

APPENDIX C

AQUATIC ASSESSMENT



HYDER CONSULTING

ASSESSMENT OF THE SYDNEY INTERMODAL TRANSPORT HUB, MOOREBANK

AQUATIC ECOLOGY

July 2011





The ALS Water Sciences Group is part of the Environmental Division of ALS, one of the largest and most geographically diverse environmental testing businesses in the world.

CERTIFICATE OF APPROVAL FOR ISSUE OF DOCUMENTS

Client: Hyder Consulting
Project Title: Assessment of the Sydney Intermodal Transport Hub, Moorebank
Report Title: Aquatic Ecology
Document No: EE2011-086
Document Status: For Review
Date of Issue: July 2011
Comments:

	Position	Name	Signature	Date
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Document Revision Control

Version	Description of Revision	Person Making Issue	Date	Approval
1	For Review	Adrian Dickson	23/06/2011	
2	For Review - V2	Adrian Dickson	06/07/2011	

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1 Introduction

1.1 Background

Hyder Consulting Pty Ltd (Hyder) is undertaking an environmental assessment for the Sydney Intermodal Terminal Alliance's (SIMTA) proposal for an intermodal freight terminal and warehouse/distribution facility. The project site is located at Moorebank Avenue, Moorebank and is currently the site of the Defence National Storage and Distribution Centre. The site covers approximately 80 hectares and contains several modified stream channels that collect overland flow.

A new rail line will also be constructed on supplementary lands of approximately 65 hectares to the south and west of the warehouse facility. This land currently contains a golf course, vacant land, extractive industries, and a waste disposal depot. Georges River, and its tributary Anzac Creek, cross the supplementary lands. Anzac Creek supports an example of the *Castlereagh Swamp Woodland*, an Endangered Ecological Community.

1.2 Scope of Works

Following the issue of the Director General's Requirements (DGRs), Hyder contracted ALS Water Sciences Group to provide the aquatic ecology component of the environmental assessment. This included:

- An assessment of threatened aquatic (including groundwater dependent) species and populations; and
- Ecological surveys commensurate with the biology/ecology of aquatic species and extent of habitat within and adjacent to the project site.

The aquatic ecosystems of the study area included a stretch of Anzac Creek (approximately 300m in length) to the south of the site and a 100m section of Georges River to the west. Construction of a rail bridge is proposed to traverse both of these waterways.

1.3 Study sites

Two study sites were selected for this study one site on Georges River, and one site on Anzac Creek. The Georges River site was 100m long and extended north from beneath the East Hills Railway Bridge. The Anzac Creek site was downstream of an old and currently unused rail crossing. A location map of the study area is provided in Figure 1-1 and approximate locations of macroinvertebrate and fish sampling points are provided in Table 1-1.

Table 1-1: Location of sites selected for the Hyder aquatic ecology assessment

Site Name	Site Code	Latitude	Longitude
Georges River	HYD01Edge1	-33.96501	150.91329
	HYD01Edge2	-33.96417	150.91342
Anzac Creek	HYD02Edge1	-33.96103	150.92451
	HYD02Edge2	-33.96103	150.92497



Source: Hyder Consulting Pty Ltd

Figure 1-1: Study sites (red stars) at the SIMTA Supplementary Land Survey Area (outlined by dashed yellow line)



2 Methodology

2.1 Field sampling

Sampling was conducted on 12 May 2011 following an on-site meeting between representatives of Hyder and ALS. Hyder staff (Jane Rodd and Laura Worthington) escorted the ALS Field Team (Adrian Dickson and Peter Hancock) to both sites.

2.2 Survey methods

2.2.1 Surface Water Physico-chemistry

Water physico-chemistry was measured at each site prior to collecting macroinvertebrate and fish samples, using a multi-parameter water quality meter. The meter was calibrated in accordance with QS/QA (Quality System/Quality Assurance) requirements and the manufacturer's specifications prior to its use in the field. The *in-situ* water quality parameters recorded include;

- Water Temperature (°C)
- pH (pH units)
- Electrical Conductivity (µS/cm)
- Dissolved Oxygen (% saturation and mg/L)
- Turbidity (NTU)
- Alkalinity (mg/L CaCO₃)

In-situ water physico-chemistry was compared to the ANZECC (2000) guidelines for lowland aquatic ecosystems of south-eastern Australia. Any parameters outside the guideline value are highlighted and discussed.

2.2.2 Macroinvertebrates

Rapid Bioassessment (RBA) protocols as outlined in the NSW AUSRIVAS Sampling and Processing Manual (Turak *et al*, 2004) were used to collect macroinvertebrate samples. The AUSRIVAS program is a nationally recognised, standardised sampling protocol used to assess the health of Australian Rivers and developed for Australia's National River Health Program (NRHP). Sampling was conducted using a standard ISO 7828 (1983) design sweep-net with 250µm mesh.

At each site, the littoral or edge habitat was sampled by sweeping the collecting net along the edge of the stream in areas of little or no current. The net was swept around overhanging terrestrial vegetation, against snags, in backwaters, and through beds of macrophytes over approximately 10m of edge. Two replicate samples of 10m sweeps were collected at the Georges River and Anzac Creek sites.

The material collected for each sample was placed into a sorting tray, and macroinvertebrates were picked for a minimum of 40 minutes by professionally qualified and experienced aquatic biologists using forceps and pipettes. If new taxa were found between 30 and 40 minutes, sorting continued for a further 10 minutes up to a maximum total sorting time of 1 hour. Any by-catch was noted (e.g. fish, tadpoles, etc.) and fish specimens identified, measured and handled following methods as detailed in section 2.2.3.



The objective of the RBA sorting protocol is to obtain a sample containing as diverse a fauna as possible (and hence provide a useful measure of taxa richness). Attempts were made to collect all taxa present, including rare and cryptic animals. Samples were preserved in 100% ethanol and clearly labelled with information including site, habitat, sampling method, date and sampler.

Nets were cleaned thoroughly between sampling sites to remove any invertebrates retained on them.

2.2.3 Fish

Initially, fish were to be surveyed using a backpack electrofisher, seine nets, and bait traps. However, both sites presented logistical difficulties that prevented the use of the electrofisher and the seine net. Georges River was too deep for effective electrofishing, and contained too many submerged logs for effective seine netting. The lack of open water at Anzac Creek made electrofishing and seine netting impossible. To compensate for this, additional bait traps were deployed at each site. Twelve bait traps were set at Georges River, and six at Anzac Creek. Fewer traps were set in Anzac Creek because of a lack of suitably deep water (>30cm). Commercially available concertina bait traps with 3mm mesh were baited with cat food and left in position for at least 3 hours. Fish specimens caught as by-catch in the macroinvertebrate sweep net samples were also counted. Upon retrieval, fish were identified to species using Allen *et al.* (2002). Fish were measured and all native species were returned to the stream. Non-native species were euthanized and disposed of in accordance with fisheries and ethics permit requirements.

2.2.4 Groundwater Dependent Ecosystems (GDE) surveys

A previous investigation of groundwater in the wider study area (URS, 2002) ascertains the depth to groundwater to generally be between 4.0 to 5.0 mbgl. Groundwater flow is generally radially from the topographic high with the location of the Georges River indicating that groundwater flow underlying the area would be predominantly westerly (URS, 2002). No groundwater monitoring bores were located in the study area so no groundwater invertebrates could be sampled. As there was no groundwater monitoring bores available, groundwater quality could not be collected and compared to surface water. A visual assessment of any potential groundwater dependent ecosystems was made at both sites.

2.2.5 Aquatic and Riparian Habitat Assessment

At each site, the habitat of a 100m reach of river was assessed. The assessment included the habitats sampled, and the surrounding riparian environment. The information recorded was used to assist interpretation of the biological data, and as part of a habitat condition assessment.

Field data was recorded on a number of specialised recording sheets which ALS WSG modified from the First National Assessment of River Health (FNARH) data sheets. The modifications were undertaken to enhance the efficiency of assessment of habitat characteristics without any loss of data accuracy or detail. Descriptions are based on visual estimates of characteristics such as streambed composition (percentage of total composition for each substrate category), aquatic and riparian vegetation cover, amount of instream organic material, area of aquatic habitats and canopy cover. The mean width (wetted width in metres), mean depth and sample depth were determined. The assessment also includes sketches of the longitudinal and cross-sectional profiles of the river reach assessed displaying the biological sampling site, location of *in-situ* water quality sampling, riparian zone width, type and height and location where photos are taken. The cross-section includes the approximate bank height, stream width and depth, and the approximate height of riparian vegetation.



2.3 Data Analysis

2.3.1 Aquatic Macroinvertebrate Communities

In order to elucidate spatial trends in the data and (where possible) determine the underlying environmental factors responsible for any observed trends, a number of univariate and multivariate routines were adopted. Both techniques provide differing levels of information, with univariate indices concentrating mainly on assessing the condition or “health” of sites, whilst multivariate analysis allows comparisons between sites based upon community structure to determine if relationships exist between relevant environmental variables and macroinvertebrate communities.

The univariate and multivariate techniques employed on macroinvertebrate data include:

- Taxa Richness and EPT Taxa Richness
- SIGNAL 2 Biotic Index (Chessman, 2003), and
- Current NSW AUSRIVAS models appropriate for the study region.
- Relative Abundance

Taxa Richness and EPT Taxa Index

Richness refers to the number of different taxa contained in a sample. The EPT taxa index refers to the proportional representation of key macroinvertebrate taxa belonging to the Ephemeroptera, Plecoptera and Trichoptera groups.

SIGNAL2 (Stream Invertebrate Grade Number – Average Level)

SIGNAL is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrate families that have been derived from published and unpublished information on their tolerance to pollutants, such as sewage and nitrification (Chessman, 1995). Each family in a sample is assigned a sensitivity grade between 1 (most tolerant) and 10 (most sensitive), and these grades were improved in Chessman (2003) with the new version called SIGNAL2 with standard errors. Those families in a sample for which no grade can be assigned are excluded from the analysis. The SIGNAL2 index and its associated standard error are calculated as the average grade number for all families present in the sample. The resulting index score can then be interpreted by comparison with reference and/or control sites.

