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Berrima Gaol: Aquatic Ecology Assessment

Blue Sox Group

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Abbreviations

Abbreviation	Description
DPE-Water	Department of Planning and Environment-Water
ELA	Eco Logical Australia Pty Ltd
FM Act	<i>Fisheries Management Act 1994</i>
GPS	Global Positioning System
LEP	Wingecarribee Local Environmental Plan 2010
VMP	Vegetation Management Plan
WM Act	<i>Water Management Act 2000</i>

1. Introduction

1.1. Scope and aims of report

Eco Logical Australia Pty Ltd (ELA) was engaged by Blue Sox Group to prepare an aquatic ecology assessment of Wingecarribee River (the 'study area', Figure 1) adjacent to Berrima Gaol. This report outlines the methods, results and impact assessment of aquatic ecology, including aquatic fauna within Wingecarribee River, as ELA understands that the client intends to develop Berrima Gaol into an accommodation and function establishment (Figure 2).

The study area covers an approximate 200 m reach of the Wingecarribee River, directly adjacent to the Berrima Gaol. Lot 101 DP 1283819 is Crown Land that is situated between the western boundary of the gaol and the Wingecarribee River. This land includes the Wingecarribee River's top of bank, a sandstone terminal step, and wooded native vegetation along the riverbank.

This report will address:

- Aquatic impacts relevant to the *NSW Fisheries Management Act 1994* (FM Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Aquatic fauna which use, or are likely to use the section of Wingecarribee River adjacent to Berrima Gaol.
- Aquatic ecology impacts relevant to the *Wingecarribee Local Environmental Plan 2010* (LEP)
- Measures to mitigate potential impacts to aquatic habitat during construction and operation.

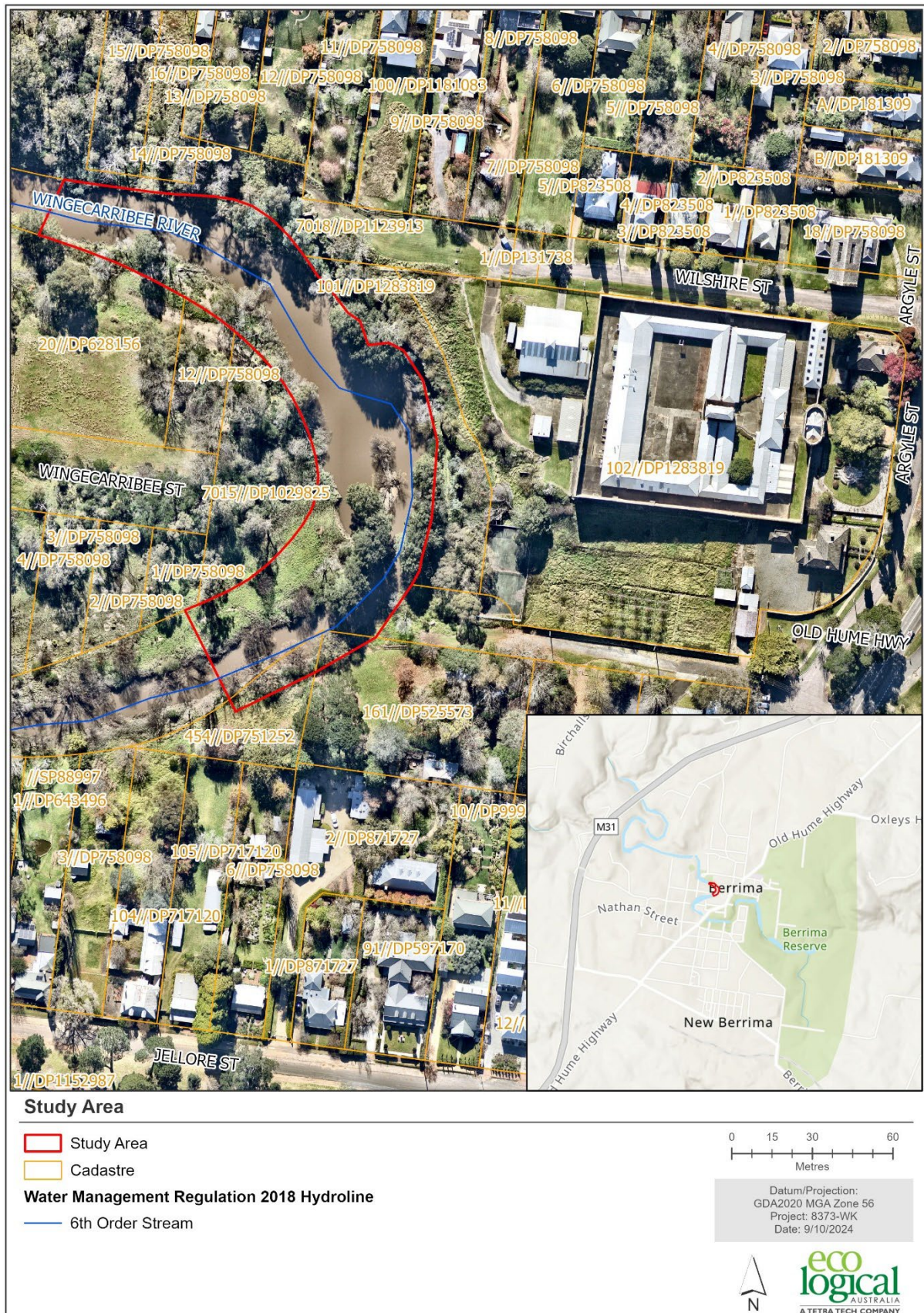
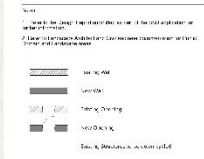


Figure 1: Location of proposed development area (study area)

[illegible]

2. Statutory context

2.1. Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Under the EPBC Act, the Commonwealth Environment Minister needs to approve any development that is likely to have a significant impact on Matters of National Environmental Significance (MNES). Should such an impact, as defined in the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines (Department of the Environment 2013), be likely, the preparation and submission of a Referral is required. MNES relevant to be considered in this study includes threatened ecological communities, flora and fauna species and migratory species that are listed under the Act. The proposed work would not cause a significant impact to aquatic species, and therefore a Referral is not recommended for impacts to aquatic species.

