exposed nature of these habitats, and public access, including 4WD use, makes these less suitable than the proximate areas of Towra Point Nature Reserve, which is a key habitat area for the populations of shorebirds known from the Kurnell Peninsula. It is likely that the habitats present provide secondary foraging habitat, but are less likely to provide breeding habitat for the majority of shorebirds.

The rock ledge at Boat Harbour is frequently used for foraging and roosting by shorebirds, as part of their broader home range in the Kurnell Peninsula.

3.5.3. Habitat for Threatened and Migratory Species

Based on assessment of the habitat values present on the subject land, and the likelihood of occurrence of threatened species on the subject land (**Appendix B**), a number of threatened fauna species are considered to have potential to occur, as discussed below.

3.5.3.1. Green and Golden Bell Frog

The wetlands present on Lot 2 North have been classified as poor condition habitat for this generalist species, which was recorded historically (November 2001) on land directly adjoining the subject land (Biosphere Environmental Consultants Pty Ltd 2004). Surveys of the subject land by Cumberland Ecology in 2018 failed to record this species and recent thorough surveys of the subject land, including Lot 8, by the BAM expert Ross Wellington also failed to detect the species and determined it was unlikely to be present anymore within the subject land.

The majority of records for this species are more than twenty years old within the Kurnell Peninsula, with the more recent records being from 2012, from approximately 1 km to the west of the subject land and with several newer records from 2021 appearing between approximately 1 km and 1.5 km to the west of the subject land

again (EHG 2023c) in the vicinity of rehabilitated habitat areas associated with and/or adjacent to the Green Hills development by Australands and Breen Holdings

It is understood from Council that the local Kurnell population has been monitored annually between 2009 – 2011 within a portion of the Australand site to the west (Biosphere Environmental Consultants Pty Ltd 2009) (Biosphere Environmental Consultants Pty Ltd 2011), which is proximate to the Cronulla STP and the Kurnell Landfill, which represented core areas of habitat for the Green and Golden Bell Frog prior to 2012. It is thought likely that the natural local population has been in decline since the last known monitoring of the Kurnell population in 2011 (Biosphere Environmental Consultants Pty Ltd 2011).

No recent records of the species occur from the east of the subject land, where the range of the population once extended. Although, the habitat present in the east of the Kurnell Peninsula was thought to be utilised infrequently for movement, but not for breeding, as part of the review of population data undertaken for the preparation of the Management Plan for the Green and Golden Bell Frog Key Population at Kurnell (DECC, 2007). This Management Plan also suggested that the eastern extent of the population may be considered to be extirpated (DECC, 2007). However, a recent reintroduction of a Green and Golden Bell Frog population to the Kurnell Desalination Plant to the east of the subject land has been undertaken and is discussed in further detail in the report by Ross Wellington (AES 2023). With the only recent records to the west of the subject site and the re-introduced population to the east, the subject site has a strategically important corridor connectivity values linking the two parts of the Kurnell Peninsula and as recognised within DECC (2007). The implementation of the Masterplan is proposed to include the creation of north-south and east-west habitat corridors to facilitate interaction and movement of the species, which is not currently prioritised by the existing land uses. A further proposed integration of habitat creation initiatives as conservation measures for the GGBF within these corridors has the potential to bolster any remnant or reintroduced GGBF populations on adjoining properties thus actually implementing a major component of the Kurnell GGBF Key Population Management Plan developed on behalf of and endorsed by the Department (DECC 2007).

3.5.3.2. Wading and Shore Birds

A large number of wading and shore birds have been recorded in close proximity to the subject land, as listed in **Appendix C**. The Little Tern was recorded breeding within the post-rehabilitation area in 2018, and an Eastern Osprey was recorded along the 4WD track to Boat Harbour. In addition, the Crested Tern and the Little Tern have been recorded post 2018 on Pimweli Rocks and the Eastern Osprey was recorded along the rear of the coastal dunes in the south west of the subject land.

The Little Tern was recorded within the subject land while it was being used as an active sand quarry. There is limited habitat for the species to breed within the boundary of the subject land due the continuous land disturbance and quarrying works occurring, and it is noted that the current sand quarry approval will ultimately result in the post-rehabilitated state that is not consistent with the landform of this in area in 2018 when the Little Tern was recorded. In addition, the Eastern Osprey was recorded along the 4WD track that is publicly accessible and subject to human disturbance, The implementation of the Masterplan would allow for the creation of stable dune habitat along the coastline within the east to west corridor that would provide greater opportunities for nesting shorebirds than exist presently and would exclude 4WD use from these areas.

The subject land is likely to provide a small area of wetland habitat on the eastern side of Lot 2 North, and coastal habitats associated with Bate Bay Marine area to the south of Lot 2 South. Habitat associated with Bate Bay includes intertidal and beach habitats and potentially the dune habitats associated with Coastal Dune Wattle Scrub vegetation (which has been rehabilitated), as shown in **Figure 13**.

3.5.3.3. Bats

Foraging for a range of threatened insectivorous bats, as listed in **Appendix B**, is present across the subject land, in particular the aquatic environments. However, no maternity or roosting habitat is present for these microbats, due to a lack of hollows or caves for roosting.

3.5.4. Significance of Fauna Habitat in the Subject land

The terrestrial habitats in the subject land are not considered to be of local, regional or state significance, as they are small and in general highly degraded by previous land uses including sand quarrying. The natural recovery potential of these habitats has been assessed, as per the scope of works, and is generally considered to be very low, except for the wetland and estuarine habitats on the Lot 2 North and Lot 8. Reconstructed habitats have been successfully established in the case of the foredune to Lot 2 South, and this is considered likely to be able to be replicated across the post-rehabilitation area, subject to selection of appropriate species for establishment on VENM fill, as discussed further in **Chapter 6**.

Although the wider Kurnell Peninsula contains highly significant wetland habitats within the Towra Point Ramsar wetlands, which are also listed as Nationally Important Wetlands under the Directory of Important Wetlands of Australia, the wetland habitats associated with the subject land are generally degraded. Although some threatened species may utilise the subject land, the habitat available is not considered to be of local, regional or state significance.

As identified in the scope of works for biodiversity, there is significant opportunity to reconstruct the pre-occurring native vegetation communities and create linkages to areas of high biodiversity value in the Kurnell Peninsula, including along the foreshore to connect with Botany Bay National Park, buffer plantings to protect the sensitive habitats of Towra Point, and east-west corridors to provide better connection to large, retained patches of native vegetation in the Kurnell Peninsula. Corridors are discussed further in **Section 5.1.7**.

3.5.5. Fauna Species

A total of 41 Vertebrate species have been recorded from the subject land during this ecological assessment. A total species list for the project area is provided in **Appendix D**.

Each faunal group recorded on the subject land, or determined to have potential to occur based on the presence of suitable habitat is discussed below.

3.5.5.1. Microchiropteran Bats

Six microchiropteran bats (microbats) were confirmed within the subject land, including two cave roosting threatened species, the Little Bent-winged bat (*Miniopterus australis*) and the Eastern Bent-winged bat (*Miniopterus orianae oceanensis*) (**Appendix D**).

A number of microchiroptern bat calls were not reliably identified, and some calls may have been the threatened species Southern Myotis (*Myotis macropus*). This species is a fishing bat, foraging for insects and small fish over water. It roosts in trees and is known from the wider locality.

3.5.5.2. Amphibians

The water bodies within the subject land provide permanent water sources constituting habitat for a number of amphibian species. No Green and Golden Bell Frogs responded to the targeted call-playbacks or were observed in the subject land during any of the surveys by Cumberland Ecology in 2018 or by Ross Wellington in 2023. Survey results were supported by detailed habitat assessment, and consideration of existing data and the habitat present on the subject land was considered to be of poor condition for the species.

Four frog species were recorded within the subject land during the surveys; the Common Eastern Froglet (*Crinia signifera*), Striped Marsh Frog (*Limnodynastes peronii*), Eastern Dwarf Tree Frog (*Litoria fallax*) and Peron's tree frog (*Litoria peronii*). None of the recorded frogs are listed threatened species.

3.5.5.3. Diurnal Birds

The subject land supports a diversity of bird species, particularly marine and migratory species. A total of 27 bird species were recorded within the subject land during fauna surveys.

3.5.5.4. Reptiles

Reptile surveys were conducted alongside targeted Green and Golden Bell Frog surveys (during the diurnal basking frog surveys). No reptiles were recorded on the subject land during these searches or opportunistically throughout the other fauna assessments.

3.5.5.5. Mammals

A total of ten mammal species, including two exotic species were recorded within the subject land. This includes six microbats, one megachiropteran bat and three terrestrial mammals.

Two exotic pest species, the feral cat (*Felis catus*) (**Photograph 12**) and Red Fox (*Vulpes vulpes*), were recorded on site from infrared camera trap footage, and are considered to be common in the subject land.

Photograph 11 : Feral cat recorded using infrared camera on the subject land



3.5.6. Recorded Threatened Species

Five threatened species were recorded within the subject land:

- Little Tern (*Sternula albifrons*);
- Sooty Oystercatcher (*Haematopus fuliginosus*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Eastern Bent-winged bat (*Miniopterus orianae oceanensis*); and
- Little Bent-winged bat (*Miniopterus australis*).

3.5.6.1. Little Tern

The Little Tern (*Sternula albifrons*) is listed as Endangered under the BC Act. The Little Tern migrates from eastern Asia, and is found on the north, east and south-east Australian coasts. In NSW it arrives from September to November and occurs mainly north of Sydney. Within its extent, the Little Tern is a coastal species that prefers sheltered environments. They nest in small colonies on sandy beaches or in low dunes, near estuary mouths or adjacent to coastal lakes or islands (DEC (NSW) 2006).

The species was observed during diurnal bird surveys on the rock platforms and the sand dunes at the south-eastern portion of the subject land (**Figure 15**).

3.5.6.2. Sooty Oystercatcher

The Sooty Oystercatcher (*Haematopus fuliginosus*) is listed as Vulnerable under the BC Act. The Sooty Oystercatcher is found along the entire Australian coast, being most common in Bass Strait (NSW Scientific Committee 2004). They prefer coastal areas with rocky headlands and shelves, exposed reefs with rock pools, beaches and muddy estuaries. They breed almost exclusively on offshore islands or isolated promontories (NSW Scientific Committee 2004).

The species was observed during diurnal bird surveys in the south-eastern most area of the beach (**Figure 15**).

3.5.6.3. Grey-headed Flying-fox

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is listed as Vulnerable under the BC Act and EPBC Act. The Grey-headed Flying-fox is distributed primarily along the eastern coastal plain from Bundaberg Queensland, through NSW and south to eastern Victoria (NSW Scientific Committee 2014). Within its extent, the Grey-headed Flying-fox occurs in rainforests, open forest, woodlands, Melaleuca swamps and Banksia woodlands (NSW Scientific Committee 2014).

The species was observed both foraging and flying over the subject land, as shown in **Figure 15**. There is no permanent roosting camp in the subject land, and the species is expected to forage across the vegetated areas of the subject land.

3.5.6.4. Little Bent-winged bat

The Little Bent-winged bat (*Miniopterus australis*) is listed as Vulnerable under the BC Act. The Little Bent-winged bat is distributed along the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW (DEC (NSW) 2005c). Within its extent, the Little Bent-winged bat occurs in moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, melaleuca swamps, dense coastal forests and Banksia scrub, roosting in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day (NSW NPWS 2005).

The species was recorded by one of the Songmeter call detection units located in the north of the subject land (**Figure 16**).

3.5.6.5. Eastern Bent-winged bat

The Eastern Bent-winged bat (*Miniopterus orianae oceanensis*) is listed as Vulnerable under the BC Act. The Eastern Bent-winged bat is distributed along the east and north-west coasts of Australia (DEC (NSW) 2005b). Within its extent, the Eastern Bent-winged bat occurs within rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands (Churchill 2009) and primarily roost in caves, but also used derelict mines, stormwater tunnels, buildings and other man-made structures (DEC (NSW) 2005b).