NSW AUSRIVAS Model

All macroinvertebrate data, water quality parameters and habitat variables required by the relevant AUSRIVAS models were collected according to the latest NSW AUSRIVAS manual (Turak *et al.*, 2004) and ANZECC & ARMCANZ (2000) Water Quality Guidelines for aquatic ecosystems in Southeast Australia. NSW-autumn-edge is the AUSRIVAS model which applies to the study area and environmental variables required by the model are provided in Table 2-1.

The appropriate NSW AUSRIVAS model and accompanying scores and bandings have been used to detect any changes in observed and expected macroinvertebrate communities within the sites samples. AUSRIVAS generates site-specific predictions of the macroinvertebrate fauna expected to be present in the absence of environmental stress. The expected fauna from sites with a similar set of physical and chemical characteristics are then compared to the observed fauna, and the ratio derived is used to indicate the extent of the impact. This ratio can range from zero (0), when none of the expected taxa are found at a site, to approximately one (1), when all of the expected taxa are present. The value can also be greater than one (1) when more families are found at the site than



predicted by the model. The ratio scores are placed in bands which indicate whether the site is richer than reference, reference quality, below reference quality, well below reference quality or impoverished (Table 2-2). The AUSRIVAS model also provides a list of missing taxa from individual sampling sites by comparing observed taxa against expected taxa. This data will be analysed and reported to provide a more detailed understanding of the health ratings assigned to individual sampling sites and observed trends in river health.

Table 2-1: Environmental variables required to run the AUSRIVAS NSW-autumn-edge model

Environmental Variable	Physical/Chemical Description
ALKALINITY	Total carbonates. (mg/l)
ALTITUDE	Height above sea level. (m)
BEDROCK	Percent bedrock in habitat. (%)
BOULDER	Percent boulder [>256mm] in habitat. (%)
COBBLE	Percent cobble [64-256mm] in habitat. (%)
LATITUDE	Latitude of site (decimal degrees to 4dp)
LOGDFSM	Log 10 [x] Distance from source. (log 10 [m])
LOGSLOPE1KUS	Log 10 [x] Slope: Elevation difference in metres between the middle of the site and a point 1km upstream. (log 10 [m])
LONGITUDE	Longitude of site (decimal degrees to 4dp)
RAINFALL	Mean annual rainfall. (mm)

Table 2-2: Key to AUSRIVAS O/E bands for NSW-autumn- edge model, scores vary according to model and season

Band Label	O/E 50 Bandwidth	Band Name	Comments
Band X	> 1.18	More biologically diverse than reference sites	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	0.82 - 1.17	Reference condition	Most/all of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.
Band B	0.47 - 0.81	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in loss of taxa.
Band C	0.12 - 0.46	Severely impaired	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	0 - 0.11	Extremely impaired	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

Relative Abundance

The relative abundance of the major taxonomic Orders is derived from the presence/absence (P/A) data for each of the samples. This measure provides an estimate of the percentage contribution of the major macroinvertebrate Orders and, when



presented in graphical form, allows for a visual representation of the macroinvertebrate community within each replicate sample, a pooled total for each site and a pooled total representing the macroinvertebrate community across the study area.

In addition to data analysis techniques macroinvertebrate taxa listed in the relevant legislation including the Environmental Protection and Biodiversity Conservation (EPBC) Act (1999), the Threatened Species Conservation (TSC) Act (1995) and the Fisheries Management (FM) Act (1994) will be highlighted.

2.3.2 Analysis of Fish Populations

At each site the first 50 specimens of each fish species caught were measured, general health condition assessed and identified to species level. This information was collated on an excel spreadsheet and basic univariate descriptive statistics derived. The main statistics generated for each site include the number of species and the maximum, minimum, and average length of each species. Length frequency distribution graphs, of each species with at least 25 specimens caught, were completed in Statistica 9.1 (StatSoft Inc., 2010). These graphs are used to examine the range of size classes and to determine if both adults and juveniles exist, indicating recruitment and consistent habitation of the species. Any species listed in the Environmental Protection and Biodiversity Conservation Act (EPBC) (1999) will be highlighted and possible impacts of the proposed development on the species discussed.



3 Results

3.1 Surface Water physico-chemistry

The majority of water quality parameters were within ANZECC (2000) guideline values for 95% species protection of lowland aquatic ecosystems in south eastern Australia, with the exceptions of pH and DO% (Table 3-1). pH was lowest at Anzac Creek (5.62) and was also below the lower guideline value of 6.5 at Georges River (6.06). DO% was also below the lower guideline value of 60% at both sample sites but was particularly low at Anzac Creek (11.6%). Alkalinity was considerably higher at Anzac Creek (70mg/L CaCO₃) compared to Georges River (18mg/L CaCO₃) but there is currently no ANZECC guideline value for this parameter.

Table 3-1: Results of *in-situ* water physico-chemistry (results highlighted in yellow are outside the ANZECC guideline values for 95% species protection of lowland aquatic ecosystems in south eastern Australia)

Water Quality Parameter	Georges River	Anzac Creek	ANZECC Guidelines
Sample Depth (m)	0.2	0.2	-
Temperature (°C)	12.45	9.50	-
Conductivity (µS/cm)	134.4	297.6	300
pH	6.06	5.62	6.5-9.0
DO (mg/L)	5.78	1.27	-
DO (% sat.)	48.8	11.6	60-120
Turbidity (NTU)	17.4	28.9	50
Alkalinity (mg/L CaCO ₃)	18	70	-
Date	12/05/2011	12/05/2011	-
Time	10:00	14:00	-

3.2 Macroinvertebrates

A total of 27 macroinvertebrate taxa at the Family level were recorded across the study area, with a total of 18 taxa in the Georges River samples and 23 in the Anzac Creek samples (Table 3-2). Average taxa richness values were 14 and 18 for Georges River and Anzac Creek respectively. None of the macroinvertebrate taxa recorded are considered endangered or vulnerable by the TSC Act (1994), the FM Act (1995) or are listed in the EPBC Act (1999). Across the study area Odonata (Dragonflies and Damselflies) were the dominant Order accounting for just over 18% of all taxa recorded, and more than 22% in the Georges River samples and 17% in the Anzac Creek samples (Figure 3-1). Other Orders with substantial relative abundance included Coleoptera (Beetles) and Diptera (Flies) which each contributed almost 15% of the total taxa richness across the study area.

SIGNAL2 values for all macroinvertebrate samples were relatively low but the Anzac Creek samples scored slightly higher than the Georges River samples (Table 3-2). The SIGNAL2 results suggest the macroinvertebrate community is dominated by pollution tolerant taxa although low scores are common of lacustrine and low flow environments, and are not likely to be due solely to polluted or poor water quality but also to the limited diversity of habitats, as discussed in section 3.5.

Table 3-2: Summary of macroinvertebrate indices calculated for the Hyder samples collected in autumn (May 2011)

Site	Replicate	Taxa Richness	EPT Taxa Richness	SIGNAL2	AUSRIVAS O/E 50	AUSRIVAS Band
Georges River HYD01	Edge1	12	0	2.78	0.32	C
	Edge2	16	1	3.15	0.32	C
	Combined Samples	18	1	2.97	0.39	C
	Average	14	0.5	2.93	0.32	C
Anzac Creek HYD02	Edge1	20	1	3.35	0.73	B
	Edge2	16	0	3.15	0.37	C
	Combined Samples	23	1	3.15	0.73	B
	Average	18	0.5	3.25	0.61	B
All Samples Combined	Average	16	0.5	3.11	0.48	-
	Total	27	1	2.92	-	-

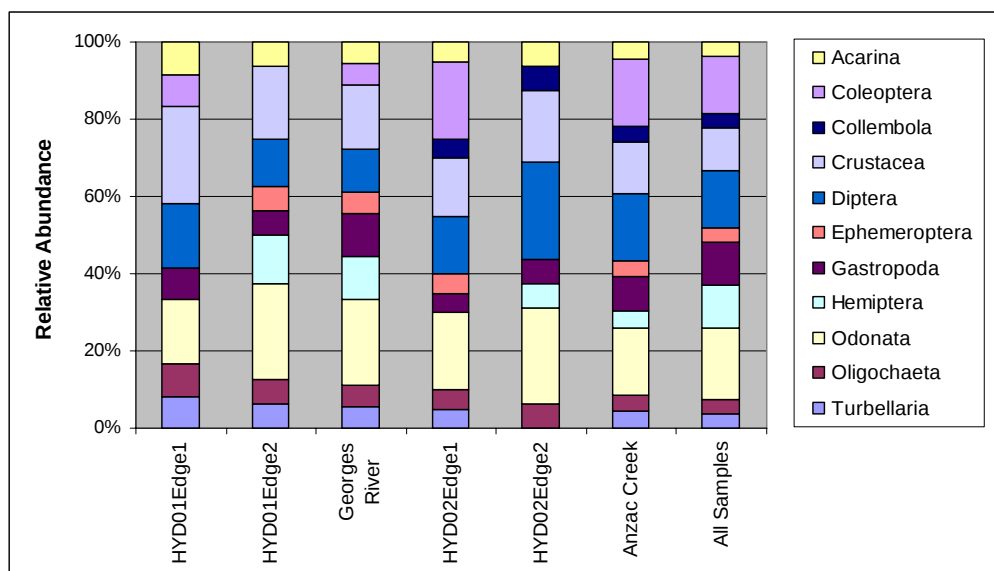


Figure 3-1: Relative abundance of macroinvertebrate taxa at the Order level for each of the Hyder samples, pooled replicate samples for each site (identified by name) and a combined total from both sites

The environmental variables used to run the NSW-autumn-edge AUSRIVAS model are provided in Table 3-3. AUSRIVAS results for the Georges River samples rated this site in Band C, suggesting that it is 'severely impaired' and that fewer macroinvertebrate families were observed than expected. This can indicate a loss of macroinvertebrate biodiversity, compared to reference sites, due to substantial impacts on water and/or habitat quality.