For terrestrial matters, refer to the Berrima Gaol Ecological Constraints Assessment (ELA 2024).

2.2. NSW Water Management Act 2000 (WM Act)

The WM Act aims to protect and use NSW water in a way that is sustainable and holistic, which will help present generations without harming the ability of future generations to satisfy their needs. The NSW Department of Climate Change, Energy, the Environmental and Water (DCCEEW) – Water Group administers licencing and approvals for controlled activities on ‘waterfront land’, which is defined as the land 40 m from the highest bank of a river, lake or estuary published on the Department’s website (Water Management (General) Regulation 2018 hydroline spatial data 1.0), known as the ‘hydroline’. Apart from the exceptions stated in Schedule 4, Part 2 of the Water Management (General) Regulation 2018, controlled activities are:

- the construction of buildings or carrying out of works
- the removal of material or vegetation from land by excavation or any other means
- the deposition of material on land by landfill or otherwise
- any activity that affects the quantity or flow of water in a water source.

The *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (DPE 2022) outlines the need for a Vegetated Riparian Zone (VRZ) adjacent to the channel to provide a transition zone between the terrestrial environment and watercourse. This vegetated zone helps maintain and improve the ecological functions of a watercourse whilst providing habitat for terrestrial flora and fauna.

For an assessment of design consistency with the WM Act, refer to the Berrima Gaol Ecological Constraints Assessment (ELA 2024).

2.3. NSW Fisheries Management Act 1994 (FM Act) and Policy and guidelines for fish habitat conservation and management

The FM Act is the principal piece of legislation protecting aquatic habitat in NSW. The act aims to conserve fish stocks, key fish habitat, aquatic vegetation, and threatened species, populations and communities. Threatened aquatic species, populations and communities are listed under Schedules 4, 4A and 5 of the FM Act, while key threatening processes are listed under Schedule 6. Section 3.3.3 of

the Policy and Guidelines for Fish Habitat Conservation and Management (Fairfull 2013) specifies that works which involve harm to aquatic habitat would be required to demonstrate how the development design and works have attempted to avoid, minimise and mitigate direct and indirect harm, plus apply the DPI Fisheries' offset policy to ensure there is no net loss of key fish habitat. An assessment of development impacts and recommended controls is provided in Chapter 5.

The *Policy and Guidelines for Fish Habitat Conservation and Management* is a supplementary document that outlines the requirements and obligations under the FM Act and the *Fisheries Management (General) Regulation 2010*. They were developed to maintain and enhance fish habitat and assist in the protection of threatened species. The Policy provides a definition of key fish habitat and provides guidance for assigning a classification of waterways for fish passage, which informs the types of infrastructure suitable for the creekline (Table 1) and sensitivity of the key fish habitat present, which determines the potential disturbance and offsetting required for development (Table 2).

Table 1: Classification of waterways for fish passage and crossing type (Fairfull 2013)

Classification	Characteristics of waterway class and preferred crossing type
CLASS 1 Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'. Bridge, arch structure or tunnel. Bridges are preferred to arch structures.
CLASS 2 Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pool or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present. Bridge, arch structure, culvert ^[1] or ford. Bridges are preferred to arch structures, box culverts and fords (in that order).
CLASS 3 Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats. Culvert ^[2] or ford. Box culverts are preferred to fords and pipe culverts (in that order).
CLASS 4 Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or freestanding water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present). Culvert ^[3] , causeway or ford. Culverts and fords are preferred to causeways (in that order).

Key to crossing type

^[1] High priority given to the 'High Flow Design' procedures presented for the design of these culverts—refer to the "Design Considerations" section of Fairfull and Witheridge 2003.

^[2] Minimum culvert design using the 'Low Flow Design' procedures; however, 'High Flow Design' and 'Medium Flow Design' should be given priority where affordable—refer to the "Design Considerations" section of Fairfull and Witheridge (2003).

^[3] Fish friendly waterway crossing designs possibly unwarranted. Fish passage requirements should be confirmed with NSW DPI.

As noted in Fairfull and Witheridge 2003, there are additional factors that must be taken into consideration by those involved in waterway crossing design and construction, including public safety, social and budgetary constraints. Each crossing is therefore assessed by NSW DPI on a case-by-case basis.

Table 2: Key fish habitat types (Fairfull 2013)

Key fish habitat and associated sensitivity classification scheme (for assessing potential impacts of certain activities and developments on key fish habitat types)	
TYPE 1 – Highly sensitive key fish habitat:	
	Posidonia australis (strapweed)
	<i>Zostera</i> , <i>Heterozostera</i> , <i>Halophila</i> and <i>Ruppia</i> species of seagrass beds >5 m ² in area
	Coastal saltmarsh >5 m ² in area
	Coral communities
	Coastal lakes and lagoons that have a natural opening and closing regime (i.e. are not permanently open or artificially opened or are subject to one off unauthorised openings)
	Marine park, an aquatic reserve or intertidal protected area
	SEPP 14 coastal wetlands, wetlands recognised under international agreements (e.g. Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia
	Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants
	Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act
	Mound springs
TYPE 2 – Moderately sensitive key fish habitat:	
	<i>Zostera</i> , <i>Heterozostera</i> , <i>Halophila</i> and <i>Ruppia</i> species of seagrass beds <5 m ² in area
	Mangroves
	Coastal saltmarsh <5 m ² in area
	Marine macroalgae such as <i>Ecklonia</i> and <i>Sargassum</i> species
	Estuarine and marine rocky reefs
	Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (e.g. managed in line with an entrance management program)
	Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area
	Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna
	Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1
	Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
TYPE 3 – Minimally sensitive key fish habitat:	
	Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna
	Coastal and freshwater habitats not included in TYPES 1 or 2
	Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