This species was recorded at one location, in the north of the subject land (**Figure 15**).

3.5.7. Recorded Migratory species

Six (6) bird species listed under the EPBC Act were recorded on the subject land, most of which were listed as either Migratory species or Marine species (**Table 8**). One species; the Little Tern (*Sternula albifrons*), is also listed as Endangered under the BC Act.

Table 9 : EPBC Act listed bird species recorded on the subject land

Scientific name	Common Name	EPBC Act listing	BC Act listing
<i>Calidris ruficollis</i>	Red-necked Stint	Mig.	
<i>Falco cenchroides</i>	Nankeen Kestrel	Mar	
<i>Pelecanus conspicillatus</i>	Australian Pelican	Mar	
<i>Sternula albifrons</i>	Little Tern	Mig, Mar.	E
<i>Thalasseus bergii</i>	Crested Tern	Mig, Mar.	

Mig = Migratory, Mar = Marine, E = Endangered

3.6. Habitat Corridors

Habitat corridors have been identified and mapped in the Kurnell Peninsula, and an assessment of the conservation significance of these linkages is provided below.

Wildlife corridors are generally areas of habitat that connect reserves or blocks of disjunct habitat. Wildlife corridors allow wildlife to disperse and provide for gene flow between populations or subpopulations (Primack 1993). Wildlife corridors are of varying relevance to fauna and are of greatest relevance to ground dwelling species that cannot fly. Highly mobile birds and microbats can fly between patches of habitat, over human developments and clearings.

On a broad-scale, habitat corridors for terrestrial fauna have been identified across the Kurnell Peninsula, linking key habitat areas including Botany Bay National Park in the east and north east, and Towra Nature Reserve in the west, north west and north east. Additional areas of retained native vegetation, including: Lucas Reserve to the south west, Charlotte Breen Memorial Reserve to the west, and retained vegetation on private lands; La Perouse Local Aboriginal Land Council owned land, Sydney Water Desalination Plant and Cronulla STP and Landfill sites, maintain secondary corridors from east to west in the Kurnell Peninsula.

On a finer scale, habitat connectivity within the subject land is restricted to the southern corridor, including; foreshore vegetation, including native shrubland/scrub and also exotic dominated grassland, and to a lesser extent, the wetlands present in association with the large lake in the centre of the site, and the tailings dam in the south west. Narrow connections occur from south east to north west through private lands that adjoin the subject land, including industrial zoned lands to the north-north east, and the retained vegetation in Lot 2 north, which adjoins Towra Point nature Reserve.

Identified corridors in the Kurnell Peninsula are shown in **Figure 16**, which also provides an indication of the proposed locations for future corridors as envisaged in the Kurnell Corridor Study 2020 (DECC, 2009). The

conservation significance of the identified corridors is very high, and provides the most important linkages between habitat areas to the east and west of the subject land.

In accordance with the Master Plan, future corridors will be established throughout the Regional Open Spaces (**Figure 10**) as both east-west and north-south connections. The creation of these interconnected corridors will establish new fauna habitats throughout the Kurnell Peninsula that will significantly enhance the possibility of movement and interaction between species that may be isolated by the current lack of connecting vegetation throughout the Kurnell Peninsula. The corridors will include the significant patch of retained vegetation in Lot 8 that will adjoin Lot 2 South to the north east, and to Kamay – Botany Bay National Park to the south east.

4. Aquatic Ecology Results

4.1. Aquatic Habitats

Due to sand quarrying the aquatic habitat present at the time of survey has been artificially formed, and occurs in a constantly changing state. As per the methodology approved by DPIE, it is acknowledged that the 'base case' for assessment is post-rehabilitation.

At the conclusion of the sand extraction and land rehabilitation, Lot 2 South will be a brownfield site with the existing aquifer being filled, and finished levels consistent with the development consent that applies to the land. The landform will be one engineered exclusively from VENM such as sandstone, clay and sand and will exhibit the characteristics envisaged by the DPIE, when consent was issued to undertake these activities. The majority of Lot 2 South will have an altered land form following sand extraction and the placement of VENM, graded so that surface runoff and stormwater is collected within the site and directed and discharged into Botany Bay or directed into the sand environment within the site infiltrating to recharge the freshwater aquifer.

Existing aquatic biodiversity on Lot 2 south are not considered further in this assessment.

4.1.1. Wetland Habitats

A range of wetland habitats occur in the subject land, including freshwater wetland and estuarine wetlands.

An area of freshwater wetland habitat occurs in the subject land, mapped as Coastal Wetlands in **Figure 17**. This wetlands area occurs across the majority of the western low-lying area of Lot 2 North and in Lot 8 to the east. To the north, this community is a degraded form, with low species diversity, dominated *Typha orientalis* (Broad-leaved cumbungi), *Hydrocotyle bonariensis*, *Cynodon dactylon* (Couch) and *Juncus kraussii subsp. australiensis* (Sea Rush).

Estuarine wetland habitats occur in Lot 2 North, mapped as Samphire Saltmarsh and *Sporobolus virginicus* Saltmarsh in **Figure 14**. These areas are periodically inundated by saltwater and are saline (see **Photograph 5** and **Photograph 6**). Samphire Saltmarsh in the subject land has a low species diversity, dominated by reeds; *Juncus kraussii subsp. australiensis* (Sea Rush), *Ficinia nodosa* (Knobby Club-rush) and *Juncus acutus subsp. acutus* (Sharp Rush), with *Baumea juncea* occurring in the brackish areas at the margins of the saltmarsh. The *Sporobolus virginicus* Saltmarsh adjoins a Mangrove community that occurs within Towra Point Nature Reserve to the north and north east, and is dominated by Sea Rush, *Sarcocornia quinqueflora subsp. quinqueflora*, *Sporobolus virginicus* and *Baumea juncea* in the understorey with some occurrences of exotic species.

Wetland habitat provides important foraging habitat for a wide range of fauna species, in particular wetland birds, including many migratory birds listed under the EPBC Act. These species forage for prey in the productive, shallow waters of these wetland habitats that support a high density of invertebrate species.

In addition to the wetland habitats that are present within the subject land, it is located adjacent to Towra Point Estuarine Wetland, which is listed as a Nationally Important Wetland under the Directory of Important Wetlands of Australia. The wetland is recognised for its significant saltmarsh and seagrass communities, and as a critical roosting and foraging habitat for diversity of migratory species; including three nationally threatened species, 24 threatened species and five endangered ecological communities protected under the BC Act (DECCW 2010). Many of the wetland bird species that utilise the adjacent wetlands are likely to utilise wetland habitats in the

subject land on occasion, however the amount of wetland habitat in the subject land is minor in comparison to the large areas that are protected nearby in Towra Point Reserve.

4.1.2. Marine Habitats

No marine habitats are present within the subject land, however due to its location on Kurnell Peninsula, the subject land is in direct proximity to several areas of marine habitat and development within the subject land has potential to impact on these habitats.

To the south, the subject land is bounded by Bate Bay and Boat Harbour that open to the Pacific Ocean, as shown in **Photograph 12**. The Boat Harbour rock platform known as Pimweli Rocks is bordered by the Boat Harbour Aquatic Reserve, extending out to encompass Merries Reef (DPI). Boat Harbour Aquatic Reserve is recognised by the DPI as an important feeding ground for a number of shorebirds, including threatened species such as Sooty Oystercatchers and migratory waders.

Photograph 12 : Boat Harbour located in the south of the subject land



To the north, the subject land (Lot 2 North) is located in close proximity to Quibray Bay, and is separated from this waterway by a narrow strip of coastal vegetation. This area is part of the Towra Point Nature Reserve, and contains extensive areas of highly significant wetlands. This wetland is listed under the Ramsar Convention on Wetlands of International Importance, and is also listed as a Nationally Important Wetland under the Directory of Important Wetlands in Australia (see **Figure 17**).

Towra Point is recognised as one of the four most important migratory wading birds sites in NSW, and Towra Spit Island as the second most important breeding area in NSW for the Little Tern (*Sterna albifrons*). This reserve is recognised as a significant area for supporting fish habitat and for providing an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks depend.

The coastal waters of Bate Bay and Quibray Bay which adjoin the subject land provide important fish habitat within Southern Sydney, and has been mapped as Key Fish Habitat by DPI (**Figure 19**). This mapping is relatively broad and includes all coastal waters, as well as major waterways and inland lakes in the region.

Posidonia australis seagrass within Botany Bay is listed as an Endangered Population under the NSW *Fisheries Management Act 1994* and this population occurs within Quibray Bay in waters joining the north of the subject land (**Figure 20**). *Posidonia australis* plays an important role in providing nursery areas, feeding grounds and shelter for many aquatic species (NSW Department of Primary Industries 2012), and due to the reduction in abundance and geographic distribution of this species, particularly in six estuaries within the Sydney and Central Coast region they have been listed as endangered populations under the threatened species schedules of the NSW *Fisheries Management Act 1994*. No areas of *Posidonia australis* are mapped within Boat Harbour (NSW Department of Primary Industries 2012) and no patches of seagrass were observed during the snorkelling surveys conducted. Habitats within boat harbour mainly comprised rocky habitats dominated by various types of algae, including *Hormosira banksii* (Neptune’s necklace (**Photograph 13**)).

Photograph 13 : Algae present in Boat Harbour



4.2. Aquatic Species

As per the approved methodology, the post-rehabilitation landform of Lot 2 South will not include large areas of open water on the subject land.

Aquatic species could only be surveyed where standing water occurred, and hence aquatic survey sites from within the subject land (but outside of the 'post-rehabilitation area') were not able to be surveyed for macroinvertebrates.

4.2.1. Threatened Species

No threatened aquatic species listed under the FM Act, EPBC Act or the BC Act were found from either the Commonwealth Protected Matters Search Tool or the BioNet database search. No threatened aquatic species were recorded during the field surveys.

4.2.2. Aquatic Weeds

No aquatic weeds were recorded from the wetlands in the subject land, however several exotic rushes and reeds were recorded. These include the following species; *Juncus articulata*, *Juncus acutus subsp. acutus* (Sharp Rush), and *Cyperus eragrostis* (Umbrella Sedge). These species will be a priority to control during future development of the subject land.

4.3. Groundwater Dependiant Ecosystems

4.3.1. Definition

A number of definitions of GDEs are used within NSW and Australia. For the purposes of this assessment, GDEs are defined as per the definition provided in Volume 1 of the Risk Assessment Guidelines (GDE Guidelines) (Serov et al. 2012), which states that a GDE is "*any ecosystem that uses groundwater at any time or for any duration in order to maintain its composition and condition*".

GDEs can rely on groundwater for the maintenance of some or all of their species composition and ecological functions and this dependence can be variable, ranging from partial and infrequent dependence (i.e. seasonal or episodic) to total (entire / obligate, continual dependence) (Serov et al. 2012). The degree and nature of dependency influences the extent to which ecosystems are affected by changes to groundwater aquifers, both in quality and quantity (DoE 2009). In general, the majority of Australian ecosystems have little dependence on groundwater, however, there are some localised or extensive ecosystems in Australia with at least a high dependence on groundwater (Hatton and Evans 1998).

Four main types of GDEs have been identified (Hatton and Evans 1998) (Serov et al. 2012), as described below:

- Terrestrial vegetation – may depend on diffuse discharges of shallow groundwater to varying degrees, either to sustain transpiration and growth through a dry season or to maintain perennially lush ecosystems in otherwise arid environments;
- Wetland ecosystems – may depend on groundwater to keep them seasonally waterlogged or flooded;

- River baseflow systems – many river reaches have a baseflow component of groundwater discharge. This groundwater component may be vital to the character and composition of in-stream and near-stream ecosystems; and
- Aquifer and cave ecosystems – the biology of karst or limestone caves, particularly micro-organisms and invertebrates, are heavily dependent on groundwater availability.