Each of the replicate samples from Anzac Creek scored a considerably different AUSRIVAS O/E 50, the difference being enough to separate the two samples in AUSRIVAS Band. The greater number of macroinvertebrate taxa in HYD02 Edge replicate 1 was the key reason for the difference as the environmental variables required for the model were identical for each replicate. Replicate 1 scored an O/E 50 of 0.73 while replicate 2 scored 0.37, the pooled sampled data scored 0.73 and the average of the two replicate samples was 0.63.



This provides an overall rating of AUSRIVAS Band B indicating that the macroinvertebrate community was 'significantly impaired'. This implies that fewer families than expected were observed and a 'potential impact' either on water quality, or habitat quality, or both.

Across all samples a large number of macroinvertebrate taxa were expected by the AUSRIVAS model to occur but were not observed. Approximately 48% of these missing taxa have a SIGNAL2 value above 5 and are considered to be sensitive to pollution and/or poor water quality. Of these missing taxa approximately 36% are from the EPT taxa groups which are highly sensitive to changes in water quality and/or habitat conditions. A complete list of the taxa expected but not observed is provided in Appendix B.

Table 3-3: Environmental variables used for input into AUSRIVAS NSW-autumn-edge model

Site Code	ALKALINITY	ALTITUDE	BEDROCK	BOULDER	COBBLE	LATITUDE	LOGDFSM	LOGSLOPE1KUS	LONGITUDE	RAINFALL
HYD01Edge1	18	16	0	0	0	-33.97	4.72	0.60	150.91	1300
HYD01Edge2	18	16	0	0	0	-33.96	4.72	0.60	150.91	1300
Georges River	18	16	0	0	0	-33.97	4.72	0.60	150.91	1300
HYD02Edge1	70	20	0	0	0	-33.96	2.69	0.30	150.92	1300
HYD02Edge2	70	20	0	0	0	-33.96	2.69	0.30	150.92	1300
Anzac Creek	70	20	0	0	0	-33.96	2.69	0.30	150.92	1300

3.3 Fish

A total of 65 specimens from 2 species were recorded at the Hyder sampling sites in May 2011 (Table 3-4). The species recorded included the native Flathead Gudgeon (*Philypnodon grandiceps*) and the introduced *Gambusia* (*Gambusia holbrooki*). Only one specimen of the native *P. grandiceps* was recorded and only at the Georges River site, thus no further summary statistics can be calculated for this species.

Table 3-4: Summary data for fish captured at the Hyder Consulting aquatic monitoring sites

Site Name & Code	Fish Species	Common Name	Count	Mean Length (mm)
Georges River HYD01	<i>Gambusia holbrooki</i>	Gambusia	50	26.4
	<i>Philypnodon grandiceps</i>	Flathead Gudgeon	1	32
Anzac Creek HYD02	<i>Gambusia holbrooki</i>	Gambusia	14	25.0
Total			65	

Gambusia were caught at both sample sites but were more abundant at Georges River (50+ specimens) compared to Anzac Creek (14 specimens). The mean length of *Gambusia* was 26.4mm and 25.0mm for Georges River and Anzac Creek respectively and both sites displayed a range of size classes (Figure 3-2) suggesting that both adults and juveniles were present and that recruiting populations exist. Bait traps were the most successful collection method at in the Georges River but due to the extensive macrophyte cover and

limited open water at Anzac Creek, the majority of fish specimens were caught as by-catch in the macroinvertebrate samples (Figure 3-3).

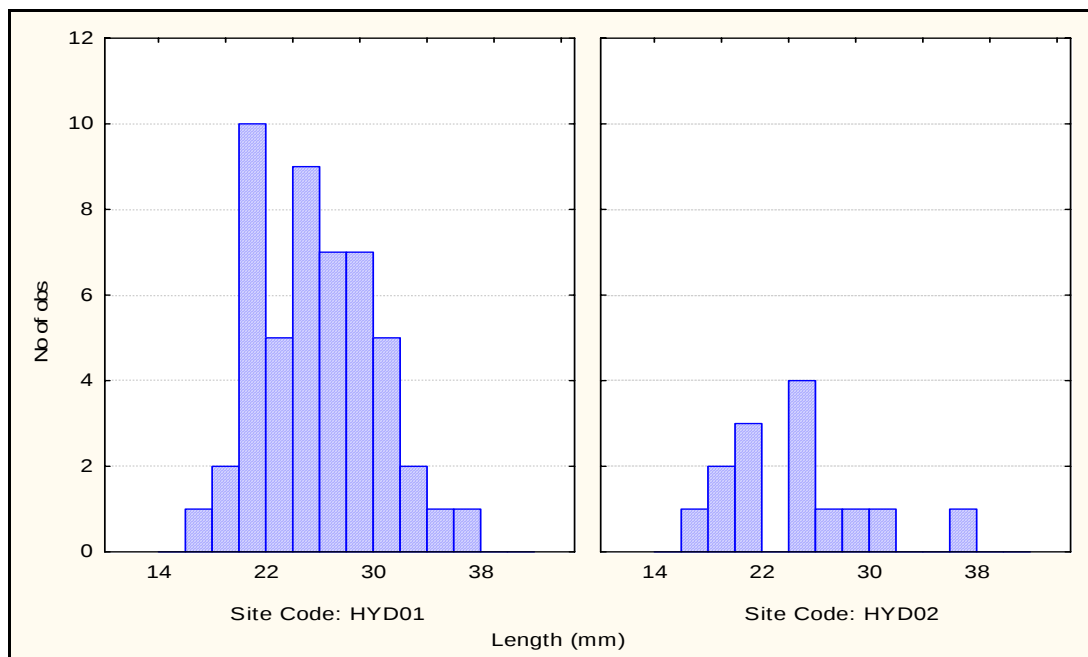


Figure 3-2: Length frequency distribution histograms of Gambusia (*Gambusia holbrooki*) at each of the Hyder aquatic monitoring sites

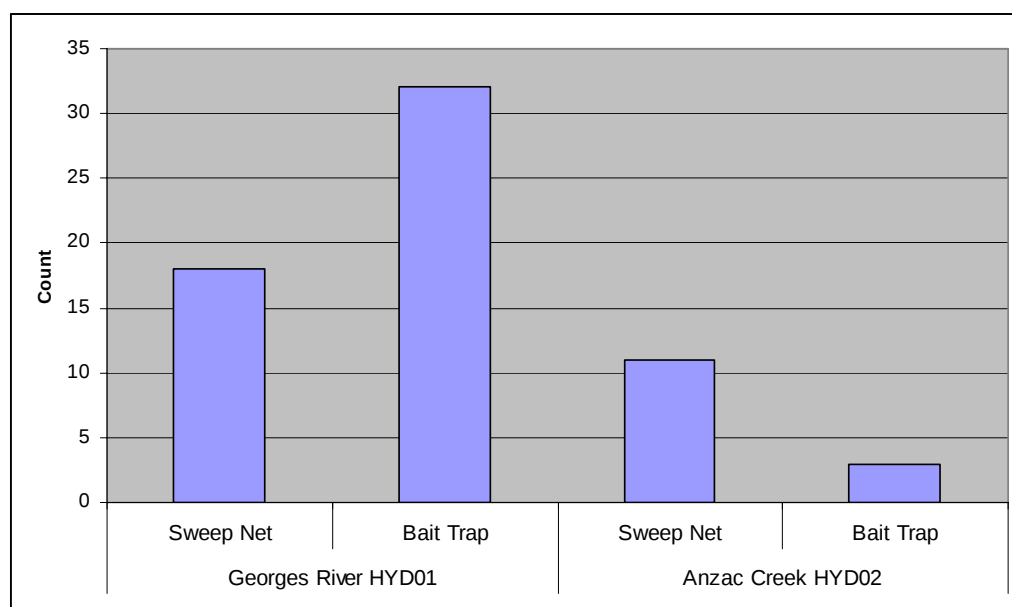


Figure 3-3: Total catch of Gambusia (*Gambusia holbrooki*) per collection method for each of the Hyder Consulting aquatic monitoring sites sampled in May 2011

3.4 Groundwater Dependant Ecosystems

A visual assessment of the site was made to consider the presence of groundwater and the potential for groundwater dependant communities to exist within the study area. No groundwater monitoring bores were located on the study site, so no groundwater samples could be collected.

Results from previous studies (URS, 2002) in an area adjacent to the Hyder study area, have shown the depth to groundwater to be generally between 4 - 5mbgl. This study suggested that groundwater flow is generally radially from the topographic high and that the location of the Georges River indicates groundwater flow underlying the study area would be predominantly westerly. Results from the URS (2002) study indicated that lower salinity waters are present in the shallow groundwater inferring that local recharge is occurring, and that the low/moderate salinity observed at deeper levels may be indicative of deep local recharge. This suggests that groundwater is likely to contribute to the existing surface water, particularly in Anzac Creek, and that there is connectivity between the groundwater and the Georges River. Analysis of the isotopic signature of the various water sources would be required to conclusively demonstrate this connectivity which would require groundwater monitoring bores at various locations across the site. Such bores could be sampled for both water quality and invertebrate communities. To ensure a sample is representative, newly constructed groundwater monitoring bores should not be sampled for at least 6 months post construction. Confirmation of the presence or absence of groundwater fauna is desirable, but construction of monitoring bores and an adequate sampling regime is likely to set back the proposed development considerably.

3.5 Aquatic and Riparian Habitat Assessment

3.5.1 Georges River

The Georges River site (Figure 3-4) was 100m long and extended north from beneath the East Hills Railway Bridge. The river was 40 to 60m wide, and the bank dropped rapidly to a depth of 1.2m before falling away at a steadier grade. Aquatic habitats present included soft substrate pool habitat, large woody debris and extensive macrophyte cover. Riparian vegetation was dominated by dense growth of Lantana (*Lantana camara*), with occasional tall *Eucalyptus* spp. The western bank could not be sampled due to access restrictions, however observations from the eastern bank suggested that access would be difficult due to vertical banks. Overhanging vegetation, fallen logs, mats of sticks, submerged (*Elodea canadensis*) and floating aquatic plants (*Azola* sp., *Salvinia molesta*) were present in the littoral and edge habitats throughout the study reach.