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

The development site is located within the Sydney drinking water catchment in accordance with Chapter 6 of the State Environmental Planning Policy (Biodiversity and Conservation) 2021. Therefore, general development controls under Division 2 (clauses 6.6 – 6.10) apply:

- Water quality and quantity – the effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial, and, the impact on water flow in a natural waterbody will be minimised.
- Aquatic ecology – the development is to have minimal impacts, whether direct, indirect or cumulative, to adjacent and downstream waterbodies and wetlands.
- Flooding – the development, if flooded, is not to release pollutants or obstruct natural flows to nearby wetlands and riverine ecosystems.
- Recreation and public access – foreshore access is not to cause an adverse impact on natural waterbodies, watercourses, wetlands or riparian vegetation.
- Total catchment management – the consenting authority must consult with downstream Councils before granting development consent.

2.5. Wingecarribee Local Environmental Plan 2010

The Wingecarribee Local Environmental Plan 2010 (LEP) outlines provisions which relate to maintaining aquatic biodiversity. Section 7.4 of the LEP identifies that native fauna and flora should be protected along with the associated ecological processes which support their existence. The LEP supports actions which would encourage the recovery of native flora and fauna and their habitats.

3. Methods

3.1. Desktop assessment

A review of the following data, background literature and relevant planning instruments and strategic documents was undertaken:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* – Protected Matters Search Tool (5 km radius)
- NSW *Fisheries Management Act 1994*; Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update) (Fairfull 2013); key fish habitat mapping; listed protected and threatened species and populations, including species profiles; ‘Primefact’ publications and expected distribution maps (Riches et al 2016)
- NSW *Water Management Act 2000* and Guidelines for controlled activities on waterfront land – Riparian corridors (DPE 2022)
- *Water Management (General) Regulation 2018* hydroline spatial data 1.0
- NSW *Wetlands Management Policy 2010* (DECCW 2010)
- Online Zoological Collections of Australian Museums (OZCAM) and Atlas of Living Australia (ALA) – individual species searches to determine likelihood of occurrence of threatened species
- NSW River styles database (DPE 2023)
- Chapter 6 – Sydney Drinking Water Catchment of the State Environmental Planning Policy (Resilience and Hazards SEPP) 2021
- *Wingecarribee Local Environmental Plan 2010*

3.2. Field survey

Two ELA aquatic ecologists completed an aquatic ecology field assessment on 10 July 2024. The fieldwork assessment included a dawn aquatic fauna survey, aquatic habitat mapping and sample collection. The aim of the field work was to assess the suitability of aquatic habitat for species of aquatic fauna which may inhabit Wingecarribee River adjacent to Berrima Gaol.

3.2.1. Dawn aquatic fauna survey

A dawn aquatic fauna survey was completed from 6:45 am to 8:00 am on 10 July 2024. The survey was conducted from the eastern bank of the Wingecarribee River, starting from the northern extent of the study area, moving south as the survey progressed. Care was taken to not disturb the water or riparian vegetation which may have spooked aquatic fauna. Binoculars were used to monitor both banks and any ripples created on the water’s surface. The location and species of aquatic fauna observed was noted. Areas of the river which were used by aquatic fauna were noted and mapped using ArcGIS Pro.

3.2.2. Water quality, eDNA samples and aquatic habitat assessment

The remainder of the field survey was conducted from kayaks launched from Berrima Reserve, approximately 200 m downstream of the study area. Water quality and environmental DNA (eDNA) samples were taken from three locations within the study area (Figure 4), the southern extent of the study area, directly opposite Berrima Gaol and the northern extent of the study area. Water quality was recorded using a calibrated Horiba U-52 water quality meter and eDNA was sampled using water filtration.

One environmental DNA (eDNA) sample was collected at each of the three locations. Water was filtered through a 1.2 µm disk filter until no more could be pushed through. The volume of water filtered was dependent on turbidity, with less water filtered from turbid locations. The filters were then stored in a cool container before being dispatched to the laboratory for analysis. Throughout the sample preparation, collection, and storage phases, care was taken to minimise contamination between locations. Environmental DNA (eDNA) samples were sent to EnviroDNA Pty Ltd for analysis. DNA sequences were matched to known fish, reptile, bird and mammal species using a general 12S primer.

Aquatic habitat was assessed by observing changes in features along the reach of the study area. A change in habitat feature (bank shape, riparian vegetation, aquatic macrophytes, flow regime etc.) was noted by taking a GPS marker and photos. Both banks were studied for evidence of faunal use. The study area was then mapped to display the condition of the aquatic habitat. The following habitat features were used to map aquatic habitat condition:

- Aquatic macrophytes
- Trailing bank vegetation
- Bank overhang
- Snags
- Woody debris
- Exposed roots of riparian vegetation
- River shading
- Cobbles, boulders and bedrock
- Stick jams

Areas which had four or more features were classed as good aquatic habitat, areas with two or three features were classed as moderate aquatic habitat and areas with less than two features were classed as poor aquatic habitat.