4.3.2. Mapping of GDEs within the Kurnell Peninsula

The potential presence of GDEs within the Kurnell Peninsula and locality has been mapped as part of the Commonwealth's Atlas of GDEs (Bureau of Meteorology 2014) which *'incorporates multiple lines of scientific evidence including previous fieldwork, literature and mapping, and combines nation-wide layers of satellite remote sensing data'*.

The Atlas of GDEs maps ecosystems that interact with the surface expression of groundwater and subsurface presence of groundwater. Within the Kurnell Peninsula Terrestrial GDEs have been mapped as occurring further north on Towra Peninsula, and the entire Kurnell Peninsula has been mapped as containing subterranean GDEs (see **Figure 21**). The Atlas of GDEs mapping shows only terrestrial GDEs within the Kurnell Peninsula.

It should be emphasised that these are all only estimates of potential interaction, and are not supported by quantitative measurements.

4.3.3. Assessment of the Occurrence of GDEs within the Subject land

It is difficult to ascertain the degree of dependence of terrestrial ecosystems on groundwater, particularly given that the subject land is highly modified, and the drainage has been artificially altered, however the degree of dependence of vegetation on groundwater can be inferred by the depth to groundwater and the likely depth of the roots of the vegetation.

Coffey (2020) monitored the ground water levels and ground water flows for many years, with monitoring ongoing. Groundwater sampling and monitoring undertaken by Coffey indicate that prior to sand quarrying, groundwater occurred at shallow depths beneath Lot 2 South (0.5 to 3.5 m below ground level) and formed a mound beneath the more elevated parts near the centre of Kurnell Peninsula, with flow north towards Quibray Bay through Lot 2 North and to the south towards Bate Bay within Lot 2 South (Coffey 2020). Groundwater was between 0.5 and 1 m above sea level beneath Captain Cook Drive which separates Lot 2 North and Lot 2 South and met sea level at the shore of Quibray Bay. Seasonal variations in groundwater level naturally range between 0.7 m and more over short terms and 1.3 m and more over longer periods (Coffey, 2020). The potential sources of this variation are rainfall and surface run off from local catchment areas

Nevertheless, given the shallow depth of the groundwater in the subject land, it is assumed that due to the depth of their roots all of the treed vegetation present is likely to be able to access groundwater and can be considered to constitute GDEs.

As a high proportion of the subject land has been cleared, GDEs are currently likely represented by areas of Estuarine Swamp Oak Twig-rush Forest that remain in the subject land. In addition, the areas of wetland in the

subject land are also likely to constitute GDEs, as shown in **Figure 21**. These include areas of Samphire Saltmarsh, *Sporobolus virginicus* Saltmarsh and Sydney Coastal Sand Swamp Scrub. Although no detailed tests have been conducted to conclusively determine the reliance of these communities on groundwater, given the shallow depth to groundwater, it is reasonable to assume that these communities rely on groundwater for at least part of their water requirements. The two estuarine communities are likely to comprise GDEs in the category of “Estuarine and near shore Marine Ecosystems” according to the NOW Guidelines, while Sydney Coastal Sand Swamp Scrub would likely comprise “Groundwater Dependent Wetlands”. Areas of Estuarine Swamp Oak Twig-rush Forest would comprise “Groundwater dependent terrestrial ecosystems” under these guidelines.

Other communities, such as the exotic and planted vegetation are shallower-rooted and are not likely to be dependent upon groundwater as their roots would not penetrate far enough into the soil. The Coastal Fore-dune Wattle Scrub is also not considered likely to access groundwater due to its location on an elevated sand dune, which is likely to preclude access to groundwater due to the additional depth required for the roots to access the groundwater.

It is unknown to what extent future rehabilitated vegetation communities will rely on groundwater, but it will depend on the vegetation types. Wetland areas, to be created as part of the bioretention basins are likely to be groundwater dependant, as these will be in low-lying areas. The dune forest types are not likely to be GDEs as they are unlikely to require or be able to access, groundwater.

5. Opportunities for Ecological Restoration and Rehabilitation

5.1. Introduction

Under BAM (2020) there is a requirement to consider potential impacts from a proposed development and then to apply the following assessment hierarchy:

- Avoid – consideration should be given to designing to avoid or minimise potential development impacts;
- Mitigate – mitigation measures should be formulated to ameliorate the impacts remaining after avoidance has been implemented; and
- Offset – biodiversity offsetting should be proposed in order to compensate for any residual impacts that cannot be avoided or mitigated.

This chapter considers the measures that have been considered in order to avoid or minimise ecological impacts of the project. The Landscape and Open Space Strategy (Group GSA 2020b) provides plans for both avoidance and improvement of flora and fauna habitat values on site, and as such it is intended to be “nature positive”. It will provide for the restoration and revegetation of 141 ha or about 67% of the site as open space corridors and will significantly increase the coverage of native flora and fauna on site. This will be managed in perpetuity for ecological and cultural values, as set out in the Ecological and Cultural Management Strategy (Besmaw 2023) or “ECMS”.

5.1.1. Native Vegetation

A high proportion of the site has been cleared for sand extraction. However, a number of native plant communities were identified and these include Coastal Fore-dune Wattle Scrub in the southern extent of the subject land, and Sydney Coastal Sand Swamp Scrub, *Sporobolus virginicus* Saltmarsh, Samphire Saltmarsh and Estuarine Oak Twig-rush Forest in Lot 2 North, plus Coastal Fore-dune Wattle Scrub, Sydney Coastal Sand Swamp Scrub, and Estuarine Oak Twig-rush Forest in Lot 8.

Native vegetation will be retained and conserved. It will be augmented by substantial revegetation of the remediated sand quarry that will aim to regenerate ecological communities at risk elsewhere on the peninsular, including the threatened ecological communities of Littoral Rainforest, Kurnell Dune Forest, Bangalay Sand Forest and Freshwater Wetlands.

5.1.2. Dune Management

The coastal sand dune along Boat Harbour and Bate Bay has been historically denuded of native vegetation by erosion. Besmaw has rebuilt and rehabilitated the frontal sand dune and continues to manage this coastal vegetation, providing a stable dune covered by a native vegetation community, with only a low density of weeds (See **Section 3.3**).

A native plant nursery has been maintained on the subject land and is used to propagate local native plant species for the rehabilitation of the fore-dune and other areas on site. The nursery has used seeds and other propagules collected from original vegetation occupying the frontal dunes.

Under the Landscape and Open Space Strategy (Group GSA 2023b) this will be remediated and managed for conservation, forming a major east west corridor along Bate Bay.

5.1.3. Provision of Habitat for Green and Golden Bell Frog

The Green and Golden Bell Frog (GGBF) is listed as an Endangered species under the NSW BC Act (OEH 2017b), and as Vulnerable under the EPBC Act (DoEE 2017). It has been previously considered a species of significance at Kurnell and is known to still occur on parts of the Kurnell Peninsula. Considerations by the Department have concluded that the eastern element of the population is extirpated and resulted in a recent reintroduction proposal on the Veolia/SDP site adjacent. Furthermore, and as explained elsewhere in this report and within (AES 2023), it has not been found on site.

Under the landscape and open space plan (Group GSA 2023b) and consistent with both the draft recovery plan actions (DEC 2005) and with the Kurnell Key Population Management Plan for the species (DECC 2007), and consistent with or using elements of the GGBF Best Practice Habitat Guide (DECC 2008) substantial areas of potential new habitat will be created within the open space corridors. Habitat elements are planned to be included, providing potential foraging, breeding, and dispersal areas for the species, and hopefully complementing existing initiatives on the Veolia managed Sydney Desalination Plant lands immediately adjacent.

5.1.4. Migratory Waders and Shorebirds

Towra Point wetland is categorised as an area “Highest Fauna Values” due to it supporting important habitat for migratory shorebirds, waterbirds, and other avian species. In the adjacent saltmarsh and bushland, GGBF, Masked Owls and one of only two remaining populations of the White-fronted Chat exist in the region (OEH, 2013).

Boat Harbour Aquatic Reserve is recognised by DPI as an important feeding ground for a number of shorebirds, including threatened species such as Sooty Oystercatchers and migratory waders.

The subject land and adjacent wetland also fall within the East Asian Australasian Flyway, one of eight recognised international flyways. Flyways are broad corridors used by migratory species in their annual migration routes, and the site is regularly surveyed for migratory species presence by the Australasian Wader Study Group (AWSG) (AWSG 2015).

Revegetation of open space corridors within the subject land will also help to improve water quality and so improve water flowing into Quibray Bay, Bate Bay and Boat Harbour, which are significant habitats for migratory waders and shorebirds. Management of areas of open space, such as the dune areas and future wetlands, may also provide opportunities for migratory waders and shorebirds.

5.1.5. Opportunities to Provide Ecological Linkages

The Planning Proposal provides a major opportunity to restore and extend flora and fauna habitats on site and create linkages to other conservation sites, consistent with the Kurnell 2020: Corridor Delineation (DECC 2009). Remaining native vegetation will be retained and restored through active management. The quarry will be remediated and replanted with a range of local native species. In total this will create a major network of open space corridors totalling 141 ha (~67%) of the site.

Under the Landscape and Open Space Strategy (Group GSA 2023b) corridors will be established throughout the subject land with varying widths of up to 460m. The corridors will support the subject land's regeneration, strengthen the biodiversity values, allowing for the reintroduction of native flora and the movement of fauna across the Kurnell Peninsula. The new habitat corridors can be revegetated to link north-south, and east-west across the site. These will form habitat linkages with, and buffers to adjoining conservation areas include Towra Point Nature Reserve and Kamay Botany Bay National Park, Wanda Reserve.

5.1.6. Opportunities for Better Management of Water Quality to Protect Marine Reserves

Revegetation of open space corridors within the subject land will also help to improve water quality and so improve water flowing into Quibray Bay, Bate Bay and Boat Harbour, which have significant marine environments of high conservation value.

5.1.7. Provision of Buffers

The Planning Proposal will provide extensive areas of revegetated open space that will serve as buffers to a suite of significant ecological values on or close to the site. These include:

- Coastal Wetlands;
- Key Fish Habitats;
- Threatened Ecological Communities;
- Known habitats for threatened and migratory species; and
- Conservation areas (Towra Point Nature Reserve and Boat Harbour Aquatic Reserve).

The opportunities afforded by the Planning Proposal to avoid and buffer these entities are explained below:

5.1.7.1. Coastal Wetlands

Mapped Coastal Wetlands under the Resilience and Hazards SEPP surround the subject land, within the Towra Point Nature Reserve to the north of Lot 2 North, and wetlands on Lot 8 to the north east of Lot 2 South. The areas within the subject land mapped as Coastal Wetlands correspond to the wetland vegetation communities associated with Lot 2 North. The Coastal Wetlands represent a high ecological constraint to development, and the retention of these areas is proposed as part of the Master Plan.

The areas mapped as 'Proximity to Coastal Wetlands' surrounds the Coastal Wetlands on Lot 2 North and Coastal Wetlands in the adjoining Lot 8 (outside of the subject land) extends over a small portion of the Lot 2 South development site, and the Boat Harbour Drive access road.

The proposed development includes land mapped as 'Proximity Area' to the Coastal Wetlands, which acts effectively as a buffer area. The proposed development is contained primarily outside of the Proximity Area, although the building footprints are proposed to extend into the outer 50% of the Proximity Area (or 50m of the 100m applied buffer) in some locations, as shown in Ecological Constraints plan prepared by Group GSA (2020b). This can be balanced by the inclusion of rigorous water cycle management measures to be developed

as part of the proposal, including Water Sensitive Urban Design (WSUD) features, as described in the Water Cycle Management Assessment (Eco Logical Australia 2020). These WSUD features may include bioretention basins, located within the Proximity Area, in order to further buffer the Coastal Wetlands, and ensure that water quality and quantity entering the wetlands is at or beyond current levels, as described further in **Section 6.4**. The inner 50% of the Proximity Area will also contain some of the landscaped zones, in order to provide additional vegetated areas to enhance the buffering capacity to the Coastal Wetlands. The purpose of the Proximity Area is to protect the Coastal Wetlands from impacts from surrounding development. The proposed mitigation measures implemented for protection of the Coastal Wetlands are compatible with the function of the Proximity Area (wetland buffer). Therefore, it is not expected to have a negative impact on the ecological function of the Coastal Wetlands.