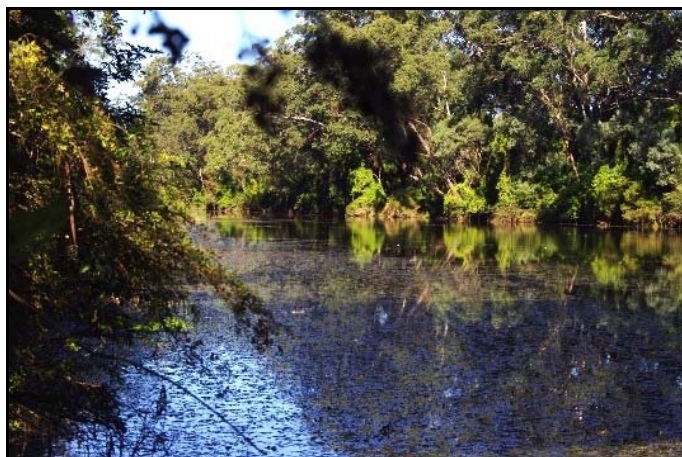


Figure 3-4: Georges River facing upstream from the macroinvertebrate and fish sampling site

3.5.2 Anzac Creek

The Anzac Creek site (Figure 3-5, Figure 3-6) was downstream of an old and currently unused rail crossing. The limited aquatic habitat included soft substrate pools and extensive macrophyte cover and there was no open or running water present at the site. The creek was obscured by dense growths of *Typha* sp. and *Salvinia molesta*. Water was mostly static and shallow (1 to 30cm deep) with a small pool of approximately 1m depth immediately downstream of the culvert tunnels running underneath the rail line. Riparian vegetation was dominated by *Melaleuca* sp., *Eucalyptus* spp., and other native shrub species.



Figure 3-5: Anzac Creek facing upstream of the railway culvert, displaying extensive growth of *Typha* sp. and *Salvinia molesta*, and the limited aquatic habitat available for macroinvertebrate and fish sampling



Figure 3-6: Anzac Creek facing downstream of the railway culvert, displaying the limited open water available for macroinvertebrate and fish sampling



4 Discussion

4.1 Surface Water Physico-chemistry

The *in-situ* water physico-chemistry showed that pH and dissolved oxygen were below the ANZECC guideline values at both sites. This maybe a factor influencing the macroinvertebrate community composition, but further monitoring would be required to confirm that the low pH and dissolved oxygen values recorded are consistent over time. The measured variables were limited to *in-situ* parameters and further laboratory analysis of pollutants, nutrients, metal concentrations, bacterial content etc. may find other conditions of water physico-chemistry that may be responsible for some impacts on the macroinvertebrate communities.

4.2 Macroinvertebrates

Results of the macroinvertebrate sampling showed both sites to have relatively depauperate macroinvertebrate communities. Richness values, at the taxonomic level of Family, were generally low and many sensitive taxa were not recorded. SIGNAL2 values for all samples suggest the macroinvertebrate community of these sites is dominated by pollution tolerant taxa. AUSRIVAS rated the Georges River site in Band C 'severely impaired' and results show that fewer macroinvertebrate families were observed than were expected by the AUSRIVAS model. This can indicate a loss of macroinvertebrate biodiversity due to 'substantial' impacts on water and habitat quality or both. Anzac Creek was rated slightly better, AUSRIVAS Band B, indicating that the macroinvertebrate community was 'significantly impaired'. This implies that fewer families than expected were observed and a 'potential' impact has occurred, either on water quality, or habitat quality or both, resulting in a loss of taxa.

Of the macroinvertebrate taxa that were expected but not observed, a large proportion are known to be sensitive to pollution and/or poor water quality (as indicated by their SIGNAL2 scores). The Family Baetidae from the Order Ephemeroptera (Mayflies) was the single representative of the sensitive EPT taxa groups but was recorded in only one replicate sample from each site. This suggests a limited distribution and low abundance of Mayflies across the study area. Across all samples Odonata (Dragonflies and Damselflies) were the most dominant Order, followed by Coleoptera (Beetles) and Diptera (Flies). These taxa generally have a highly motile adult stage. The dominance of these taxa suggests that aerial dispersal is a primary colonisation pathway and a major influence on macroinvertebrate community structure within the study area. None of the macroinvertebrate taxa recorded is considered endangered or vulnerable by the TSC Act (1994), the FM Act (1995) or is listed in the EPBC Act (1999).

The macroinvertebrate community at both sample sites was found to have at least some level of impairment and any further degradation of these sites is likely to influence the macroinvertebrate community on a local scale. The study area of the Georges River is isolated to a 100m stretch of the river. A large proportion of this reach is heavily vegetated with Lantana on the banks and dense submerged and floating aquatic plants including *Elodea Canadensis*, *Azolla* sp. and *Salvinia molesta*. This could be considered as poor quality habitat which lacks the diversity of micro-habitats to support a diverse and healthy macroinvertebrate community. While construction of a rail bridge may have localised impacts on the macroinvertebrate community it is unlikely to have any prolonged or widespread impacts and the community should recover from any disturbance in a short time following construction. Potential impacts such as increased sedimentation or instream habitat alterations should be minimised to ensure the macroinvertebrate community does not degrade further. Ongoing monitoring of the Georges River, both upstream and downstream of the proposed development, may help to identify and minimise any potential impacts to aquatic macroinvertebrate communities.



Assessment of the macroinvertebrate community at the Anzac Creek site showed it to be more diverse and healthy than that of the Georges River site. If development of the site alters the habitat of Anzac Creek, through direct habitat removal or indirect sources such as increased runoff and sedimentation, it is likely to impact the aquatic macroinvertebrate community. As previously mentioned much of the macroinvertebrate taxa recorded at the two sites have aerial adult stages. It is possible that Anzac Creek may be an important source of macroinvertebrate colonisers to the Georges River (and vice versa, but to a lesser extent) and as such consideration should be given to maintaining the condition of the macroinvertebrate community in Anzac Creek. As this site is at the top of the Anzac Creek catchment any changes to the aquatic or riparian habitats, or landuse within the catchment, are likely to have impacts on communities downstream. Ongoing monitoring of macroinvertebrate communities downstream of the development may assist in identifying changes in aquatic communities and help to minimise any potential impacts that may occur.

4.3 Fish

To identify the potential for fish presence at each of the study sites the assessed habitat was compared to the waterway types according to Faithfull and Witheridge (2003). The Georges River at the Hyder study site was a permanent water body which classifies it as a Class 1 Major fish habitat. This site was a wide deep pool with steep vegetated banks which made access to the site difficult. The edge habitats of the river were also densely covered with aquatic macrophyte and any region beyond the macrophyte was too deep to wade. The depth of the river, dense macrophyte cover, and cover of snags and large woody debris, prevented seine netting, fyke netting and backpack electrofishing from being conducted, thus bait traps and sweep nets were the only methodologies able to be employed. This limited the assessment of fish communities at the Georges River study site to the littoral and edge dwelling species only.

Anzac Creek was limited to small static pools with dense covering of macrophytes including *Typha* sp. and *Salvinia molesta* which limited the habitat available for fish sampling. Anzac Creek at the location of the Hyder study site could be considered an intermittent waterway or wetland that would only flow immediately following a substantial rain event. This would classify this site as a Class 3 Minimal fish habitat according to Faithfull and Witheridge (2003). As with the Georges River site bait traps and sweep netting only could be used and the limited open water reduced the number of bait traps able to be deployed.

Only one native fish species was recorded across the study area. One specimen of the native Flathead Gudgeon (*Philypnodon grandiceps*) was recorded within the Georges River and no native fish were recorded in Anzac Creek. Flathead Gudgeon is generally a benthic species that prefers slow flowing areas of lowland streams or lakes and dams and is often found in weedy or muddy areas with abundant cover (Lintermans, 2007). The extensive cover of aquatic macrophyte and woody debris in the edge habitats of the Georges River provide an ideal habitat for this species. Although only one specimen was recorded it is likely that further sampling would record additional specimens and that the species is widely distributed in the lower reaches of the Georges River. The species matures at 42-50mm length and breeds in spring and summer when water temperatures are between 18-27°C and eggs are laid attached to solid objects such as rock and wood (Lintermans, 2007). The specimen observed was 32mm and would be likely to reach sexual maturity in the next breeding season and, with abundant cover of woody debris, a consistent population of this species is highly likely to occur.

Flathead Gudgeon is not considered an endangered or vulnerable species in the FM Act (1994), nor is it listed in the EPBC Act (1999) and is common throughout its range. It occurs throughout the Murray-Darling Basin and in coastal drainages in Victoria, northern Tasmania, New South Wales and Queensland (Lintermans, 2007). Although a widely distributed and common species care should be taken to maintain the aquatic habitats preferable to this species as they are likely to be beneficial to other potential species.



Gambusia (*Gambusia holbrooki*) were caught at both sample sites but were more abundant at Georges River compared to Anzac Creek. This small, introduced fish rapidly reproduce, disperse widely, occupy diverse habitats and is also a highly aggressive predatory species, often to the detriment of native species (NSW National Parks and Wildlife Service, 2003). Predation by *G. holbrooki* is listed as a key threatening process under Schedule 3 of the TSC Act (1995). *Gambusia* are commonly found in lakes or slow flowing streams, mostly around the edges or amongst freshwater plants. Maturity can be reached after only two months, at about 25mm long, and females produce about fifty young in each batch, and up to nine batches per year (Lintermans, 2007). Both sites displayed a range of size classes and even though the Anzac Creek population was less abundant and possessed fewer size classes, data from both populations suggests that recruitment is occurring. *Gambusia* tolerates a wide range of water temperatures, oxygen levels, salinities and turbidities and due to its ability to breed rapidly, it has assumed plague proportions in many habitats (Lintermans, 2007). Changes to the aquatic habitats, such as reduced habitat diversity and increased sedimentation, that may result from construction works are likely to benefit *Gambusia* and be detrimental to native fish species. *Gambusia* are known to display aggressive fin-nipping behaviour and often compete with small native fishes (McDowell, 1996). Any further increase in the *Gambusia* population is highly likely to negatively impact the native Flathead Gudgeon therefore processes which could potentially reduce aquatic habitat diversity, such as siltation during construction works, should be minimised if possible.