4. Results

4.1. Desktop review

The study area consists of a 6th order stream, Wingecarribee River (Figure 1), forming part of the Hawkesbury Nepean catchment. The River Style of Wingecarribee River was good geomorphic stream condition with bedrock substrate within a margin-controlled gorge. Wingecarribee River is classed as key fish habitat (3rd order and greater). The Fisheries spatial portal identifies the reach of Wingecarribee River, adjacent to Berrima Gaol, as having a poor freshwater fish community status.

The nearest expected threatened aquatic species distribution (*Euastacus dharawalus*-Fitzroy Falls Spiny Crayfish) is modelled to occur outside of the study area, 14 km to the east in the Wingecarribee River (Riches et al 2016). The MNES search tool shows one threatened species of fish and one threatened species of aquatic plant with potential habitat in the study area. A likelihood of occurrence of the two threatened species, *Macquaria australasica* (Macquarie Perch) and *Persicaria elatior* (Tall Knotweed) can be found in Appendix A.

A review of online databases including Atlas of Living Australia and The Platy-Project lead by the Australian Conservation Foundation, provided records of aquatic mammals including *Ornithorhynchus anatinus* (Platypus) and *Hydromys chrysogaster* (Rakali) using the study area. There were seven records of Platypus and two records of Rakali in the past 10 years. There were no previous fish records within the study area. A review of records 5 km upstream and downstream of the study area identified three species of fish, *Perca fluviatilis* (European Perch), *Cyprinus carpio* (European Carp) and *Gambusia holbrooki* (Mosquitofish) observed in Wingecarribee River. All three fish species are introduced.

4.2. Aquatic habitat

No threatened species of fish or aquatic plants are known to occur, or expected to occur in the study area, or upstream of the study area. An assessment of their likelihood of occurrence is provided in Appendix A.

Wingecarribee River is a perennial river which flows from south to north in all figures presented in this report. The section of the river within the study area meets the DPI Fisheries definition of KFH (Figure 3). The study area was classed as Type 1, highly sensitive key fish habitat with snags greater than 3 m in length and native aquatic plants present. The study area met the DPI Fisheries definition of a Class 1 waterway for fish passage as it is a permanently flowing freshwater river.

A walking track on the eastern bank begins north of the study area at Berrima Reserve and extends further south along Wingecarribee River. There is a large sandstone terminal step located between Berrima Gaol and Wingecarribee River.

The overall condition of the aquatic habitat within the study area was moderate-high. While there were areas of the river which lacked aquatic habitat complexity, the adequate depth for fauna allowed unobstructed passage from areas of low complexity to areas of high complexity. A large portion of the upstream extent of the study area was identified as poor aquatic habitat during the field survey (Figure 4). These areas either had heavily eroded banks with a near-vertical slope or sandy substrate which provided limited habitat for aquatic fauna, in particular burrowing fauna. The eastern bank was

partly vegetated with *Salix* sp. (Willow), which provided some habitat in the form of shading and trailing bank vegetation, however there were no other habitat features present.

The majority of the aquatic habitat in the study area adjacent to the banks was of moderate or good condition. Trailing bank vegetation, shading, aquatic macrophytes, adequate depth, and snags were present at most of these locations (Figure 5 and Figure 6). There were also log jams, bank overhang and large diameter rocks or bedrock present at locations which were classified as good habitat.

4.3. Aquatic fauna survey

Two *Ornithorhynchus anatinus* (Platypus) and one *Hydromys chrysogaster* (Rakali) were observed in the surveyed reach of Wingecarribee River (Figure 7). Both species were observed near the riverbanks exhibiting foraging behaviour. The two Platypus dived intermittently between resting on the surface of the water in shaded areas. They remained confined to smaller sections of the river and one was observed close to a potential Platypus burrow above the water's mark on the western bank. The hole could not be confirmed as a platypus burrow as it was not seen to be actively used by the observed platypus (Figure 8). The observed Rakali moved along the waterway returning to the eastern bank between dives. Two feeding platforms were found during the survey (Figure 8). One was located in the downstream extent of the study area with a discarded bivalve shell and tracks leading to and from the water (Figure 8). The other feeding platform was used by the observed Rakali in the upstream extent of the study area.



Figure 3: DPI Fisheries mapped Key Fish Habitat



Figure 4: Condition of aquatic habitat and sampling locations of water quality and eDNA



Upstream extent of study area: Facing upstream (left) and facing downstream (right)



Upstream extent of the study area: Facing the western bank (left) and eastern bank (right)



Wingecarribee River, opposite the proposed development site: Facing upstream (left) and facing downstream (right)



Wingecarribee River, opposite the proposed development site: Facing the western bank (left) and eastern bank (right)



Downstream extent of study area: Facing upstream (left) and downstream (right)



Downstream extent of study area: Facing the western bank (left) and eastern bank (right)

Figure 5: Representative photos of section of Wingecarribee River assessed



Habitat features present in study area: Large snag (top left), trailing bank vegetation (top right), exposed roots (middle left), large diameter substrate, aquatic macrophytes and bank overhang (middle right), erosion of bank (bottom left) and sandstone terminal step directly adjacent to Berrima Gaol (bottom right)

Figure 6: Aquatic habitat features present in study area



Figure 7: Observations of aquatic fauna and evidence of aquatic fauna



Figure 8: Evidence of aquatic fauna - potential Platypus burrow openings in bank (top left) and Rakali feeding platform with tracks (top right and bottom)

4.4. eDNA analysis

The eDNA analysis detected four fish species, two were native and two were introduced (Table 3). The two native species *Philypnodon grandiceps* (Flatheaded Gudgeon) and *Philypnodon macrostomus* (Dwarf Flatheaded Gudgeon) are common species and not considered threatened under the NSW FM Act or the Commonwealth EPBC Act.