5.1.7.2. Key Fish Habitats

No key fish habitats occur on subject land but they occur to the north in Quibray Bay and to the south in Bate Bay. There are also some key fish habitats mapped on or closely adjacent to the north of the site, including mangroves and saltmarsh within Towra Point Nature Reserve.

Coastal Saltmarsh is part of the Coastal Wetlands that extend into Towra Point Nature Reserve (RAMSAR site). Saltmarsh is listed as Type 1 – Highly Sensitive Key Fish Habitats as defined by the Policy and Guidelines for Fish Habitat (DPI, 2013). A buffer of between 50 – 100 m from Type 1 habitat is required.

5.1.7.3. Threatened Ecological Communities

Two TECs have been identified on the subject land; Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions (Coastal Saltmarsh), and Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Oak Floodplain Forest) which are listed under the EPBC Act and the BC Act. Kurnell Dune Forest in the Sutherland Shire and City of Rockdale (Kurnell Dune Forest) may also occur in the subject land as it is associated with the Coastal Sands Littoral Scrub-Forest mapped by EcoPlanning along Captain Cook Drive. Kurnell Dune Forest is listed as an EEC under the BC Act and is not listed under the EPBC Act.

Coastal Saltmarsh occurs on the subject land within the Coastal Wetlands Area of Lot 2 North. Swamp Oak Floodplain Forest on the subject land occurs at the edge of the wetlands in Lot 2 North and in larger tracts in Lot 8. The location of TECs within the subject land is mapped in **Figure 14**.

5.1.7.4. Threatened and Migratory Species Habitats

The majority of the subject land is cleared of native vegetation, and therefore habitat for threatened and migratory species is restricted to areas of native vegetation. Wetland and estuarine habitats within Lot 2 North provide potential habitat for threatened and migratory wading birds, threatened bats, and marginal potential habitat for the Green and Golden Bell Frog (as identified in **Section 3.5.3**).

Threatened and migratory shorebirds, which are listed under the BC Act and/or EPBC Act primarily utilise habitats associated with Bate Bay Marine area, including intertidal and beach habitats (See **Figure 19**) and potentially the dune habitats associated with Coastal Fore-dune Wattle Scrub vegetation (see **Figure 14**).

The native vegetation on the subject land represents marginal foraging habitat for the Grey-headed Flying-fox (*Pteropus poliocephalus*), although the maternity camps that was present in the Kurnell Peninsula (within the Sydney Water Desalination Plant site), have relocated, and therefore no maternity sites are located close by. Foraging for insectivorous bats is present across the subject land, in particular the aquatic environments. However, no roosting habitat is present for these microbats.

The wetlands, estuarine and swamp habitats present on the subject land provide low quality potential habitat for the Green and Golden Bell Frog (*Litoria aurea*) which was recorded historically (November 2001 and in 2021) on land directly adjoining the subject land (Biosphere Environmental Consultants Pty Ltd 2004) (EHG 2023a). However, this species was not recorded during targeted surveys by Cumberland Ecology in 2018 or by Ross Wellington in 2023. The majority of records for this species are more than twenty years old within the Kurnell Peninsula, with the most recent being in in 2021 between approximately 1 km to 1.5 km to the west of the subject land and prior to that in 2012, from approximately 1 km to the west of the subject land. It is noted that since the 2018 surveys conducted by Cumberland Ecology a re-introduction of a Green and Golden Bell Frog population has been undertaken at the Kurnell Desalination Plant to the east; nevertheless, surveys of the subject land in 2023 by the BAM biodiversity expert, Ross Wellington, did not detect any occurrence of the species in the subject land.

- In consideration of the low likelihood of occurrence on the subject land, and the sub-optimal habitat present, any loss of potential habitat for the Green and Golden Bell Frog are unlikely to be significant constraint to development. Potential significant habitat for this species can be created as part of the proposed future development that would be accordance with the requirements for the creation and management of habitat outlined in the documents Protecting and Restoring Green and Golden Bell Frog Habitat (DECC (NSW) 2008b) and Best Practice Guidelines: Green and Golden Bell Frog Habitat (DECC (NSW) 2008a), as discussed in **Chapter 7**.
- However, as agreed previously with DPE, the focus should not be re-introducing historic biodiversity values but rather, integrating the site into the surrounding biodiversity network and improving connections and biodiversity corridors, and therefore it is not intended to re-introduce the species.

Adjoining wetland and marine habitats, located in conservation areas including Towra Point Nature Reserve, provide highly constrained habitat for these species, as described further in **Section 3.5.3.1**.

5.1.7.5. Groundwater Dependent Ecosystems

GDEs are limited on site due to the historic removal of the majority of the vegetation. The main areas of remaining native vegetation that are considered likely to comprise GDEs in the subject land are the areas of Estuarine Swamp Oak Twig-rush Forest and wetland vegetation types, as discussed in **Section 4.3**.

5.1.7.6. Nationally Significant Wetlands

The wetland area adjoining Lot 2 North identified in the Resilience and Hazards SEPP as Coastal Wetlands presents a high ecological constraint due to its habitat value for terrestrial and aquatic species, and water quality functions. Coastal Wetlands are protected under the CM Act and under the FM Act are categorised as Type 1 Sensitive Fish Habitats. All wetland vegetation on Lot 2 North, are included as high constraints.

Approximately 386 ha of wetlands occur in the Towra Point Nature Reserve which is an extensive area of wetlands that is protected under the Ramsar Convention. This area of habitat presents a high ecological constraint, which requires protection from indirect impacts from future development on the subject land, as discussed further in **Section 4.1.1**. However, the Master Plan would include implementation of best practice storm water management measures (Shrestha 2023) that would result in an opportunity to control, manage and monitor water throughout the subject land and surrounds. This would ensure a strategy is in place to protect the surrounding significant wetlands from unmanaged water runoff or release.

5.1.7.7. Significant Marine Areas

Significant marine habitats are present on and adjoining the subject land including the Boat Bay Aquatic Reserve (see **Figure 19**). As this is a Type 1 Sensitive Key Fish Habitat, this area must be buffered by 50 – 100m from development.

5.1.7.8. Endangered Population of *Posidonia australis*

An Endangered Population of *Posidonia australis*, as listed under the *Fisheries Management Act 2005*, occurs adjacent to the northern boundary of the subject land, in Quibray Bay (see **Figure 20**).

The endangered population of *Posidonia australis* is defined as Type 1 – Sensitive Key Fish Habitat, and is protected under the Fisheries Management Act, as described in **Section 5.1.1**.

5.1.8. Medium Ecological Constraints

The dune vegetation, which is required for landscape stability and habitat connectivity, represents a medium constraint to development. This vegetation represents a medium ecological constraint, as it is planted, and can therefore be easily replaced, does not conform to a TEC, and provides fairly limited habitat for threatened species. There is significant opportunity for expansion of this community on the final landform, and the buffer area to the habitat corridors identified in **Figure 16**.

5.1.9. Low Ecological Constraints

Low ecological constraints are represented by all non-native vegetation types, including exotic grassland, planted endemic trees (without the full structured community present) and urban native and exotics.

Cleared land represents no ecological constraints.

Areas of low ecological constraint present high opportunities for habitat corridors as part of the Master Plan. Substantial open space is proposed throughout the development area, as shown in the Site Plan in **Figure 10**. It is further suggested that as a mitigation measure that a wider corridor is developed through the middle of the subject land, to provide an additional 'stepping-stone corridor', as described in **Section 7.4**.

5.1.10. Recovery Potential

Habitats classified as high ecological constraints include TECs, and sensitive aquatic ecosystems. The recovery potential is generally high for TECs, despite moderate abundance of exotic species, and the communities would respond well to management. High constraint aquatic habitats on and adjoining the subject land are in good condition, being within aquatic reserves, and hence are already managed for conservation.

The Green and Golden Bell Frog is recognised as a species that has high fecundity, good dispersal capability and is a colonising species, that therefore has a high recovery ability according to the species' draft recovery plan (DEC (NSW) 2005a). The creation of proposed habitat corridors within the Regional Open Spaces will establish habitat for the species throughout the site consistent with the breeding, foraging, refuge and movement habitat features that the species needs throughout its various lifecycle stages (DECC (NSW) 2007), thus supporting the recovery potential for the Green and Golden Bell Frog throughout the Kurnell Peninsula.

Habitats classified as low ecological constraints are considered to have a low natural recovery potential. Due to the low diversity of native species, and prevalence of invasive exotics throughout the majority of the subject land, there is very limited potential for natural regeneration to occur. All non-native, planted and some areas of degraded wetlands are unlikely to contribute to the creation and enhancement of corridors within and across the subject land. It is therefore expected that a constructed landscape will be the final landform, post development, with the exception of the retained TECs and high ecological value attributes, as described above.

5.2. Conclusion

The Planning Proposal will provide for the avoidance of and retention of native vegetation on site. That vegetation will be substantially increased over time as a result of revegetation of the sand quarry with local native plant communities as explained in the ECMS. Such vegetation, combined with new ponds will create a sizeable, diverse network of new habitats that connect across the site to adjacent reserves of high conservation significance. The result is a nature positive development that will address the aims of Kurnell 2020: Corridor Delineation (DECC 2009).

6. Potential Ecological Impacts

6.1. Introduction

Under BAM (2020) there is a requirement to consider potential impacts from a proposed development and then to apply the following assessment hierarchy:

- Avoid – consideration should be given to designing to avoid or minimise potential development impacts;
- Mitigate – mitigation measures should be formulated to ameliorate the impacts remaining after avoidance has been implemented; and
- Offset – biodiversity offsetting should be proposed in order to compensate for any residual impacts that cannot be avoided or mitigated.

This chapter considers the potential ecological impacts that could still occur, considering the avoidance measures built into the Planning Proposal explained in the preceding chapter. This includes direct and indirect impacts as well as prescribed impacts identified by the BAM, and cumulative impacts.

6.2. Direct Impacts

As shown in **Figure 9**, the proposed footprint for the development is located in areas cleared and disturbed for quarrying. There is no proposal to clear remaining native vegetation and therefore no direct impacts are likely to occur due to the construction of the development. However, there is a requirement for the provision of asset protection zones (APZs) for bushfire protection of residential areas, which may result in some selective removal of vegetation in open space areas to maintain appropriate fuel loads.

Inner and outer APZs are required within the open space areas, as set out in the Landscape and Open Space Strategy (Group GSA 2023b) and the bushfire assessment. Where these are to be prepared, there is potential to:

- Clear native vegetation; and
- Limit the density of replanted vegetation.

As set out in the bushfire assessment, inner APZs require canopy cover of no more than 15%, while outer APZs require canopy cover of no more than 30%. If implemented as shown in **Figure 11**, then this will result in a mosaic of vegetation structure across the open space area.

Native vegetation subject to APZs will be kept at a minimum and the scale of APZs required will be refined and reduced where feasible in the future, as the development proposal is further refined. For example, there is a plan for the recreation of ponds and associated habitats to provide for potential habitats of the Green and Golden Bell Frog. Details about the configuration and location of such ponds will be refined as the development proposal is progressed. Where appropriate, the location of such ponds will be incorporated into the APZs and used to reduce the extent of APZs required in areas of native vegetation.

6.3. Potential Indirect Impacts

Indirect impacts are those that result indirectly as a consequence of the construction or operation of a proposal, and usually impact on adjacent areas that are not directly impacted by habitat clearance. Indirect impacts can include noise, dust, light spill, weed invasion, erosion, spread of disease, etc. Potential indirect impacts of the project are considered below in subsequent subsections.

6.3.1. Noise

The proposal will produce elevated levels of noise during the construction stage due to the operation of the machinery required for excavation and construction. Subsequently, noise levels will reduce during the operational stage of the development, however there will still be intermittent noise from vehicles and people. Noise can affect animal physiology and behaviour, and if it becomes an ongoing stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. Other potential impacts of noise include habitat loss through avoidance, reduced reproductive success and a retreat away from favourable habitats (AMEC 2005).