Previous studies within the Georges River catchment (Williams *et.al*, 2004) surveyed fish approximately 500m upstream of the Hyder Study site at the Cambridge Avenue road bridge. This survey recorded several other native species including Striped Gudgeon (*Gobiomorphus australis*), Empire Gudgeon (*Hypseleotris compressa*) and Australian Bass (*Macquaria novemaculeata*) and habitat requirements of these species are similar to those of Flat-head Gudgeon. The threatened Macquarie Perch (*Macquaria australasica*) has also been identified in parts of the upper Georges River catchment (NSW Industry & Investment, 2010), but generally, the Macquarie Perch are found upstream of areas inhabited by Australian Bass (Native Fish Australia, 2009b) so it is highly unlikely that Macquarie Perch occur in the lower reaches of the Georges River at or near this site.

It may be possible to conduct a more comprehensive assessment of the fish community at the Georges River site through other methods such as gill netting and/or boat electrofishing. These methods may be more costly and time consuming, as boat access to the river would be required, but are likely to provide more comprehensive and conclusive results of the fish species present at the site. The proposed development is confined to a small stretch of the Georges River and any construction works are likely to be confined to this site and possibly a small distance downstream. Development of a rail bridge at this site is likely to have limited impact on any other potential native fish populations which, if present, are likely to populate a much wider region of the lower reaches of the Georges River.

4.4 Groundwater Dependant Ecosystems

No groundwater monitoring bores were located on the study site, so no groundwater samples could be collected. Confirmation of the presence or absence of groundwater dependant fauna (stygo fauna) is desirable, but construction of monitoring bores and an adequate sampling regime is likely to set back the proposed development considerably. Results from the URS (2002) study indicated that that local recharge is occurring, which suggests that groundwater contributes to the existing surface water, particularly in Anzac Creek, and there is connectivity between the groundwater and the Georges River. Although the extent of groundwater distribution in the area is not clear it is probable, due to local hydrogeology, that groundwater across the study area and the wider region is interconnected. This would suggest that if stygo fauna were present they are unlikely to be isolated to the vicinity of the proposed developments and while isolated areas of the groundwater may be influenced, a significant impact on the wider region is highly unlikely.



An example of the Castlereagh Swamp Woodland (CSWL), listed as an Endangered Ecological Community in the TSC Act (1995), is located within the study area and surrounding the Anzac Creek study sites. Characteristic tree species in the CSWL are *Eucalyptus parramattensis subsp. parramattensis* and *Melaleuca decora* and small billabongs and/or wetlands may occur within the community (OEH, 2011). As Anzac Creek is likely to be predominantly a result of groundwater recharge specimens of these tree species within the Anzac Creek area are likely to be groundwater dependent. This suggests that the CSWL community within the study area could be considered a groundwater dependant ecosystem. Species composition at any site depends on local topography and drainage conditions and CSWL is typically associated with poorly-drained depressions and creeklines on clay soils associated with Tertiary alluvium (OEH, 2011). Any development within or in close proximity to the Anzac Creek CSWL community should thoroughly consider any potential impacts on groundwater quality and quantity as any localised pollution or reduction in the groundwater table is likely to influence this endangered community.

4.5 Aquatic and Riparian Habitat Assessment

The two sites assessed were vastly different in their habitat types. The Georges River site is a lowland, slow flowing river close to the end of the catchment. Landuse in the catchment upstream of the sampling site is a mixture of residential, light industrial and natural forest. The sampling site had steep heavily vegetated banks which made access difficult and the instream habitat was generally a deep soft bottomed pool and also heavily vegetated with aquatic macrophytes. The combination of these factors made macroinvertebrate and fish sampling difficult and limited the variety of habitats which could be successfully sampled. The extensive macrophyte cover of submerged *Elodea canadensis* and floating aquatic plants (*Azola* sp., *Salvinia molesta*) present throughout the study reach, reduced the overall heterogeneity of the aquatic habitat and is likely a factor influencing the macroinvertebrate community composition. Riparian and bankside vegetation was dominated by the introduced Lantana (*Lantana camara*) and invasion, establishment and spread of this species is listed as a key threatening process in the TSC Act (1995) while degradation of native riparian vegetation along NSW water courses is also listed in the FM Act (1994). Consideration of these threatening processes should be given with management of the study area and development could consider control/removal of Lantana as an offset to any potential impacts that may result from construction works.

The site on Anzac Creek was quite different and more similar to a swamp or wetland environment than to a river. The dense macrophyte cover and small catchment area upstream of the site (catchment area approximately 450m²) provided static water only and the samplable aquatic habitat was limited to two small pools both heavily vegetated with floating and emergent macrophytes. The introduced *Salvinia* (*Salvinia molesta*) dominated the floating macrophyte composition at the Anzac Creek sample sites. *Salvinia* is a Weed of National Significance and is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts (Department of the Environment and Heritage and the CRC for Australian Weed Management, 2003). *Salvinia* is an aquatic weed that can grow rapidly to cover the entire water surface which shades out any submerged plant life and impedes oxygen exchange, making the water unsuitable for fish and other animals. The presence of *Salvinia* at the Anzac Creek study site has potential to negatively impact the aquatic ecosystem both directly at this site and downstream. Development of a rail bridge at this site should consider the management of *Salvinia*, both locally and downstream, as it may help to reduce any potential impacts that may result as a consequence of construction works.

The proposed development site is relatively small and only limited areas of development are expected to disturb the aquatic habitats. The section of rail proposed over the Georges River is unlikely to influence any potential surface water to groundwater connectivity as it is limited to a small stretch of the river. Development of the site around the upper areas of Anzac Creek may influence the potential connectivity of surface water and reduce the likelihood of it becoming habitat for native fish species. Consideration of



this connectivity should be given in the design and construction of the rail bridge to minimise impacts at this site that may have implications for ecosystems downstream.

The aquatic ecosystems within the proposed development area could be considered slightly to moderately disturbed and not in pristine condition. However, care should be taken to minimise any further degradation of this site. The proposed development has potential to have a greater impact on the aquatic ecosystem of Anzac Creek compared to the Georges River as this area remains in a more 'natural' state. This area also contains an example of the endangered Castlereagh Swampland Community which is likely to be groundwater dependant and consideration should be given to minimise any potential impacts to this community. The development of the rail bridge across the Georges River should consider any additional sedimentation that may result during construction works, but any potential impacts to the aquatic communities at this site are likely to be negligible, both spatially and temporally.



5 Conclusions and Recommendations

The aquatic ecology survey designed by ALS focused on macroinvertebrate and fish communities and a general assessment of the aquatic habitat at each of the sampling sites was made. A summary of findings of this study follow;

- Results of the macroinvertebrate sampling showed both sites to have relatively depauperate macroinvertebrate communities and any further degradation of these sites is likely to influence the macroinvertebrate community on a local scale.
- The Georges River site was rated in Band C by the AUSRIVAS model indicating that was 'severely impaired'.
- Anzac Creek rated slightly better and the overall rating of AUSRIVAS Band B indicates the macroinvertebrate community was 'significantly impaired'.
- The *in-situ* water physico-chemistry showed that pH and dissolved oxygen were below the ANZACC guideline values at both sites. This maybe a factor influencing the macroinvertebrate community composition, but further monitoring would be required to confirm that the low pH and dissolved oxygen values are consistent over time.
- None of the recorded macroinvertebrate taxa are listed in the EPBC Act.
- The assessment of fish communities within the reach of Georges River was limited to the littoral and edge dwelling species only as access to the river prevented most of the proposed sampling methodologies.
- Flathead Gudgeon (*Philypnodon grandiceps*) was the only native fish species recorded and only one specimen was recorded at the Georges River site. This species is not listed in the EPBC Act and is considered common throughout its range.
- The introduced *Gambusia* (*Gambusia holbrooki*) was caught at both sample sites but was more abundant in the Georges River. Any further increase in the *Gambusia* population is likely to negatively impact the native Flathead Gudgeon population therefore processes which could potentially reduce aquatic habitat diversity, such as increased siltation during construction works, should be minimised.
- It is possible that other fish species are present in the open waters of the Georges River site but other sampling methods, such as gill netting or boat electrofishing, would be required to confirm this. The proposed development, confined to a small stretch of the Georges River, is likely to have limited impact on the river and any other potential native fish populations.
- The presence/absence of groundwater fauna could not be confirmed due to the lack of monitoring bores on the study site. Any potential fauna are unlikely to be isolated to the vicinity of the proposed developments and while isolated areas of groundwater may be influenced, a significant impact on the wider region is highly unlikely.
- The Castlereagh Swampland Community within the vicinity of Anzac Creek and within the study area could be considered a groundwater dependant ecosystem. Any development within the Anzac Creek CSWL community should thoroughly consider potential impacts on groundwater quality and quantity as any localised pollution or reduction in the groundwater table is likely to influence this endangered community.
- Management of the study area should consider control/removal of Lantana as an offset to any potential impacts that may result from construction works. The aim would be reducing the impact of Lantana on the aquatic ecosystems through reducing the degradation of streamside vegetation.
- While the aquatic ecosystems within the proposed development area are slightly to moderately disturbed, care should be taken to minimise impact and prevent any further degradation.