It is noted that the turbid condition of the river (Table 4) limited the amount of water which could be filtered and therefore may have restricted the ability to detect species of lower abundance. Terrestrial species detected by the analysis can be found in Appendix B.

Table 3: Aquatic species detected using eDNA analysis

Species	Common Name	Status	Downstream Study Area	Midway Study Area	Upstream Study Area
<i>Misgurnus anguillicaudatus</i>	Oriental weatherloach	Introduced			✓
<i>Cyprinus carpio</i>	European carp	Introduced	✓	✓	✓
<i>Philypnodon grandiceps</i>	Flatheaded gudgeon	Native	✓		✓
<i>Philypnodon macrostomus</i>	Dwarf flatheaded gudgeon	Native	✓	✓	✓

4.5. Water quality

The water quality results from upstream, downstream and the midway point of the study area were relatively typical for an upland large river (Table 4). All parameters remained within the acceptable range of the ANZ guidelines with the exception of turbidity. Turbidity exceeded the monthly average of 16.5 NTU in the Wingecarribee River at Berrima (NSW Water 2024). It is likely recent rainfall prior to the fieldwork washed sediment into the system and increased flow velocity in the creeks and rivers which caused fine sediments to become suspended, increasing the turbidity within Wingecarribee River.

Table 4: In-situ water quality results

Parameter	Units	ANZ Guidelines ^a	Upstream Study Area	Midway Study Area	Downstream Study Area
Temperature	°C		10.83	10.76	10.91
pH	pH units	6.5-7.5	7.31	7.24	7.25
Dissolved Oxygen	% saturation	90-110	97.1	94.4	93.5
Turbidity	NTU	25	79.5	78.5	77.5
Conductivity	mS/cm	0.35	0.162	0.162	0.161
Salinity	ppt		0.1	0.1	0.1

^a Guideline values for upland rivers in southeast Australia

Grey shading indicates exceedances of the ANZ Guidelines

5. Impact assessment

This section considers the impact of construction and operation of the proposed development. As the specific construction methods are yet to be determined, the impacts listed below are specific to the site but should be viewed in general terms and re-assessed during detailed design and construction planning stage. The impacts and controls have been prepared with specific consideration of the direct and indirect impacts on aquatic fauna.

5.1. Construction and operational impact

The severity of impacts and recommended mitigation measures for construction and operation are shown in Table 5 and Table 6. All mitigation measures are also listed in Section 6.

Table 5: Assessment of construction impact

Activity	Impact	Severity	Mitigation
Clearing riparian vegetation	Destabilise banks and increase susceptibility to erosion.	Moderate to high impact to aquatic ecology. Higher levels of erosion within catchments can increase turbidity of streams and rivers which can blanket benthic organisms and limit light penetration for aquatic plants. Destabilised banks can inhibit burrowing aquatic fauna from creating burrows.	Implement a sediment and erosion control plan in accordance with The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004). The plan should include temporary erosion controls such as sediment fences to stop sediment from entering Wingecarribee River during construction. Any material which needs to be temporarily stockpiled during works must be located well outside the riparian zone. The works should be scheduled outside of predicted heavy rain periods and works should stop during heavy rainfall to reduce risk of mobilising sediment. Erosion controls should be inspected regularly (daily during works) and after rainfall. Repairs should be made immediately if required. Avoid removing native riparian vegetation or minimise the area of riparian land to be disturbed. Revegetate disturbed areas with deep rooted native plants which will restabilise the bank once works are complete.
	Loss of aquatic habitat and reduction of organic material available instream.	Moderate impact to aquatic ecology. Riparian vegetation provides important habitat such as trailing bank vegetation, shading and detritus as a source of food for macroinvertebrate communities.	Avoid removing native riparian vegetation or minimise the area of riparian land to be disturbed. Remove willows by cutting off at base and poisoning, so that roots are left in the bank to provide stability. Revegetate disturbed areas with native plants which will restabilise the bank and provide organic material once works are complete.

Activity	Impact	Severity	Mitigation
General works surrounding the top of bank	Destruction of burrows	High impact to aquatic fauna. Destruction of a critical habitat to aquatic fauna and could cause death of burrowing species.	The proposed development footprint remains above the sandstone terminal step on the eastern bank of Wingecarribee. The footprint would be very unlikely to interfere with aquatic fauna burrows as they are very unlikely to extend past the sandstone terminal step. Prior to any works within 30 m of the watermark and below the sandstone terminal step, a suitably qualified ecologist should inspect the banks for burrow locations. Avoid conducting works below the sandstone terminal step during critical Platypus breeding periods and juvenile emergence (i.e. July to February), where practicable. Should a burrow be located while completing works, progress should be stopped to allow a suitably qualified ecologist to inspect the burrow and relocated any observed Platypus.
Construction machinery.	Accidental spills.	Moderate impact to aquatic ecology. Chemical spills are unlikely but may occur during refuelling or if there is a hydraulic fluid leak. Spilt petrochemicals have the potential to wash into creeks and rivers and disperse downstream. This could kill or impair aquatic fauna and invertebrate communities.	Refuelling and storage areas to be established well out of riparian areas. Oil/fuel/chemical storage and spill management procedures should be followed. Machinery and engine maintenance schedule to chance of oil/fuel leakage. Spill kits available on site for all chemicals used during construction.
	Spread of pest plant species.	Moderate impact to aquatic ecology. Machinery may be a vector for movement of plant pest species. Pest plant species could become established which would alter the species composition of riparian vegetation. A reduction in native riparian vegetation can reduce the availability of preferred aquatic habitat such as trailing bank vegetation, shaded areas and deep-rooted plant species which stabilise banks. Additionally riparian vegetation would increase the amount of detritus which promotes macroinvertebrate community composition.	Wash all equipment, including, erosion and sediment control measures and trailers to prevent spread of exotic species. A visual check for vegetation and seeds on all vehicles, equipment and machinery to be used in the activities must be carried out before work commences.