The majority of the subject land currently does not provide significant habitat for native species and the construction of the development is expected to be largely complete by the time that the habitat corridors and open space areas have developed sufficiently to provide habitat for native species. Accordingly, as few species are likely to be present, the noise impacts to fauna during construction are expected to be minor. It is likely that most animal species that currently occur will habituate to the periodic noise disturbance (AMEC 2005), and the construction phases of future development are likely to cause only temporary disturbance. It is also important to recognise that the subject land has been subject to sand quarrying for a long period of time, which required the regular operation of heavy machinery and therefore the fauna species that currently occur are used to high levels of noise in the environment. After construction is complete, the low levels of operational noise are not likely to exceed the previously experienced noise levels. Therefore, it is considered unlikely that noise levels will have a significant, long-term, impact on any wildlife populations.

6.3.2. Dust

Future construction and development activities have the potential to generate dust, which may result in negative consequences on the ecological values of the subject land and adjacent areas. This includes negative impacts on plant health and impacts on fauna species that utilise these plants as food resources or habitat. Dust pollution can lead to a decrease in habitat quality which has the potential to extend the area of impact beyond the direct footprint of future developments.

In the subject land, the impacts from dust are likely to be restricted to the construction phase. However, the majority of the subject land currently does not provide significant habitat for native species and the construction of the development is expected to be largely complete by the time that the habitat corridors and open space areas have developed sufficiently to provide habitat for native species. Accordingly, as few species are likely to be present, the potential impacts of dust during construction are expected to be minor and able to be managed with the implementation of standard dust minimisation protocols. Any increase in dust levels is expected to be localised to the subject land and immediate surrounds, and due to its temporary nature, is unlikely to have significant, long-term impact on existing biodiversity.

6.3.3. Light Spill

Construction and future development of the subject land has the potential to increase the level of artificial light in the natural environment which may adversely impact wildlife by direct glare, chronic or periodic increased illumination and temporary unexpected fluctuations in light levels (Saleh 2007, Longcore and Rich 2010).

The impacts of light during the construction stage of the project is likely to be minor as the majority of the subject land currently does not provide significant habitat for native species. Night works are not expected to be required and lighting is expected to be limited.

The future operational stage of the project will result in some increases to light levels due to street lighting, vehicle lights, and light spill from windows. Although these will have some effect on the surrounding environment and future open space areas, the impacts from light pollution are expected to be minimal and localised to the subject land and immediate surrounds. Detailed design will ensure that lighting will be directed away from high value habitat areas and surrounding areas of open space. It is expected that fauna species will become habituated to the increased light levels and light pollution from the future developments is unlikely to have a significant or long-term impact on any fauna species.

6.3.4. Weed Invasion

Alterations to habitat conditions often favour introduced and/or hardy native plant and animal species that can proliferate in disturbed conditions. Such species have potential to impact upon the original local native plant and animal species. Weeds such as exotic grasses and other introduced plants have potential to outcompete regenerating native plant species and result in changes to community composition.

The construction of the project has the potential to facilitate weed invasion due to the soil disturbance and through the inadvertent introduction of weeds on machinery or vehicles. That notwithstanding, the subject land is already highly disturbed due to many years of sand quarrying which has resulted in the complete alteration of the landscape and the proliferation of weeds. Over 50% of the flora species recorded from the subject land are exotic weeds. Therefore, the potential for significant increases in weeds as a result of the construction of the project is considered to be low. There is some minor potential for the operational stage of the project to result in weed invasion through exotic garden plants escaping into surrounding areas of open space and reconstructed native vegetation.

As detailed in **Chapter 7**, a range of mitigation measures will be implemented including the preparation of a detailed Weed Management Plan and a Vegetation Management Plan, which will include weed control measures. Construction site hygiene measures will be implemented to prevent entry of new weeds to the area such as the cleaning of equipment prior to entering the subject land.

Considering the already highly degraded condition of the subject land and with the implementation of the mitigation measures listed above, it is not considered that the development of the project will result in substantial impacts due to weeds. Rather, ongoing management of the open space areas and biodiversity corridors will result in a reduction in the weeds present and an improvement in the long term.

6.3.5. Feral Animal Invasion

Vegetation clearance and land disturbance has the potential to encourage feral animals. Feral animals such as foxes, rabbits and some species of overabundant native birds can more readily breed in the more open areas following clearance of forest and woodland. They can cause problems for native fauna species by preying upon them or by competing with them for food and resources.

As discussed previously, the subject land is already highly disturbed due to many years of sand quarrying which has resulted in the complete alteration of the landscape. No clearing will take place in the development footprint which has already been totally cleared. Accordingly, it is considered unlikely that the proposal will result in any disturbance that will facilitate the invasion of feral animals further than current conditions.

6.3.6. Spread of Disease

There is potential for the proposed development works to increase the risk of infection of native plants with *Phytophthora cinnamomi*. This plant pathogen can spread easily, causing disease, death and potential extinction in susceptible plants, and loss of habitat for animals.

Any activity that moves soil, water or plant material can spread *Phytophthora*, including earthworks for construction of the project. Although it has not been recorded from the subject land to date, there is potential for it to be introduced during construction. To minimise the likelihood of introduction of the disease, wash-down stations will be established and all construction vehicles entering and leaving the subject land will be required to be washed down to prevent pathogens entering or leaving the site.

With the implementation of appropriate mitigation measures, it is considered unlikely that *Phytophthora cinnamomi* will be introduced into the subject land.

6.3.7. Erosion and Sedimentation

The future construction stages of the proposal have the potential to increase sedimentation and turbidity of adjacent waterways and the marine environment, with flow on effects to the aquatic values of these areas. The project will result in a significant amount of soil disturbance for the creation of roads, infrastructure and housing throughout the subject land, with an associated increase in the potential for erosion and consequent impacts. Erosion may also be exacerbated by any kind of vegetation clearance, given the role that vegetation plays in stabilising soils. Turbidity in streams in disturbed catchments is closely connected with rainfall and surface runoff, with spikes in turbidity typically occurring after rain events. Turbidity levels then reduce as flows return to normal.

Suspended particulates (turbidity) can influence the aquatic ecosystem when:

- In suspension – when in the water column particulates reduce light penetration and thus primary production as well as affecting gill function of fish; and
- Settling out – when settled sediments can smother organisms and their habitats (ANZECC and ARMCANZ 2000).

Sediment movement can also mobilise nutrients and pollutants to adjacent aquatic and marine habitats. Soils from the exposed areas, and potential pollutants, will be readily mobilised into local drainage lines and water bodies via erosion processes. The potential for mobilisation of soils and potential pollutants will be maximised after rain events and during high winds. Nutrient pollution has the potential to impact upon a system via the stimulation of growth of nuisance plants and cyanobacteria (ANZECC and ARMCANZ 2000). Growth of these plants can lead to changes in the biological community composition as well as flow on effects to habitat suitability and aspects of water quality such as DO concentration which can impact upon aquatic fauna communities.

Sedimentation has the potential to impact negatively on *Posidonia australis* seagrass communities. The relatively high light requirements of seagrasses make them vulnerable to decreases in light penetration of coastal waters (NSW Department of Primary Industries 2012), which may be caused by sedimentation. Seagrass may also be directly smothered by sediment as it settles out of the water column, and can either settle on the plant directly, thereby reducing photosynthesis, or in extreme cases can smother the seagrass completely, leading to mortality. Nutrient enrichment from erosion also has the potential to impact on seagrass through eutrophication, leading to excessive growth of algae which de-oxygenates the water and further reduces light availability to the seagrass (NSW Department of Primary Industries 2012).

Although the project has the potential to increase the rates of erosion and sedimentation in the subject land, this area has been subject to intensive soil disturbance for many years from the sand quarry. Taking into consideration the significant soil disturbance that has already taken place in the subject land, the project is not likely to significantly increase the level of soil disturbance relative to current conditions.

Although erosion and sedimentation can potentially give rise to significant impacts on aquatic and marine ecosystems, the impacts are manageable through implementation of appropriate mitigation measures. Measures to minimise sedimentation and erosion will be developed at the detailed design phase of the Planning Proposal and best practice measures will be identified to prevent and minimise sedimentation and erosion on adjacent waterways and wetlands. This includes the implementation of sediment control and reduction measures such as sediment fences, covering soil stockpiles and avoiding soil disturbance during heavy rainfall.

Further details of the measures to be implemented to avoid sedimentation of nearby aquatic receiving environments will be provided in a detailed Erosion and Sediment Control Plan (see **Section 7.5**) that will be prepared prior to any soil disturbance for any DA facilitated by the Planning Proposal. This will provide details of the measures that will be implemented to prevent any uncontrolled run-off of water or sediment from the subject land entering Quibray Bay or Bate Bay. With the implementation of comprehensive sedimentation control measures, it is considered unlikely that the project will result in an increase in sedimentation of marine habitats.

6.3.8. Stormwater Discharge and Water Quality

Post development, there is the potential for stormwater discharge and urban run-off to carry pollutants from urban areas, into the aquatic environment, thereby impacting on water quality. This will be exacerbated by the increase in 'hard stand' area and decrease in water retention and infiltration post development.

Although the project has the potential to result in water quality impacts aquatic and marine ecosystems, the impacts will be manageable through implementation of a comprehensive range of mitigation measures that will be developed at the detailed design phase of the Planning Proposal. This includes the preparation of a Water Cycle Management Plan (see **Section 7.7**) that will be implemented prior to the commencement of construction. One of the key water management measures already identified is the construction of water detention basins and wetlands to capture stormwater and manage surface flows and runoff in the subject land. In addition, rainfall runoff will be conveyed towards and detained within bioretention swales/depression located at various sites across the development. Stormwater runoff will be retained onsite where possible and will be attenuated within the swales and onsite detention basins, allowing the water to infiltrate to the underlying groundwater system and discharge to Quibray Bay. The WSUD strategy would be to provide a combination of bioretention swales, basins and wetlands along the treatment train to ensure that the system enables a Neutral or Beneficial Effect (NorBE) on the receiving environments.

The Planning Proposal will be developed utilising best practice measures to prevent and minimise water quality impacts. With the implementation of appropriate water quality control measures, it is considered unlikely that water quality will decrease because of stormwater discharge or urban runoff such as to impact on the Towra Point Aquatic Reserve and associated seagrass, mangrove and saltmarsh communities.

6.3.9. Changes to Groundwater Levels & Impacts to GDEs

Theoretically, the filling and rehabilitation of the sand quarry could result in changes to groundwater, which in turn could impact GDEs on and off site. Additionally, due to the proximity of the site to Towra Point conservation reserves, there is potential for changes to subterranean flows of freshwater to impact upon estuarine ecosystems. However, this is not considered to be likely, for reasons set out below.

Groundwater sampling and monitoring undertaken by Coffey indicate that prior to sand quarrying, groundwater occurred at shallow depths beneath Lot 2 South (0.5 to 3.5 m below ground level) and formed a mound beneath the more elevated parts near the centre of Kurnell Peninsula, with flow north towards Quibray Bay through Lot 2 North and to the south towards Bate Bay within Lot 2 South (Coffey 2020). Groundwater was between 0.5 and 1 m above sea level beneath Captain Cook Drive which separates Lot 2 North and Lot 2 South and met sea level at the shore of Quibray Bay. Seasonal variations in groundwater level naturally range between 0.7 m and more over short terms and 1.3 m and more over longer periods (Coffey, 2020). The potential sources of this variation are rainfall and surface run off from local catchment areas.

Coffey (2020) has monitored the ground water levels and ground water flows for many years, with monitoring ongoing. This work has also modelled future groundwater levels and confirmed that the rehabilitated site will not alter the groundwater levels as the quarry is filled and rehabilitated.