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Appendix A - Macroinvertebrate Data, May2011



Taxa Code	Class/Order	Family/Sub-family	SIGNAL 2 Value	HYD01Edge1	HYD01Edge2	HYD02Edge1	HYD02Edge2
IF619999	Turbellaria	Dugesidae	2	3	4	4	
KG059999	Gastropoda	Lymnaeidae	1				1
KG079999	Gastropoda	Planorbidae	2		2	1	
KG089999	Gastropoda	Physidae	1	2			
LO999999	Oligochaeta	Oligochaeta	2	4	2	6	3
MM999999	Acarina	sp.	6	51	22	5	17
QA999999	Collembola	sp.	1			2	5
QC099999	Coleoptera	Dytiscidae	2	1		12	
QC119999	Coleoptera	Hydrophilidae	2			5	
QC139999	Coleoptera	Hydraenidae	3			1	
QC209999	Coleoptera	Scirtidae	6			1	
QD099999	Diptera	Ceratopogonidae	4			8	4
QD249999	Diptera	Stratiomyidae	2				1
QDAE9999	Diptera	s-f Tanypodinae	4	2	1	6	8
QDAJ9999	Diptera	s-f Chironominae	3	1	3	7	4
QE029999	Ephemeroptera	Baetidae	5		5	1	
QH539999	Hemiptera	Hebridae	3				16
QH629999	Hemiptera	Belostomatidae	1		1		
QH689999	Hemiptera	Pleidae	2		1		
QO029999	Odonata	Coenagrionidae	2	45	52	10	5
QO129999	Odonata	Aeshnidae	4			1	1
QO179999	Odonata	Libellulidae	4		5	4	1
QO309999	Odonata	Hemicorduliidae	5		1	4	1
QO999998	Odonata	Epiproctophora	3	2	2		
OG999999	Crustacea	Cladocera	N/A	3	2	1	12
OH999999	Crustacea	Ostracoda	N/A	6	5	3	4
OJ999999	Crustacea	Copepoda	N/A	12	11	13	1



Appendix B - List of Macroinvertebrate Taxa Expected in AUSRIVAS model but not observed in Hyder samples.



Taxa Code	Class/Order	Family	SIGNAL2 Value
IF499999	Turbellaria	Temnocephalidae	0
IJ019999	Nematomorpha	Gordiidae	5
KG029999	Gastropoda	Hydrobiidae	4
KG049999	Gastropoda	Thiaridae	4
KG069999	Gastropoda	Ancylidae	4
KP029999	Gastropoda	Corbiculidae	4
LH019999	Hirudinea	Glossiphoniidae	1
OP029999	Amphipoda	Ceinidae	2
OP039999	Amphipoda	Eusiridae	7
OR129999	Isopoda	Cirolanidae	2
OT019999	Decapoda	Atyidae	3
OT029999	Decapoda	Palaemonidae	4
OV019999	Decapoda	Parastacidae	4
QC069999	Coleoptera	Haliplidae	2
QC089999	Coleoptera	Noteridae	4
QC109999	Coleoptera	Gyrinidae	4
QC189999	Coleoptera	Staphylinidae	3
QC349999	Coleoptera	Elmidae	7
QC379999	Coleoptera	Psephenidae	6
QD019999	Diptera	Tipulidae	5
QD069999	Diptera	Dixidae	7
QD079999	Diptera	Culicidae	1
QD109999	Diptera	Simuliidae	5
QD119999	Diptera	Thaumaleidae	7
QD229999	Diptera	Athericidae	8
QDAD9999	Diptera	Podonominae	6
QDAF9999	Diptera	Orthoclaadiinae	4
QE039999	Ephemeroptera	Oniscigastridae	8
QE059999	Ephemeroptera	Coloburiscidae	8
QE069999	Ephemeroptera	Leptophlebiidae	8
QE089999	Ephemeroptera	Caenidae	4
QH529999	Hemiptera	Mesoveliidae	2
QH549999	Hemiptera	Hydrometridae	3
QH569999	Hemiptera	Veliidae	3
QH579999	Hemiptera	Gerridae	4
QH649999	Hemiptera	Gelastocoridae	5
QH659999	Hemiptera	Corixidae	2
QH679999	Hemiptera	Notonectidae	1
QL019999	Lepidoptera	Pyralidae	3



Taxa Code	Class/Order	Family	SIGNAL2 Value
QM019999	Megaloptera	Corydalidae	7
QM029999	Megaloptera	Sialidae	5
QO039999	Odonata	Isostictidae	3
QO049999	Odonata	Protoneuridae	4
QO059999	Odonata	Lestidae	1
QO079999	Odonata	Megapodagrionidae	5
QO089999	Odonata	Synlestidae	7
QO139999	Odonata	Gomphidae	5
QO169999	Odonata	Corduliidae	5
QP029999	Odonata	Austroperlidae	10
QP039999	Plecoptera	Gripopterygidae	8
QP049999	Plecoptera	Notonemouridae	6
QT019999	Trichoptera	Hydrobiosidae	8
QT039999	Trichoptera	Hydroptilidae	4
QT049999	Trichoptera	Philopotamidae	8
QT069999	Trichoptera	Hydropsychidae	6
QT079999	Trichoptera	Polycentropodidae	7
QT089999	Trichoptera	Ecnomidae	4
QT139999	Trichoptera	Tasimiidae	8
QT159999	Trichoptera	Conoesucidae	7
QT179999	Trichoptera	Helicopsychidae	8
QT189999	Trichoptera	Calocidae	9
QT219999	Trichoptera	Philorheithridae	8
QT229999	Trichoptera	Odontoceridae	7
QT239999	Trichoptera	Atriplectididae	7
QT249999	Trichoptera	Calamoceratidae	7
QT259999	Trichoptera	Leptoceridae	6



Appendix C - Fish Data, May 2011



Site Code	Date	Collection Method	Common Name	Scientific Name	Length (mm)
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	25
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	17
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	38
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	29
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	22
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	33
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	26
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	21
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	20
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	36
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	32
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	26
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	22
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	22
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	29
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	34
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	29
HYD01	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	32
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	21
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	24
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	25
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	23
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	22
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	26
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	30
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	28
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	32
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	29
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	22
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	20
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	24
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	27
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	31
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	28
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	22
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	25
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	27
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	26
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	24



Site Code	Date	Collection Method	Common Name	Scientific Name	Length (mm)
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	30
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	28
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	28
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	22
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	25
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	26
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	30
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	23
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	32
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	27
HYD01	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	21
HYD01	12/05/2011	Bait Trap	Flathead Gudgeon	<i>Philypnodon grandiceps</i>	32
HYD02	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	22
HYD02	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	22
HYD02	12/05/2011	Bait Trap	Gambusia	<i>Gambusia holbrooki</i>	25
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	27
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	26
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	37
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	20
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	22
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	25
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	26
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	32
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	29
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	18
HYD02	12/05/2011	Sweep Net	Gambusia	<i>Gambusia holbrooki</i>	19

APPENDIX D

FLORA SPECIES LIST

Plant species recorded in the study area

Notes:

* indicates exotic species; # indicates non-local native species; + indicates threatened species.

Columns Q1 to Q12 represent Quadrats 1 to 12. The values for each species are the estimated percentage foliage cover of the species within the 0.04 hectare quadrat.

Species that are not defined as present within a specific sampling location are those that were opportunistically recorded within the study area during surveys.

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
Ferns and Allied Plants															
Blechnaceae	<i>Doodia caudata</i>	Small Rasp Fern													
Dennstaedtiaceae	<i>Hypolepis muelleri</i>						20								
	<i>Pteridium esculentum</i>	Bracken													
Dicksoniaceae	<i>Calochlaena dubia</i>	Rainbow Fern								2					
Gleicheniaceae	<i>Gleichenia dicarpa</i>	Pouched Coral-fern										2			
Lindsaeaceae	<i>Lindsaea linearis</i>	Screw Fern			1										
Pteridaceae	<i>Adiantum aethiopicum</i>	Common Maidenhair Fern					2			2					
	<i>Cheilanthes sieberi</i>	Rock Fern			1							1			
Salviniaceae	* <i>Salvinia molesta</i>	Salvinia													
Schizaeaceae	<i>Schizaea bifida</i>	Forked Comb Fern										1			
Gymnosperms															
Araucariaceae	<i>Araucaria heterophylla</i>	Norfolk Island Pine			1										X
Cupressaceae	<i>Callitris rhomboidea</i>	Port Jackson Cypress-pine													
	* <i>Cupressus sempervirens</i> cv. <i>Stricta</i>	Pencil Pine													X
Pinaceae	* <i>Pinus</i> sp.								5						
Zamiaceae	<i>Macrozamia spiralis</i>	Burrawang													

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
Angiosperms - Dicotyledons															
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet, Blue Yam													
Amaranthaceae	<i>Alternanthera denticulata</i>	Common Joyweed			2										
	* <i>Alternanthera philoxeroides</i>	Alligator Weed					2			2	25				
Apiaceae	<i>Centella asiatica</i>	Indian Pennywort					1							1	
	* <i>Hydrocotyle bonariensis</i>	Beach Pennywort													
	<i>Hydrocotyle peduncularis</i>						1					1			
	<i>Platysace ericoides</i>	Heath Platysace	3			1							1		
	<i>Trachymene incisa</i>		1			1						1	1		
Apocynaceae	* <i>Araujia sericifera</i>	Moth Vine, Cruel Plant								1					
	* <i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush													
	* <i>Nerium oleander</i>	Oleander													X
	<i>Parsonsia straminea</i>	Common Silkpod		15								1			
Araliaceae	<i>Polyscias sambucifolia</i>	Elderberry Panax													
Asteraceae	* <i>Aster subulatus</i>	Wild Aster													
	* <i>Bidens pilosa</i>	Cobblers Pegs							1						
	<i>Cassinia uncata</i>	Sticky Cassinia													
	* <i>Chrysanthemoides monilifera subsp. rotundata</i>	Bitou Bush													
	* <i>Cirsium vulgare</i>	Black Thistle								1					
	* <i>Conyza sp.</i>	Fleabane			1										
	<i>Coronidium scorpioides</i>	Button Everlasting													
	* <i>Delairea odorata</i>	Cape Ivy								10					
	<i>Euchiton sphaericus</i>				1										