Table 6: Assessment of operational impact

Activity	Impact	Severity	Mitigation
Increase in recreational use of Wingecarribee River.	Disturbance of aquatic fauna.	Low impact to aquatic fauna. Increased pedestrian traffic unlikely to have a major impact to Platypus and Rakali as both are nocturnal and most recreational walkers would be walking during the day.	Dogs should be walked on-leash within the proposed development area so they do not disturb Platypus or Rakali borrows or feeding stations.
	Increase use of area may result in litter.	Low impact to aquatic fauna. Rubbish washed into waterways can pose as hazards to aquatic fauna when mistaken for food.	Ensure an adequate number of rubbish bins are included in development design, and any drain discharge points near the creek are appropriately fitted with litter retention screens.
Hotel suites lining riparian corridor	Light pollution at night.	Low to moderate impact to aquatic fauna. Artificial light at night may interfere with Platypus and Rakali behaviour as both tend to forage mostly at night. Artificial light may cause these species to avoid the area and become more susceptible to predation.	Minimise the use of permanent outdoor lights and install blinds or curtains for the proposed hotel suites.
	Noise pollution.	Low to moderate impact to aquatic fauna. Noise pollution over prolonged periods of time can alter the behaviour of some aquatic fauna and cause fauna to avoid the area.	Install double glazed windows in the proposed hotel suites. Implement a noise curfew to discourage prolonged loud noise into the night.

5.2. Guidelines for Controlled Activities on waterfront land—Riparian corridors

A Controlled Activity Approval (CAA) is usually required for works within waterfront land, defined as the land 40 m from the highest bank of a river, lake or estuary. However, as development will be submitted as a State Significant Development, a CAA is not required. The proposed development will remain subject to The Guidelines for Controlled Activities on waterfront land—Riparian corridors (DPE 2022):

- Non-permissible impacts must stay outside of the 50% VRZ and avoid stands of native riparian vegetation.
- Offsets should be located on cleared areas if possible, with the aim to restore previous disturbed riparian land, rather than offsetting overtop of vegetation protected for other purposes.
- Permissible impacts do not need offsetting, unless they do not meet the design criteria (e.g., online basins require a VRZ around them, but if this is not possible then the basin area needs to be offset).

An assessment of consistency with the proposed development design and the WM Act is provided in the Berrima Gaol Ecological Constraints Assessment (ELA 2024).

5.3. DPI Fisheries policy and guidelines for fish habitat conservation (FM Act)

DPI Fisheries' *Policy and Guidelines for Fish Habitat Conservation and Management* (Fairfull 2013) outline requirements for assessing impact of waterfront development to ensure the sustainable

management, and 'no net loss', of KFH in NSW (Table 6). Part 7 of the FM Act addresses the protection of aquatic habitats and works that requires a permit.

Table 7: Assessment requirements under DPI Fisheries' Policy and Guidelines for Fish Habitat Conservation

Assessment	Response	Comment
Will the proposed works directly or indirectly impact threatened species, populations or communities?	☐ Yes ☐ Potential ☒ No	No, it is unlikely that any threatened species, populations or communities use the section of Wingecarribee River parallel to the proposed development (Appendix A).
Will the proposed works harm protected vegetation (seagrass, macroalgae, mangroves or saltmarsh)?	☐ Yes ☒ No	No, the proposed development site is outside of the marine and estuarine environment.
Are the proposed works in or near critical habitat for the Grey Nurse Shark (Part 7A of FM Act)?	☐ Yes ☒ No	No, the proposed development site is outside of the marine environment.
Will the proposed works impact aquaculture leases or commercial fisheries?	☐ Yes ☒ No	No, the proposed development site is over 250 km upstream of any aquaculture lease.
Are the works categorised as a key threatening process (as per Schedule 6 of the FM Act) for example: Current shark meshing program in NSW waters Hook and line fishing in areas important for survival of threatened fish species Human-caused climate change Instream structures and other mechanisms that alter the natural flow Introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW Introduction of fish to fresh waters within a river catchment outside their natural range Removal of large woody debris from NSW rivers and streams Degradation of native riparian vegetation along NSW watercourses.	☐ Yes ☒ No	The proposed works for the development do not involve or would not result in any of the listed key threatening process.
Will the works result in a 'net loss' of key fish habitat?	☐ Yes ☒ No	The proposed development does not involve direct disturbance to aquatic habitat and is unlikely to cause any indirect loss to the KFH in Wingecarribee River with suitable control measures.
Do the works require a permit or consultation under Part 7 of the FM Act? Permits relate to: Harming marine vegetation Dredging and/or reclamation of bed or bank Obstruction of fish passage Relocation of threatened species.	☐ Yes ☒ No	No, the proposed development works would not involve any process requiring a Part 7 permit under the FM Act.

5.4. Matters of National Environmental Significance (MNES)

The following MNES (Table 7) were returned from the database search for a 5 km radius around the site. A likelihood of occurrence table of aquatic MNES which may be impacted by the proposed works is provided in Appendix A.