No change in groundwater level is anticipated beneath Lot 2 North and observed groundwater levels between 2007 and 2019 are consistent with anticipated groundwater levels after rehabilitation in Lot 2 South and Lot 8. That is, groundwater levels will be like those currently observed in the western two-thirds of Lot 2 South and will rise in the eastern one-third when the hydraulic boundary of the dredge pond is replaced by VENM fill during rehabilitation (Coffey 2020). Furthermore, it is understood that stormwater quality and quantity is also not to exceed pre-development (base case scenario levels). All stormwater flows and water quality that exceed the base case are to be treated and managed on site before being discharged into the environment. Accordingly, increased stormwater run-off is not expected to impact on groundwater levels.

As no decrease in depth to groundwater is anticipated the development it is considered unlikely that GDEs in or adjacent to the subject land will be impacted by reduced groundwater levels. The final landform will result in changes to the landform where development will occur, but the landform of surrounding areas will remain unchanged and the depth to groundwater in these areas is also expected to remain unchanged. Accordingly, no impact to nearby GDEs within or surrounding the subject land is expected to occur.

6.3.10. Indirect Impacts to Towra Point Conservation Reserves

The northern part of the site adjoins Towra Point Nature Reserve, which is the largest and most diverse estuarine wetland complex remaining in the Sydney region (NPWS 2001). The nature reserve and nearby wetlands are vital to the viability of important remnant terrestrial vegetation and wildlife habitats that contain rare or threatened species.

Towra Point has been declared a wetland of international importance under the Ramsar Convention. Under Ramsar, and other inter-governmental agreements, the Federal and NSW governments are obligated to protect the endangered and migratory birds and the wetland habitats at Towra Point.

Towra Point Aquatic Reserve, adjoins the nature reserve, includes much of the remaining important seagrasses (including the endangered population of *Posidonia australis*), mangroves and migratory wading bird habitats in Botany Bay (NPWS 2001). It represents major habitat supporting commercial and recreational fish stocks in the coastal Sydney region.

These two conservation reserves complement each other and are intended to protect the most significant wetlands and shallow marine habitats remaining in the Sydney region. The natural resources they conserve benefit to the environmental health of Botany Bay and to the amenity of the Sutherland Shire and Sydney region.

Threats to Towra Point ecosystem, especially introduced species, pollution and human induced erosion of wetlands at Towra Point, have been the subject of much concern over recent decades (NPWS 2001).

While the proposal has potential for indirect impacts from changes to stormwater and changes to human activity on the site, it will be nature positive and will help to augment and protect the two adjacent conservation reserves. Existing wetlands that adjoin Towra Point Aquatic Reserve will be rehabilitated and will be dedicated to add additional habitat and buffer lands to the reserve.

The proximity of the site to Towra Point Aquatic Reserve is noted in the BAR and mitigation measures are proposed to protect the reserve in Chapter 7, within the ECMS and within the Stormwater Assessment (Shrestha 2023).

Chapter 7 and the ECMS provide a suite of measures that address physical disturbance from clearing riparian vegetation and foreshore development. The Stormwater Assessment provides detailed information about plans for management of stormwater to provide for high quality management of stormwater discharge in a way that protects the marine estate.

Overall, the Planning Proposal is predicted to benefit the two Towra Point conservation reserves, by providing additional wetland and terrestrial vegetation buffers, and by providing extensive storm water controls to maintain or improve water quality entering the wetlands from the site.

6.3.11. Indirect Impacts to Sea Grass (*Posidonia australis*)

As stated above, Towra Point Aquatic Reserve, adjoins the nature reserve, includes much of the remaining important seagrasses (including the endangered population of *Posidonia australis*), mangroves and migratory wading bird habitats in Botany Bay (NPWS). It represents major habitat supporting commercial and recreational fish stocks in the coastal Sydney region.

Within the Sydney region, including Towra Point, fragmented endangered populations of *Posidonia australis* are known to be subjected to many ongoing pressures including:

- The construction of foreshore structures such as jetties, pontoons and berthing areas which cause shading and loss of seagrass;
- Dredging;
- Damage from anchors, boat propellers, moorings and other boating related activities;
- Increased sediment entering waterways which can smother seagrass and block light;
- Trampling of seagrass beds due to wading by humans and domestic animals;
- Extreme storm events can dislodge large areas of *Posidonia*. Stormwater discharges can also change water quality and salinity levels; and
- Climate change.

There are none of the direct impacts that will occur because of the Planning Proposal to the *Posidonia* beds in Towra Point Aquatic Reserve. In theory, there is potential for future developments to cause changed to water quality, including turbidity, sedimentation and nutrients. However, as mentioned above for the two Nature Reserves, the Planning Proposal will have a beneficial impact on Towra Point by permanently conserving wetlands on site and subjecting them to active management. There will also be mitigation measures to protect the reserve in Chapter 7 of the BAR, within the ECMS and within the Stormwater Assessment (Shrestha 2023).

6.3.12. Human Disturbance

There is potential for impacts to occur on existing biodiversity values in the subject land as a result of human disturbance. This includes access to and interaction with sensitive coastal environments including fishing, collecting, rubbish dumping and trampling. These impacts are likely to be exacerbated by the Planning Proposal which will result in a higher population density and increased access to areas of biodiversity value such as the coast and areas of native vegetation.

These potential impacts can be mitigated through the implementation of appropriate measures. These may include but are not limited to the following:

- Fencing to exclude unwanted access to particular environments;
- Informative signage regarding the value of the area and what activities are prohibited;
- Provision of sufficient garbage bins to avoid littering, and;
- Appropriate penalties for inappropriate access.

It is expected that through a combination of education and exclusion fencing, human disturbance will be able to be appropriately managed.

6.4. Prescribed Impacts

Prescribed impacts are identified in Clause 6.1 of the *Biodiversity Conservation Regulation 2017*. Prescribed impacts are those that are additional to the clearing of native vegetation and associated habitat. These include the following impacts:

- Development on the habitat of threatened species or ecological communities associated with:
 - karst, caves, crevices, cliffs, rock outcrops and other geological features of significance;
 - human-made structures;
 - non-native vegetation;
- Development on areas connecting threatened species habitat, such as movement corridors;
- Development on movement of threatened species that maintains their lifecycle,
- Development on water quality, water bodies and hydrological processes that sustain threatened species and TECs (including from subsidence or upsidence from underground mining);
- Wind turbine strikes on protected animals; and
- Vehicle strikes on threatened species or on animals that are part of a TEC.

Of the prescribed impacts listed above, there is potential for impacts on the following as a result of the development:

- Habitat connectivity;
- Impacts on the movement of threatened species;
- Impacts on water quality and waterbodies; and
- Impacts of vehicle strikes

These are considered in more detail below.

6.4.1. Habitat Connectivity

Potential indirect impacts on threatened and migratory species may potentially occur from interrupting movement corridors for some highly mobile species across a broader landscape, through the construction of multi-level structures. However, the subject land is already highly fragmented, and the potential for this indirect impact to be exacerbated by development of a portion of land within the subject land which will form the future project's 'Disturbance area' is very minimal. Furthermore, there will be significant areas of planting of native vegetation throughout the MasterPlan area, as shown in the Site Plan (**Figure 2**). This will provide both habitat corridors (along the foreshore), and 'stepping-stone corridors' throughout the planted and open-space areas and bio-retention basins. In this regard, the MasterPlan will increase habitat connectivity, and will therefore increase connectivity, far beyond current conditions.

6.4.2. Impacts on the Movement of Threatened Species

As outlined in **Section 6.4.1** above, the project is unlikely to have any impacts on the movement of threatened species. The subject land is currently highly fragmented, and there will be significant areas of planting of native vegetation throughout the MasterPlan area, as shown in the Site Plan (**Figure 8**). This will provide both habitat corridors (along the foreshore), and 'stepping-stone corridors' throughout the planted and open-space areas and bio-retention basins. In this regard, the MasterPlan will increase the ability of threatened species to move between areas of habitat, and will therefore increase connectivity, far beyond current conditions.

6.4.3. Impacts on Water Quality and Waterbodies

As discussed previously in **Section 6.3.8**, post development, there is the potential for stormwater discharge and urban run-off to carry pollutants from urban areas, into the waterbodies of Bate Bay and Quibray Bay, thereby impacting on water quality. This will be exacerbated by the increase in 'hard stand' area, and decrease in water retention and infiltration post development.

According to the storm water management plan (Shrestha 2023):

Within this report requirements for the proposed development that were identified through the Scoping Proposal process have been identified and summarised. The proposed methodology and measures proposed to be implemented to address them has been identified and discussed. The key elements of concern within the areas of Coastal Management, Environmental Impacts and Flooding have each been reviewed and addressed within the proposed design to ensure that the development will have a Neutral or Beneficial Effect on the receiving waters outside of the proposed site boundaries. Both parts of the development have a proposed Stormwater Management and Treatment train including Onsite Detention, Onsite Retention and

Reuse, Gross-Pollutant Traps, Stormwater Filters Bio-Retention Swales/Basins, Grassed Swales and Wetlands to ensure that both the Water Quantity and Quality discharging from the site do not exceed the identified baseline levels or Authority Guidelines.

Although the project has the potential to result in water quality impacts aquatic and marine ecosystems, the impacts are likely to be manageable through implementation of a comprehensive range of mitigation measures. Measures to minimise water quality impacts will be developed at the detailed design phase of the Planning Proposal including the preparation of a Water Cycle Management Plan (see **Section 7.7**) that will be implemented prior to the commencement of construction. One of the key water management measures is the construction of water detention basins to capture stormwater and manage surface flows and runoff in the subject land. In addition, rainfall runoff will be conveyed towards and detained within bioretention swales/depression located at various sites across the development. Stormwater runoff will be retained onsite where possible and will be attenuated within the swales and onsite detention basins, allowing the water to infiltrate to the underlying groundwater system and discharge to Quibray Bay.

The Planning Proposal will be developed utilising best practice measures to prevent and minimise water quality impacts. With the implementation of appropriate water quality control measures, it is considered unlikely that water quality in the receiving waterbodies will decrease because of stormwater discharge or urban runoff.

6.4.4. Impacts of Vehicle Strike.

The construction of roads, houses and driveways as a result of the project will result in an increase in vehicles that will traverse the subject land and will increase the risk of fauna vehicle strike.

However, the risk of vehicle strike will only occur within the proposed road network and it is expected that the numbers of wildlife struck by cars will be very low. This is because the subject land is not utilised extensively by fauna and it is considered unlikely that any species will be impacted to any extent by vehicle strike. Furthermore, it is expected vehicle movement will be slow (<50km/hr speed limits) throughout the subject land and the potential increase in fauna vehicle strike will be minimal. It is recommended that appropriate signage be installed to inform motorists of the potential for fauna collisions.

With the implementation of the low speed limits and informative signage, it is not expected that the impacts of vehicle strike will be significant.

6.5. Cumulative Impacts

The future project will add to the cumulative gain of native vegetation in the region, through the proposed planting, which far exceeds the existing conditions. The majority of the broader Kurnell Peninsula consists of conservation areas, and hence the future development of the Kurnell Peninsula will be restricted to smaller private landholdings, if zoning permits. However, the SEPP Amendment will facilitate the strategic rehabilitation of native communities, including wetland habitats and corridors, which will mitigate the impacts of habitat removal across the Kurnell Peninsula as a whole. Furthermore, there will be significant areas of planting of native vegetation throughout the MasterPlan area, as shown in the Site Plan (**Figure 8**). This will provide both habitat corridors (along the foreshore), and 'stepping-stone corridors' throughout the planted and open-space

areas and bio-retention basins. In this regard, the MasterPlan will increase habitat connectivity far beyond current conditions, resulting in a cumulative gain in biodiversity values.

6.6. Conclusion

The proposed footprint for the development is located in areas cleared and disturbed for quarrying. There is no proposal to clear remaining native vegetation and therefore no direct impacts are likely to occur due to the construction of the development. However, there is a requirement for the provision of APZs for bushfire protection of residential areas, which may result in some selective removal of vegetation in open space areas to maintain appropriate fuel loads. However, there is scope to minimise the extent of the APZs required by the strategic location of proposed habitat ponds for the Green and Golden Bell Frog and other measures.