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	* <i>Hypochaeris radicata</i>	Catsear, False Dandelion													
	<i>Olearia microphylla</i>														
	<i>Ozothamnus diosmifolius</i>	White Dogwood		1	2										
	* <i>Senecio madagascariensis</i>	Fireweed			1									1	
	<i>Senecio quadridentatus</i>	Cotton Fireweed													
	* <i>Sonchus oleraceus</i>	Common Sow-thistle													
	* <i>Tagetes minuta</i>	Stinking Roger													
	<i>Vernonia cinerea</i>														
	<i>Vittadinia pustulata</i>														
	* <i>Xanthium occidentale</i>	Noogoora Burr													
Bignoniaceae	* <i>Jacaranda mimosifolia</i>	Jacaranda													X
Boraginaceae	* <i>Echium plantagineum</i>	Paterson's Curse													
Brassicaceae	* <i>Brassica sp.</i>														
Cactaceae	* <i>Opuntia sp.</i>	Prickly Pear							1						
Caprifoliaceae	* <i>Lonicera japonica</i>	Japanese Honeysuckle							2						
Caryophyllaceae	* <i>Paronychia brasiliiana</i>	Chilean Whitlow-wort												1	
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-Oak													
	<i>Casuarina glauca</i>	Swamp Oak							2	1					X
Chenopodiaceae	<i>Atriplex semibaccata</i>	Creeping Saltbush													
	<i>Einadia hastata</i>	Berry Saltbush							1						
	<i>Einadia nutans subsp. linifolia</i>	Climbing Saltbush													
Clusiaceae	<i>Hypericum gramineum</i>	Small St Johns-wort	1			1		1				1			
Convolvulaceae	<i>Dichondra repens</i>	Kidney-weed		1					1						
Dilleniaceae	<i>Hibbertia obtusifolia</i>	Guinea-flower										1			

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	<i>Hibbertia riparia</i>	Erect Guinea-flower	5			1						1	1	1	
Ericaceae Styphelioideae	<i>Astroloma humifusum</i>	Cranberry Heath													
	<i>Epacris microphylla</i>	Coral Heath				1						2			
	<i>Leucopogon ericoides</i>	Beard-heath		1								1			
	<i>Lissanthe strigosa</i>	Peach Heath													
	<i>Melichrus procumbens</i>													1	
Euphorbiaceae	* <i>Triadica sebifera</i>	Chinese Tallow Tree													X
Fabaceae Caesalpinioideae	* <i>Senna pendula</i> var. <i>glabrata</i>	Easter Cassia													
Fabaceae Faboideae	<i>Bossiaea heterophylla</i>	Variable Bossiaea			1	2						1	1		
	<i>Bossiaea scolopendria</i>											1			
	<i>Chorizema parviflorum</i>	Eastern Flame Pea													
	<i>Daviesia ulicifolia</i>	Gorse Bitter-pea												1	
	<i>Dillwynia parvifolia</i>														
	* <i>Erythrina x sykesii</i>	Coral Tree													X
	<i>Glycine clandestina</i>	Twining Glycine		1			2						1		
	<i>Glycine tabacina</i>								1						
	<i>Gompholobium glabratum</i>	Dainty Wedge Pea	1			1		1							
	<i>Gompholobium pinnatum</i>	Pinnate Wedge Pea	1												
	<i>Hardenbergia violacea</i>	False Sarsaparilla			1	1	1							1	
	<i>Jacksonia scoparia</i>	Dogwood					2								
	* <i>Lathyrus</i> sp.														
	* <i>Lupinus angustifolius</i>	Narrow-leaved Lupin													
	* <i>Medicago polymorpha</i>	Burr Medic													
	* <i>Melilotus indica</i>	Sweet Melilot													

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	<i>Pultenaea retusa</i>	Notched Bush-pea													
	<i>Pultenaea tuberculata</i>		1			1							1		
	<i>Pultenaea villosa</i>	Hairy Bush-pea													
	* <i>Trifolium arvense</i>	Haresfoot Clover													
	* <i>Trifolium repens</i>	White Clover													
	* <i>Vicia sp.</i>	Vetch													
	* <i>Wisteria sinensis</i>	Chinese Wisteria													
Fabaceae Mimosoideae	<i>Acacia binervia</i>	Coast Myall		10					40	5					X
	<i>Acacia brownii</i>	Golden Prickly Moses	1			2		1							
	<i>Acacia decurrens</i>	Black Wattle						2	1			1		5	
	<i>Acacia falcata</i>	Sickle Wattle			2								2		
	<i>Acacia floribunda</i>	White Sally							1	2		2		1	
	<i>Acacia implexa</i>	Hickory Wattle													
	<i>Acacia longifolia</i>	Sydney Golden Wattle													
	<i>Acacia parramattensis</i>	Parramatta Green Wattle					5							1	X
	# <i>Acacia podalyriifolia</i>	Queensland Wattle			1										
Fagaceae	* <i>Quercus palustris</i>	Pin Oak													X
Goodeniaceae	<i>Dampiera stricta</i>	Blue Dampiera				1									
	<i>Goodenia hederacea</i>	Ivy Goodenia	1			1								1	
	<i>Goodenia paniculata</i>														
Haloragaceae	<i>Gonocarpus tetragynus</i>	Common Raspwort	1									1			
	* <i>Myriophyllum aquaticum</i>	Parrot's Feather													
Hamamelidaceae	* <i>Liquidambar styraciflua</i>	Liquidambar													X
Lamiaceae	<i>Plectranthus parviflorus</i>								1						

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
Lauraceae	<i>Cassytha glabella</i>					1	1					1	1	1	
	<i>Cassytha pubescens</i>	Devil's Twine	1	2	1				2	1			1		
	* <i>Cinnamomum camphora</i>	Camphor-laurel													X
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot		1			1					1	1		
Loganiaceae	<i>Mitrasacme polymorpha</i>	Mitre Weed	1			1									
Loranthaceae	<i>Amyema gaudichaudii</i>	Paperbark Mistletoe													
Malaceae	* <i>Cotoneaster</i> sp.														
	* <i>Sorbus</i> sp. (unidentified)														X
Malvaceae	* <i>Modiola caroliniana</i>	Red-flower Mallow													
	* <i>Sida rhombifolia</i>	Paddy's Lucerne		1	1				1						
Myrtaceae	<i>Acmena smithii</i>	Lilly-pilly													
	# <i>Agonis flexuosa</i>	Willow-myrtle													
	<i>Angophora bakeri</i>	Small-leaved Apple			5	5	2					7	5	15	X
	<i>Angophora costata</i>	Sydney Red Gum													X
	<i>Angophora floribunda</i>	Rough-barked Apple													X
	<i>Angophora subvelutina</i>	Broad-leaved Apple													
	<i>Backhousia myrtifolia</i>	Grey Myrtle, Ironwood													
	<i>Callistemon citrinus</i>	Scarlet Bottlebrush													
	<i>Callistemon linearis</i>	Narrow-leaved Bottlebrush				2		1							
	<i>Callistemon pinifolius</i>	Pine-leaved Bottlebrush	2			2						10	1		
	<i>Callistemon salignus</i>	White Bottlebrush								2					X
	# <i>Corymbia citriodora</i>	Lemon-scented Gum													X
	<i>Corymbia eximia</i>	Yellow Bloodwood													X
	<i>Corymbia maculata</i>	Spotted Gum													X

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	<i>Eucalyptus amplifolia</i>	Cabbage Gum													X
	<i>Eucalyptus baueriana</i>	Blue Box													
	<i>Eucalyptus botryoides</i>	Bangalay													X
	<i>Eucalyptus camaldulensis</i>	River Red Gum													X
	<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark													X
	<i>Eucalyptus eugenoides</i>	Thin-leaved Stringybark													
	<i>Eucalyptus fibrosa</i>	Red Ironbark													X
	<i>Eucalyptus longifolia</i>	Woollybutt													X
	<i>Eucalyptus microcarpa</i>	Western Grey Box													X
	<i>Eucalyptus moluccana</i>	Grey Box													X
	<i>Eucalyptus parramattensis</i>	Parramatta Red Gum	7		5	2	2					5	10	5	X
	<i>Eucalyptus punctata</i>	Grey Gum													X
	<i>Eucalyptus racemosa</i>	Snappy Gum													X
	# <i>Eucalyptus saligna</i>	Sydney Blue Gum													X
	<i>Eucalyptus saligna x botryoides</i>			15			1		10	5					
	<i>Eucalyptus sclerophylla</i>	Scribbly Gum	7		5	10		30					2		X
	<i>Eucalyptus sideroxylon</i>	Mugga, Red Ironbark													X
	<i>Eucalyptus tereticornis</i>	Forest Red Gum													X
	<i>Kunzea ambigua</i>	Tick-bush			5	2		30				15		10	
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree													
	<i>Leptospermum parvifolium</i>	Small-leaved Tea-tree				1									
	# <i>Leptospermum petersonii</i>	Lemon-scented Tea-tree													
	<i>Leptospermum polygalifolium</i>	Tantoon				2	1				1	5		2	
	<i>Leptospermum trinervium</i>	Slender Tea-tree	5			2	2					5			

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	# <i>Lophostemon confertus</i>	Brush Box													X
	<i>Melaleuca armillaris</i>	Bracelet Honey-myrtle													
	<i>Melaleuca decora</i>	White Cloud Tree	4									10	20	1	X
	<i>Melaleuca erubescens</i>		1										1		
	<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark			1		40		1		2	20			
	<i>Melaleuca nodosa</i>	Ball Honey-myrtle	6		2	5		2				20	60	15	
	<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark													
	<i>Melaleuca thymifolia</i>	Thyme Honey-myrtle	1			5						1	1		
	<i>Syncarpia glomulifera</i>	Turpentine													X
Nyctaginaceae	* <i>Bougainvillea</i> cv. (unidentified)	Bougainvillea													X
Ochnaceae	* <i>Ochna serrulata</i>	Mickey Mouse Plant							1	1					
Oleaceae	* <i>Ligustrum lucidum</i>	Broad-leaved Privet							2	10					
	* <i>Ligustrum sinense</i>	Small-Leaved Privet		2					20	20					
	<i>Notelaea longifolia</i>	Mock-olive		1											
	* <i>Olea europaea</i> subsp. <i>cuspidata</i>	African Olive		1					50	10					
Onagraceae	* <i>Ludwigia peruviana</i>	Peruvian Primrose									1				
Oxalidaceae	<i>Oxalis perennans</i>			1					1						
Phyllanthaceae	<i>Breynia oblongifolia</i>	Coffee Bush		1					1						
	* <i>Phyllanthus tenellus</i>														
Picrodendraceae	<i>Micrantheum ericoides</i>						1								
Pittosporaceae	<i>Billardiera scandens</i>	Hairy Apple Berry		1	1							1			
	<i>Bursaria spinosa</i>	Blackthorn		1					1						
	<i>Pittosporum undulatum</i>	Pittosporum													