Table 8: Potential impacts to matters of National Environmental Significance

Matter of NES	Count	Comment	Impact Assessment
World Heritage Properties	None		No impact
National Heritage Places	None		No impact
Wetlands of International Importance (Ramsar Wetlands)	None		No impact
Great Barrier Reef Marine Park	None		No impact
Commonwealth Marine Areas	None		No impact
Listed Threatened Ecological Communities	4	Terrestrial species excluded – see Berrima Gaol Ecological Constraints Assessment (ELA 2024).	No impact
Listed Threatened Species	62	Terrestrial species excluded – see Berrima Gaol Ecological Constraints Assessment (ELA 2024).	No impact (Appendix A)
Listed Migratory Species	14	Terrestrial species excluded – see Berrima Gaol Ecological Constraints Assessment (ELA 2024).	No impact (Appendix A)

5.5. State Environmental Planning Policy (Biodiversity and Conservation SEPP) 2021

An assessment under the Biodiversity and Conservation SEPP are provided below for controls on development generally (Table 8).

Table 9: Impact assessment for Part 6.2, Division 2 - Controls on development generally

Item	Impact assessment
Clause 6.6 Water quality and quantity	<i>(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied the development ensures—</i> <i>(a) the effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial.</i> The proposed development would need to ensure any impact on water quality such as development run off or stormwater release has a neutral or positive effect on water quality. Control measures may need to be considered which involve the use of water sensitive urban design. <i>(b) the impact on water flow in a natural waterbody will be minimised.</i> The proposed development must have negligible impact on the natural flow within Wingecarribee River. Predicted discharge volumes and any temporary storage (if water sensitive urban design is adopted) should be investigated to ensure the development does not have an impact to the flows of Wingecarribee River.

Item	Impact assessment
Clause 6.7 Aquatic ecology	(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied of the following— (a) the direct, indirect or cumulative adverse impact on terrestrial, aquatic or migratory animals or vegetation will be kept to the minimum necessary for the carrying out of the development. The proposed development will be required to demonstrate mitigation strategies to minimise any impact on terrestrial, aquatic or migratory animals. Predicted potential impacts on aquatic ecology and associated mitigation strategies are addressed in Section 5.1. (b) the development will not have a direct, indirect or cumulative adverse impact on aquatic reserves. The nearest aquatic reserve is over 250 km downstream. Water leaving the development site would be highly diluted by other creeks and rivers once it reached Barrenjoey Head. (c) if a controlled activity approval under the Water Management Act 2000 or a permit under the Fisheries Management Act 1994 is required in relation to the clearing of riparian vegetation—the approval or permit has been obtained. As a State Significant Development, the proposed development would not require a CCA. Based on the current development design, it is unlikely that the development would require a permit under the FM Act. (d) the erosion of land abutting a natural waterbody or the sedimentation of a natural waterbody will be minimised. During construction, erosion controls and procedures which minimise the likelihood of sedimentation will be required to prevent sediment from washing into the Wingecarribee River. (e) the adverse impact on wetlands that are not in the coastal wetlands and littoral rainforests area will be minimised. There are no wetlands surrounding the proposed development area which can be directly impacted.
Clause 6.8 Flooding	(2) Development consent must not be granted to development on flood liable land in a regulated catchment unless the consent authority is satisfied the development will not— (a) if there is a flood, result in a release of pollutants that may have an adverse impact on the water quality of a natural waterbody. An integrated water cycle management study may be required by the proposed development. The water cycle management study will be required to demonstrate compliance with water quality targets set out within the Wingecarribee Berrima Village Development Control Plan 2021. (b) have an adverse impact on the natural recession of floodwaters into wetlands and other riverine ecosystems. The development site does not lie between the river and any flood-dependant ecosystems and would not affect the hydrology of the wetlands downstream.
Clause 6.9 Recreation and public access	(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied of the following— (a) the development will maintain or improve public access to and from natural waterbodies for recreational purposes, including fishing, swimming and boating, without adverse impact on natural waterbodies, watercourses, wetlands or riparian vegetation. The proposed development will maintain the current public access to Wingecarribee River. The public trail which runs through the crown land between the proposed development site and Wingecarribee River will not be impacted.

5.6. Wingecarribee Local Environmental Plan 2010

Under Section 7.4 of the Wingecarribee LEP, native fauna and associated ecological processes which support their existence should be protected. The proposed development will be required to demonstrate that mitigation measures have been taken to avoid, minimise or mitigate any potential impacts to the aquatic ecology in the Wingecarribee River. Potential impacts to aquatic ecology have been identified in Section 5 and recommended strategies to address potential impacts are listed in Section 6.

6. Recommendations

This aquatic ecology assessment was commissioned by Blue Sox Group with the intention of identifying aquatic species that use the section of Wingecarribee River adjacent to Berrima Gaol and discern potential impacts to aquatic ecology of the proposed development. While the section of waterway which borders Berrima Gaol is unlikely to be habitat for threatened species, the presence of aquatic mammal species was confirmed by previous records and a contemporary field survey. To minimise impacts to aquatic ecology and allow Platypus and Rakali to continue using this section of Wingecarribee River undisturbed, the mitigation strategies below are recommended.

During preparation of final designs, construction and operation of the development, the following points are recommended for consideration.

Detailed design stage, the following tasks are recommended:

- Development footprint not to encroach closer to the river corridor than currently designed (the current location of the accommodation footprint above the sandstone terminal step is acceptable on the basis that the recommendations of this report are adopted)
- Design for double-glazed windows in hotel suites which face the river to reduce noise pollution.
- Stabilise and rehabilitate all disturbed areas including topsoiling, revegetation, weed control and maintenance in order to adequately restore and improve the integrity of the zone adjoining the river corridor
- Implement a noise curfew to discourage prolonged loud noise throughout the night.
- Minimise the use of bright external lights for the hotel suites lining the river.
- Install blinds and curtains for windows facing the river.
- Incorporate adequate bin locations to reduce the potential for littering.
- At the river corridor interface design signage alerting dog walkers they must use a leash

Prior to construction, the following tasks are required:

- Prepare a Construction Environmental Management Plan (CEMP) to address measures to be adopted to minimise impacts to the aquatic ecology as a result of the construction works, including type and location of sediment and erosion controls.
- A Sediment and Erosion Control Plan (within the CEMP) is to be prepared in accordance with *The Blue Book – Managing Urban Stormwater: Soils and Construction* (Landcom 2004) and implemented prior to works, with the aim of achieving an outcome of 'no visible turbid plumes migrating through the waterway'.
- Have an appropriately qualified ecologist inspect the adjacent river corridor for burrows. If any are found seek ecologists further advice as to any protection measures that may be required.