In addition to direct impacts, the proposal has the potential to result in a range of indirect impacts to habitats outside the development footprint including, but not limited to noise, dust, weeds, sedimentation, stormwater discharge and water quality. Many of the indirect impacts are not likely to be exacerbated by the proposed development as the subject land currently exists in a highly degraded condition and has been subject to sand quarrying over many years that has removed nearly the entirety of the pre-existing vegetation. Indirect impacts relating to sedimentation, erosion and water quality have potential to impact surrounding receiving waterways and these impacts will be appropriately managed through the implementation of a range of management plans including an Erosion and Sedimentation Plan (see **Section 7.5**) and a Water Cycle Management Plan (see **Section 7.7**). More detailed ecological assessments will be conducted after the detailed design stage for submission with future DAs, when the development layout has been finalised and the impacts are better understood, and it is expected that additional impact avoidance measures will be able to be identified and implemented.

Overall, the potential impacts of the proposal are considered to be minor and will be able to be managed appropriately. Furthermore, there will be significant areas of planting of native vegetation throughout the Master Plan area, as shown in the Site Plan (**Figure 8**). This will provide both habitat corridors (along the foreshore), and 'stepping-stone corridors' throughout the planted and open-space areas and bio-retention basins. In this regard, the project will increase the amount of habitat in the subject land, improve connectivity, and will result in an improved ecological outcome, far beyond current conditions.

7. Mitigation, Compensation, Offsetting and Other Conservation Measures

7.1. Introduction

Under BAM (2020) there is a requirement to consider potential impacts from a proposed development and then to apply the following assessment hierarchy:

- Avoid – consideration should be given to designing to avoid or minimise potential development impacts;
- Mitigate – mitigation measures should be formulated to ameliorate the impacts remaining after avoidance has been implemented; and
- Offset – biodiversity offsetting should be proposed in order to compensate for any residual impacts that cannot be avoided or mitigated.

This chapter considers the presents mitigation measure that will be implemented as part of the Planning Proposal.

A range of mitigation measures will need to be developed as part of the future of the subject land to mitigate the potential impacts of the project on the terrestrial, aquatic and marine environment. One of the most important of these measures is to minimise the likelihood and potential impact of erosion, run-off and sedimentation of adjacent areas of important wetland and marine habitats. In particular these include the Ramsar listed wetlands in the Towra Point Nature Reserve, the Endangered Population of *Posidonia australis* in Quibray Bay and the Aquatic Habitat Reserve in Boat Harbour.

7.2. Ecological and Cultural Management Strategy

Besmaw (2023) prepared an Ecological and Cultural Management Strategy (ECMS). The purpose of the strategy is to provide a framework and principles to ensure the cultural and ecological values of the proposal can be delivered and managed in the future, capturing the vision and intent of the proposal.

It will embed the Connecting with Country principles and outcomes into the planning framework, it will provide a framework for delivery and management of ecological values on the site and will propose a governance structure to ensure collaboration and alignment for stakeholders.

In line with the project's vision, the ecological guidelines should seek to maximise the significant opportunities presented by the site to regenerate the landscape while recognising the balance it strikes with the cultural and economic opportunities it presents.

Restoration of the sand-quarried landscape will afford substantial opportunities to rehabilitate a range of ecological systems on site, and to reconnect habitats on the Kurnell Peninsula, which have been significantly fragmented and impacted since European settlement took place.

As set out in the ECMS, a detailed Biodiversity Management Plan (BMP) should be prepared to guide ecological restoration to maximise biodiversity and sustainability of the future landform within open space areas and around the built environment. Consistent with the cultural strategy it should also reintroduce aboriginal food plants and use cultural burning practices to help manage the resultant landscape.

The locality around the site once included a range of forests and other types of vegetation that were extensively cleared and modified soon after European settlement. The BMP should provide for the restoration of such key habitats within the extensive open space corridors to be created as the quarried landscape is remediated.

7.3. Biodiversity Management Plan

A Biodiversity Management Plan (BMP) is required for management of retained vegetation, to address the potential indirect impacts of the future project.

As set out in the ECMS, the BMP should provide for:

- Protection and enhancement of existing native vegetation and wildlife habitats;
- Restore or reintroduce vegetation types that were historically removed from the landscape after European settlement;
- Restoration of some important wildlife habitats such as habitats for the endangered Green and Golden Bell Frog; and
- Prescribe a major reconnection of habitats across the site and to other key ecological areas of the Kurnell Peninsula, consistent with the Kurnell 2020 Corridor Delineation Plan (DECC 2009).

At a minimum, the BMP is required to include the following:

- Weed control during and post construction;
- Feral animal control during and post construction;
- Threatened species management and habitat enhancement (including details of habitat creation for GGBF, as described below);
- Ecological management of riparian corridors, buffers and Asset Protection Zones; and
- Vegetation management, including use of natural regeneration techniques, for all retained native vegetation.

The BMP will be prepared with regard to all applicable guidelines produced by EHG, DPI and Council.

In addition the BMP will be prepared to ensure the corridors proposed within the Open Spaces create and maintain habitat suitable for the Green and Golden Bell Frog in line with the documents Protecting and Restoring Green and Golden Bell Frog Habitat (DECC (NSW) 2008b) and Best Practice Habitat Guidelines: Green and Golden Bell Frog (DECC (NSW) 2008a). These documents were prepared in response to the Draft Recovery Plan for the Green and Golden Bell Frog (*Litoria aurea*) (DEC (NSW) 2005a) and provide the conservation framework and strategies for the creation and management of suitable habitat for the species.

In particular, it is noted in the Best Practice Guidelines (DECC (NSW) 2008a) that the frogs require different habitats during different parts of its life cycle, including habitat for breeding, foraging, refuge and movement.

These are reproduced below along with how the Masterplan will incorporate the relevant habitat components and how they can be included and directed under the BMP.

- Breeding habitat – the Green and Golden Bell Frog breeds in and around a wide variety of water bodies. These range in size from large freshwater and estuarine lakes to small temporary pools and depressions. The Masterplan will include numerous wetland areas and specialised detention basins throughout the corridors and will retain and enhance the wetlands area currently occurring in the northern lot of the subject land. These will be ‘stepping-stone’ breeding habitat areas that are created in areas that will be devoid of this habitat in the post-rehabilitated state. The BMP will provide for the creation and management of this habitat in perpetuity.
- Foraging habitat - foraging areas generally contain flowering plants, grasses and foliage. Plants that form tussocks provide foraging habitat and shelter. Foraging habitat will be created throughout the interconnected open space corridors that provide optimal Green and Golden Bell Frog foraging habitat based on the native species endemic to the vegetation communities identified in the subject land, including a variety of aquatic and terrestrial flowering plants and foliage to attract their prey and provide the adequate cover.
- Refuge habitat - areas in which the frog can escape from dangers such as predation or fire, and can retreat to avoid climatic extremes for short periods. Refuge habitat can also include sites where individuals might hide over winter. Rocks and vegetation surrounding the constructed pools will be incorporated into the design to provide suitable refuge areas.
- Connectivity habitat - enables frogs to move between different areas of habitat at different times of the year. This includes:
 - wet areas such as river banks or wetlands;
 - drainage lines;
 - stormwater culverts;
 - swales;
 - periodically damp areas;
 - connecting or partially connecting areas of vegetation the frog prefers;
 - easements;
 - laneways; and
 - grassy open areas that do not restrict movement.

The Open Spaces within the Masterplan provide significant opportunity for the creation of this connectivity habitat, with a variety of the above listed features incorporated into the design. Particularly, the connecting vegetation and with grassy open areas being a key feature of the overall layout as shown in **Figure 8**.

In addition, the implementation of the Master Plan and BMP will reduce the threats to the Green and Golden Bell Frog identified in the Kurnell GGBF Key Population by the following mechanisms:

- **Loss of Habitat:** The Masterplan will result in the creation of significant areas of habitat suitable for the Green and Golden Bell Frog within the Open Space areas and these will be established with consideration of the documents Protecting and Restoring Green and Golden Bell Frog Habitat (DECC (NSW) 2008b) and Best Practice Guidelines: Green and Golden Bell Frog Habitat (DECC (NSW) 2008a).
- **Introduced Predators:** Introduced predators will be reduced under the BMP through feral animal control and monitoring;
- **Disease:** Any population that is re-introduced to the subject land or migrates into the constructed habitat areas will be monitored and the prevalence of disease recorded and managed. All BMP works would be performed in accordance with the Hygiene Protocols for the Control of Disease in Frogs (NPWS 2008);
- **Habitat Degradation:** Habitat will be actively restored and managed under the BMP throughout the Open Space areas;
- **Water Quality:** Storm water best practice will be a key component of the project and water quality will be monitored and managed to maintain and enhance beyond current conditions;
- **Herbicide spraying:** Herbicide use around Green and Golden Bell Frog habitat under the BMP will be restricted to include only cut and paint methods of control when dealing with glyphosate herbicides;
- **Predation of the Green and Golden Bell Frog from Native Predators:** The Masterplan implementation will create far greater areas of refuge habitat such as rocky areas that will ensure the frogs a greater degree of protection than the current open areas of the northern lot and the post-rehabilitation state of the southern lot; and
- **Inappropriate recreational 4WD use:** 4WD access to the beach will cease under the Masterplan, which will benefit not only frogs but the diverse range of shorebirds occurring in this habitat.

A separate sub-plan for the management of dunes is required, as described below.

7.3.1. Dune Management Plan

The majority of the dunes located on the southern boundary of the subject land fringing Bate Bay are proposed for dedicated to Council. It is intended that these dunes will be conserved and managed, and areas of exotic grassland that occur behind the dunes will also be rehabilitated to naturally occurring vegetation types by removal of the exotic species and replacement with native species.

A Dune Management Plan will be prepared and implemented prior to the commencement of construction to minimise impacts to these dunes and to restore and enhance their ecological function, including restoration of the adjacent exotic grasslands. The Dune Management Plan will include but not be limited to the following:

- Measures to maintain and enhance dune stability by the installation of mesh fences to stabilise the dunes prior to revegetation;

- Detailed prescriptions for the staged revegetation of the dunes including species lists, densities and management requirements;
- Rehabilitation measures to be undertaken in the exotic grassland behind the dunes;
- Weed control;
- Monitoring and Reporting

Beach access will be required to be established, and the Dune Management Plan will provide details of how this will be provided, including details of signage, and track locations through the dunes.

7.4. Buffers and Corridors

Ecological buffers are required between the development areas, retained native vegetation, and high ecological constraint areas located offsite. The minimum buffers required are as follows:

- 50-100m from Key Fish Habitats, including Bate Bay, Quibray Bay and saltmarsh;
- 100m from Chapter 2 (Coastal Management) of the Resilience and Hazards SEPP - Coastal Wetlands, which is provided by the Proximity Area to Coastal Wetlands. Reduced buffers within the Proximity Area to Coastal Wetlands is acceptable with appropriate controls to protect aquatic habitats and water quality;
- 100m from the high-tide mark;
- 50m from C1 zoned land and dedicated areas;
- Establishment of habitat corridors, as shown in **Figure 16** and **Figure 26**; and
- 20m buffers from any other retained or constructed wetland habitats

As described in **Section 5.1.7**, existing corridors are generally absent within the subject land, and the degraded and non-native vegetation communities have limited potential to be regenerated for inclusion in future corridors. It is therefore expected that corridors will be created, through the application of buffers to high conservation significant lands and through the significant Open Space areas identified within the Master Plan. The existing corridor that surrounds Quibray Bay within Towra Point Nature Reserve can be expanded on within the buffer areas of Lot 2 North to widen this habitat corridor and the area of the current Lot 8 will provide ample connection with the Kamay – Botany Bay National Park to the east and towards the north east of the subject land as well. Consideration should be given to consultation with EHG for the planting and management of this corridor, as part of a management plan.