During construction, the following mitigation measures should be implemented by the Principal Contractor and all sub-contractors to reduce potential impacts on the watercourse (sedimentation, erosion, pollution and weed invasion):

- Avoid works (including machinery access) below the sandstone terminal step.

- If works uncover a suspected platypus burrow, works surrounding the suspected burrow are to cease for an ecologist to assess if the burrow is active.
- Schedule the works outside of predicted heavy rain periods (noting construction sites are generally closed during heavy rain periods for safety reasons).
- Environmental engineer to inspect the affected areas of the site following heavy rain periods to determine if a heightened risk of sediment being mobilised exists in any work areas and advise of any such areas where works re-commencing should be delayed, also to inspect to ensure integrity & adequacy of environmental controls in place.
- Store all chemicals (e.g. fuel, oil) used for construction purposes away from the riparian zone. Chemicals should be stored in appropriate bunding/storage systems.
- Dedicated refuelling areas are to be established outside of the riparian area and away from other drainage and swales. These areas are to be bunded to ensure any spills do not enter the riparian areas or creek.
- Ensure appropriate spill kits are present on site at all times.
- Ensure all equipment is in good working order.
- Carry associated Safety Data Sheets (SDS) for all chemicals.
- Do not use any chemicals that are labelled as 'Class 9 Environmentally hazardous' as part of the proposed activities (noting lithium-ion battery powered tools and equipment are permissible).
- Any concrete/cement slurry used in the construction must not leave the work area. Slurry must not enter the waterway.
- Wash all equipment, including, erosion and sediment control measures and trailers to prevent spread of exotic species. A visual check for vegetation and seeds on all vehicles, equipment and machinery to be used in the activities must be carried out before work commences.
- Leave erosion and sediment controls in place until after all works are completed.

Other constraints may occur on site that may affect rehabilitation of lands adjoining river corridors, such as heritage items, contaminated lands, gas pipes and other items not discussed in this report.

During development operation, the following tasks is recommended:

- For the accommodation buildings closest to the river, implement a noise restriction policy to discourage prolonged loud noise throughout the night (it is noted the accommodation suites do not include any functions venue, licenced premises, retail or other significant noise generating activities and as such are expected to generally be a quiet area of the proposed development)

7. References

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Appendix A – Presence or likelihood of threatened and protected species, populations and communities

If a species has suitable habitat present on site AND is likely to use this habitat AND the species or its habitat would be directly or indirectly impacted, THEN an Assessment of Significance is required. Such species, if any, are highlighted in the table below. This list excludes terrestrial species and those only listed under the BC Act.

Table 10: Likelihood of threatened aquatic species occurring in the study area

Scientific name	Common name	FM Act	EPBC Act	Habitat associations	ALA records	Likelihood of occurrence and impact
<i>Macquaria australasica</i>	Macquarie Perch	E	E	Habitat for this species is bottom or mid-water in slow-flowing rivers with deep holes, typically in the upper reaches of forested catchments with intact riparian vegetation. Macquarie Perch also do well in some upper catchment lakes. In some parts of its range, the species is reduced to taking refuge in small pools which persist in midland-upland areas through the drier summer periods.	None	Unlikely, species prefers forested upper reaches of catchments. While some preferred habitat features are present in study area including large woody debris and overhanging banks, this species prefers clear water. No detection in eDNA or ALA records within 10 km of study area. No further assessment of significance required.
<i>Persicaria elatior</i>	Tall Knotweed		V	This species is found in damp locations, next to streams or bodies of still water. Its known distribution is somewhat fractured along the NSW and southern QLD coast.	None	Unlikely, as the site is situated approximately 30 km west of the closest known distribution (upper reaches of Avon River) where there is one ALA record of the species, however the creek is in a separate catchment (Avon River catchment). No further assessment of significance is required.

Key: ALA = Atlas of Living Australia records within 10 km; E = Endangered; V= Vulnerable

Appendix B Terrestrial eDNA Results

Table 11: Terrestrial animals detected by eDNA analysis

Class	Species	Common Name	Status	Downstream	At Site	Upstream
Amphibian	<i>Crinia signifera</i>	Common Froglet	Native	✓		
Bird	<i>Chenonetta jubata</i>	Australian Wood Duck	Native	✓	✓	✓
Bird	<i>Fulica atra</i>	Eurasian Coot	Native	✓	✓	✓
Bird	<i>Gallinula tenebrosa</i>	Dusky Moorhen	Native	✓	✓	✓
Mammal	<i>Bos taurus</i>	Cow	Introduced	✓	✓	✓
Mammal	<i>Capra hircus</i>	Goat	Introduced	✓		
Mammal	<i>Sus scrofa</i>	Pig	Introduced		✓	✓
Mammal	<i>Canis lupus</i>	Dog	Introduced	✓		
Mammal	<i>Vulpes vulpes</i>	Fox	Introduced		✓	
Mammal	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	Native	✓		✓
Mammal	<i>Pseudocheirus peregrinus</i>	Eastern Ring-tailed Possum	Native	✓		
Mammal	<i>Vombatus ursinus</i>	Bare-nosed Wombat	Native		✓	
Mammal	<i>Equus caballus</i>	Horse	Introduced		✓	