Habitat corridors are required to be established to provide habitat connectivity for less mobile species, from east to west. In consideration of the species likely to use corridors, the primary corridor is most appropriately located along the Bate Bay foreshore, and will be over 200m wide, from the high tide mark (see **Figure 26**). This corridor can include buffer lands, provided they are not also used for asset protection purposes. Habitat corridors that form 'stepping-stone habitats' are provided by the Master Plan throughout the open-space and drainage areas. These stepping-stone corridors will be intersected by minor roads, open parklands (playing

field etc.) and clusters of development. However, consideration should be given to the provision of a wider corridor of denser planting in the middle of the subject land, to strategically connect the relatively isolated habitat on Lot 8 (adjoining Lot 2 South to the north east).

Indicative buffers and corridors are shown in **Figure 26**.

7.5. Erosion and Sediment Control Plan

Prior to any disturbance of the subject land, and prior to the commencement of construction, an Erosion and Sediment Control Plan will be required. This will provide details of the measures that will be implemented to prevent any uncontrolled run-off of water or sediment from the subject land entering Quibray Bay or Bate Bay. This should include but not be limited to the following measures:

- Minimise area to be disturbed at any one time and install temporary fences to define 'no go' areas that are not to be disturbed;
- Install sediment fence(s) before work begins;
- Divert water around the work site;
- Provide for internal drainage basins to collect rain water in the subject land;
- Establish a single stabilised entry/exit point;
- Check the erosion and sediment controls every day and keep them in good working condition;
- Stockpile topsoil within a sediment controlled zone;
- Cover stockpiles when not in use to prevent them washing away during rainfall; and
- Stabilise disturbed earth as soon as practical after disturbance

7.6. Weed Control

Exotic species were found to constitute approximately 58% of flora species present, although the majority are not listed as Priority Weeds under the Biosecurity Act. Due to the potential for spread of these Priority Weed species during construction, a detailed Weed Management Plan should be prepared, as part of the Construction Environmental Management Plan (CEMP). Ongoing management of retained vegetation should be guided by a detailed Vegetation Management Plan, which includes weed control measures.

No aquatic weeds were recorded from the wetlands and waterways in the subject land, however several exotic rushes and reeds were recorded. These include the following species; *Juncus articulata*, *Juncus acutus subsp. acutus* (Sharp Rush), and *Cyperus eragrostis* (Umbrella Sedge). Only *Juncus acutus subsp. acutus* is a priority weed species, and will therefore require control.

7.7. Water Cycle Management

Due to the low lying nature of the subject land, the future development will be required to include the construction of approximately six large water detention basins to manage surface flows and runoff in the subject land.

The design of WSUD basins will be designed and constructed to be dual purpose, and to provide aquatic habitat as well as serve water management objectives. Aspects of these basins that will be designed to provide aquatic habitat include the following:

- Sloping edges to facilitate usage by the GGBF and wetland birds;
- Fringing vegetation and woody debris for shelter and nesting habitat; and
- Nearby trees for shading.

A Water Cycle Management Plan has been prepared by Coffey that will be implemented prior to the commencement of construction.

In Lot 2 South it is proposed that rainfall runoff will be conveyed to the north and west of Lot 2 South, towards Lindum Road and Captain Cook Drive and runoff from the eastern portion of the site is conveyed towards and detained within bioretention swales located at various sites across the development and swales/depressions within Lot 8. Stormwater runoff will be retained onsite where possible and will be attenuated within the swales and onsite detention basins, allowing the water to infiltrate to the underlying groundwater system and discharge to Quibray Bay (Coffee 2020).

Lot 2 North is proposed to be raised from the current 2 m to 5 m AHD to a level 5 m AHD to mitigate flood risk, with drainage radially to the edges of the raised area. In order to buffer the coastal wetlands in Towra Point Nature Reserve, it is proposed that rain gardens, bio-retention swales, and onsite detention systems are implemented at Lot 2 North to capture this surface runoff water and ensure the water quality and quantity entering the wetlands is at or beyond the current levels (Coffee 2020).

With the proposed water sensitive urban design principles included within the Water Cycle Management Plan, it is expected that groundwater and surface water runoff can be appropriately managed.

It is expected that a Controlled Activity Approval under the WM Act will be required for any works on waterfront land, including landscaping and water cycle management works (structures), to be determined as part of the detailed design and future development application stages of the proposal.

8. Conclusion

This BAR has been prepared by Cumberland Ecology to accompany a Planning Proposal for the subject land in support of a proposed amendment to SEPP Precincts and SSLEP 2015. The Planning Proposal aims to enable a diverse range of land uses at the subject land including residential, employment, tourism, education, cultural facilities, ecological regenerative zones and public open space areas.

As part of the Scoping Proposal process, Council referred the Scoping Proposal package to the DPE, a range of other relevant State agencies, and several internal Council teams for review and comment. In addition, extensive and ongoing engagement with relevant State agencies has occurred since November 2022. The advice received from these stakeholders has provided clear directives on the necessary updates and key focus areas and this BAR has been prepared to address the feedback received and reflects the engagement undertaken to date.

One of the key outcomes of the consultation conducted to date is the need to identify and consider the opportunities for achieving net improvement in ecological value in the development of the subject land. These opportunities are significant as the subject land is surrounded by areas of high ecological significance, including Quibray Bay and Towra Point Nature Reserve RAMSAR site to the north, Bate Bay and Boat Harbour Aquatic Reserve to the south, Wanda Reserve to the west and Kamay Botany Bay National Park to the east (see **Figure 3**). These areas contain significant areas of habitat for native species, examples of TECs and numerous records of threatened species.

Despite the ecological values in the locality, the subject land itself is highly disturbed and degraded and the majority of it has been used as a sand quarry since 1965. This has resulted in the removal of most of the pre-existing native vegetation and the exposure of a natural freshwater aquifer that occupies a large area in the centre of Lot 2 South. Backfilling and compaction using VENM is occurring moving from west to east following the direction of the sand quarrying process and due to the high degree of disturbance these areas have negligible ecological value. Areas of high biodiversity on the subject land are located mostly in the north-eastern corner, where areas of PCT 3788 Coastal Foreddune Wattle Scrub and PCT 4028 Estuarine Swamp Oak Twig-rush Forest, and the two Saltmarsh communities occur. These areas are currently zoned E4 General Industrial (see **Figure 4**).

Given the high biodiversity values surrounding the subject land and the currently relatively low ecological value of most of the subject land, the Planning Proposal represents an opportunity to conserve the ecological values of the subject land and to enhance those values, particularly by facilitating connectivity between the areas of high biodiversity that surround it. The current proposal has been developed in consultation with the DPE and other State agencies and has identified the potential for biodiversity corridors to be created through the subject land, linking existing areas of habitat and removing existing barriers to connectivity.

Instead of concentrating development in the centre of the subject land as per the previous masterplan (see **Figure 7**), the current proposed masterplan provides for two substantial biodiversity corridors running north to south between areas of existing native vegetation in the north and the dune vegetation flanking Bate Bay to the south (see **Figure 9**). Additional north to south connectivity will be provided by areas of native vegetation that will be created on the edges of the subject land. This perimeter vegetation will act as a buffer between the development and the adjacent areas of high biodiversity and will also contribute to north - south connectivity. Although Captain Cook Drive interrupts these corridors to some extent in the north, they will

ultimately provide a corridor that connects the biodiverse habitats in Quibray Bay with Bate Bay to the south. East to west connectivity will also be created by the provision of a biodiversity corridor along the dunes to the south of the subject land which will connect Wanda Reserve to the west and Kamay Botany Bay National Park to the east. The area dedicated to the corridors identified above is approximately 160 ha and will be designated as Regional Open Space (see **Figure 10**). The proposed corridors would complement the existing and proposed corridors identified for the Kurnell Peninsula in the Kurnell Corridor Study 2020 (DECC, 2009). (see **Figure 16**).

It is important to recognise that this connectivity does not currently exist due to the disturbance created by the sand quarry, and the creation of the biodiversity corridors represents a substantial improvement relative to current conditions. Furthermore, in addition to the redesign of the proposed layout to enable the creation of the biodiversity corridors described above, the current proposal also represents a reduction in the overall area of proposed development relative to the previous proposal. As well as the creation of the biodiversity corridors outlined above, there will be significant planting of native vegetation and habitat creation within the subject land. A total of 11.58 ha will be dedicated to Local and District parks (see **Figure 10**) which will provide additional 'stepping-stone corridors' in the subject land.

It is expected that the biodiversity corridors and the dunes located on the southern boundary of the subject land fringing Bate Bay will be dedicated to Council and managed in perpetuity according to a range of management plans, including a BMP and a Dune Management Plan. These plans will provide details of the revegetation techniques that will be implemented to establish the corridors, weed control methods, lists of plant species to be used and ongoing management measures that will occur to ensure that the corridors provide the intended outcomes. It is expected that some of the original vegetation communities that were historically cleared from the Kurnell Peninsula such as swamp forests, etc will be able to be incorporated into the biodiversity corridors, thereby increasing the representation of these communities in the locality. Ongoing management will include weed control, feral animal control, replacement plantings if required and monitoring and reporting. The Dune Management Plan will be prepared and implemented prior to the commencement of construction to minimise impacts to the dunes and to restore and enhance their ecological function, including restoration of the adjacent exotic grasslands by removal of exotic species and replacement with native species.

The current proposal is in line with the recommendations of the recent independent review of the BC Act which recommends a shift towards a 'nature positive' vision (DPE 2023a). A nature positive approach moves away from simply conserving existing biodiversity values, but is an approach where the environment is being repaired and regenerated and focusses on biodiversity net gain, and ecosystem recovery. It is an approach where biodiversity is protected, restored and improving, thereby ensuring the integrity of ecosystem services and cultural values, preserving opportunities for future generations. The proposal is consistent with the nature positive vision articulated in the BC Act review, and would result in a substantial net ecological gain relative to current conditions, as well as providing housing and economic opportunities.

Moving to a nature positive view is also about protecting culture and there is a very strong focus in the BC Act review on the cultural connections of Aboriginal people and their role in regenerating the ecosystem. The proposal is consistent with this aspect of the review, and a draft Ecological and Cultural Management Strategy (Besmaw 2023) has been prepared which provides a framework and principles to ensure the cultural and ecological values of the proposal can be delivered and managed in the future. It provides a mechanism that

prioritises Aboriginal ways of connecting to Country and ensures the future co-design and collaboration with Aboriginal stakeholders to achieve the best ecological, cultural, land management and design outcomes for the subject land.

With the implementation of the ecological improvement strategies identified in this document, in particular the creation of the biodiversity corridors as well as the ongoing management, monitoring and reporting that will take place, it is considered that the proposal will result in a positive ecological outcome for the Kurnell Peninsula. The involvement of the Aboriginal community will also enable culturally sensitive land management practices to be developed. It is envisaged that further consultation and engagement with all relevant stakeholders will identify further opportunities to improve ecological outcomes and these will be implemented where possible in future detailed planning.

8.1. Recommendations

Review and rationalise the asset protection zones for more extensive protection and development of native flora and fauna in the site.

- Consider the use of ponds and wetlands to improve the performance of the APZs;
- Fine tune the location of buildings and other infrastructure in order to limit the use of APZs; and
- Fine tune the BAL ratings of buildings in order to limit the extent of APZs.

Biodiversity Management Plan

- Prepare a detailed BMP for implementation in perpetuity;
- Base the BMP on best practice and scientific information;
- Complete a suite of updated flora and fauna surveys in line with the requirements of BAM at the time of preparing a BDAR and BMP;
- Develop Key Performance Indicators (KPIs) that are guided by benchmark data for PCTs within the subject land, and for those proposed to be planted;
- Make the BMP measures compliant with the requirements of relevant recovery plans for Green and Golden Bell Frog, Little Tern, and other species;
- Use monitoring to demonstrate achievement of KPIs, and also to provide feedback for adaptive management; and
- Incorporate a Trigger Action Response Plan into the BMP to make it clear how, when and where corrective action responses will be made to biodiversity management in order to better fulfil the KPIs of the BMP.

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