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
Plantaginaceae	* <i>Plantago lanceolata</i>	Plantain, Ribwort			1				1						
Polygonaceae	* <i>Acetosa sagittata</i>	Rambling Dock													
	<i>Persicaria decipiens</i>	Slender Knotweed									1				
	<i>Persicaria hydropiper</i>	Water Pepper													
	<i>Persicaria praetermissa</i>						1				1				
	* <i>Rumex sp.</i>	Dock													
Proteaceae	<i>Banksia ericifolia</i>	Heath-leaved Banksia											2		
	<i>Banksia oblongifolia</i>	Fern-leaved Banksia				2	2					2			
	<i>Banksia serrata</i>	Saw Banksia													
	<i>Banksia spinulosa</i> var. <i>spinulosa</i>	Hairpin Banksia	8			1									
	+ <i>Grevillea parviflora</i> subsp. <i>parviflora</i>		2										1		
	# <i>Grevillea robusta</i>	Silky Oak													X
	<i>Hakea dactyloides</i>	Finger Hakea	1			2	2								
	<i>Hakea salicifolia</i>	Willow Hakea													
	<i>Hakea sericea</i>	Needlebush	5			10	2					20	5	1	
	<i>Hakea teretifolia</i>	Needlebush													
	<i>Isopogon anemonifolius</i>	Broad-leaf Drumsticks													
	<i>Lambertia formosa</i>	Mountain Devil			2										
	<i>Lomatia silaifolia</i>	Crinkle Bush					1								
	<i>Persoonia lanceolata</i>	Geebung													
	<i>Persoonia laurina</i> subsp. <i>laurina</i>	Laurel Geebung			2										
	<i>Persoonia linearis</i>	Narrow-leaf Geebung			2			1							
	+ <i>Persoonia nutans</i>							1							

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	<i>Petrophile sessilis</i>					10									
Ranunculaceae	<i>Clematis aristata</i>	Traveller's Joy		2			1								
	<i>Clematis glycinoides</i>	Headache Vine							1						
	<i>Ranunculus inundatus</i>	River Buttercup					1								
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash, Soap Tree													
	<i>Pomaderris ferruginea</i>														
Rosaceae	* <i>Rubus anglocandicans</i>	Blackberry			1		1								
	<i>Rubus parvifolius</i>	Native Raspberry													
Rubiaceae	* <i>Galium aparine</i>	Cleavers, Goose-grass													
	<i>Morinda jasminoides</i>	Morinda													
	<i>Opercularia varia</i>	Variable Stinkweed			1			1							
	<i>Pomax umbellata</i>	Pomax						1					1		
	* <i>Richardia humistrata</i>														
Rutaceae	<i>Phebalium squamulosum</i>	Scaly Phebalium													
	<i>Philotheca salsolifolia</i>	Philotheca													
Salicaceae	* <i>Salix alba</i>	White Willow													
Santalaceae	<i>Exocarpos cupressiformis</i>	Cherry Ballart		2	2										
Sapindaceae	* <i>Cardiospermum grandiflorum</i>	Balloon Vine								5					
	<i>Dodonaea triquetra</i>	Hopbush													
Solanaceae	* <i>Lycium ferocissimum</i>	African Boxthorn													
	* <i>Solanum nigrum</i>	Blackberry Nightshade													
Stylidiaceae	<i>Stylidium graminifolium</i>	Grass-leaf Triggerplant	1			1									
Thymelaeaceae	<i>Pimelea linifolia</i>	Slender Rice Flower	1		1	1		1						1	
Ulmaceae	* <i>Ulmus parvifolia</i>	Chinese Elm													

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
Verbenaceae	* <i>Lantana camara</i>	Lantana		2					25	20					
	* <i>Verbena bonariensis</i>	Purpletop			1									1	
	* <i>Verbena rigida</i>	Veined Verbena													
Angiosperms - Monocotyledons															
Agavaceae	* <i>Agave americana</i>	Century Plant													
Alismataceae	<i>Alisma plantago-aquatica</i>	Water-plantain													
Alliaceae	* <i>Agapanthus praecox subsp. orientalis</i>	Agapanthus													
Anthericaceae	<i>Caesia parviflora</i>	Pale Grass Lily					1								
	<i>Laxmannia gracilis</i>	Slender Wire Lily						1					1		
	<i>Tricoryne simplex</i>		1											1	
Arecaceae	* <i>Syagrus romanzoffiana</i>	Cocos Palm, Queen Palm													
Asparagaceae	* <i>Asparagus aethiopicus</i>	Asparagus Fern		1											
	* <i>Asparagus asparagoides</i>	Bridal Creeper		2					1						
	* <i>Asparagus officinalis</i>	Asparagus					1								
Asphodelaceae	* <i>Aloe maculata</i>	Common Soap Aloe													
Colchicaceae	<i>Burchardia umbellata</i>	Milkmaids			1										
Commelinaceae	<i>Commelina cyanea</i>	Blue Spiderwort					2			1					
	* <i>Tradescantia fluminensis</i>	Wandering Jew					2		30	20					
Cyperaceae	<i>Baumea articulata</i>	Jointed Twig-rush													
	<i>Baumea sp.</i>														
	<i>Bolboschoenus fluviatilis</i>	Club-rush									50				
	<i>Carex appressa</i>	Tall Sedge			1		1								
	<i>Carex breviculmis</i>														
	<i>Chorizandra cymbaria</i>	Heron Bristle-rush													

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	<i>Cyathochaeta diandra</i>		5		1	5						2	2	1	
	<i>Cyperus brevifolius</i>														
	* <i>Cyperus eragrostis</i>	Drain Flat-sedge													
	<i>Eleocharis sphacelata</i>	Tall Spike-rush									1				
	<i>Fimbristylis dichotoma</i>				1									1	
	<i>Fimbristylis ferruginea</i>														
	<i>Gahnia clarkei</i>	Tall Saw-sedge		1			5								
	<i>Gahnia sp.</i>														
	<i>Isolepis inundata</i>	Water Club-rush					1				1				
	<i>Lepidosperma laterale</i>	Variable Sword-sedge	2											1	
	<i>Ptilothrix deusta</i>		20										1		
	<i>Schoenus apogon</i>	Fluke Bog-rush													
Haemodoraceae	<i>Haemodorum planifolium</i>	Strap-leaf Bloodroot			1										
Iridaceae	<i>Patersonia sericea</i>	Native Iris	5										1		
Juncaceae	* <i>Juncus cognatus</i>	Argentine Rush			1										
	<i>Juncus continuus</i>	Rush													
	<i>Juncus prismatocarpus</i>	Branching Rush													
	<i>Juncus usitatus</i>	Common Rush													
Lomandraceae	<i>Lomandra cylindrica</i>	Needle Mat-rush													
	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		1	1	2			1					1	
	<i>Lomandra multiflora</i>	Many-flowered Mat-rush												1	
Orchidaceae	<i>Dipodium punctatum</i>	Hyacinth Orchid													
	<i>Eriochilus cucullatus</i>	Parson's Bands													
	<i>Orthoceras strictum</i>	Bird's-mouth Orchid													

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	<i>Pterostylis acuminata</i>	Sharp Greenhood Orchid													
Philydraceae	<i>Philydrum lanuginosum</i>	Woolly Waterlily													
Phormiaceae	<i>Dianella caerulea</i>	Blue Flax-lily	1				1						1	1	
	<i>Dianella revoluta</i>	Blue Flax-lily				1		1						1	
Poaceae	* <i>Andropogon virginicus</i>	Whisky Grass													
	<i>Anisopogon avenaceus</i>	Oat Spear Grass													
	<i>Aristida ramosa</i>	Wiregrass						5					1		
	<i>Aristida vagans</i>	Threeawn Speargrass						2						2	
	<i>Aristida warburgii</i>	Wiregrass											1		
	* <i>Arundo donax</i>	Giant Reed													
	<i>Austrodanthonia fulva</i>	Wallaby Grass						2							
	<i>Austrodanthonia tenuior</i>	Wallaby Grass													
	<i>Austrostipa pubescens</i>	Speargrass	10		2	10									
	<i>Austrostipa ramosissima</i>	Bamboo Speargrass		3					1						
	<i>Austrostipa rudis</i>														
	* <i>Axonopus fissifolius</i>	Narrow-leaved Carpet Grass												5	
	<i>Bothriochloa macra</i>	Redleg Rass													
	* <i>Briza subaristata</i>				1									1	
	* <i>Bromus catharticus</i>	Prairie Grass													
	* <i>Chloris gayana</i>	Rhodes Grass							1					1	
	* <i>Cortaderia selloana</i>	Pampas Grass												1	
	<i>Cynodon dactylon</i>	Couch, Bermuda Grass		1										5	
	* <i>Dactylis glomerata</i>	Cocksfoot													
	<i>Dichelachne micrantha</i>	Shorthair Plumegrass			2										

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	* <i>Digitaria sanguinalis</i>	A Summer Grass													
	<i>Digitaria sp.</i>														
	<i>Echinopogon ovatus</i>	Forest Hedgehog Grass		1	1		5								
	* <i>Ehrharta erecta</i>	Panic Veld-grass		30					10						
	<i>Entolasia marginata</i>	Bordered Panic													
	<i>Entolasia stricta</i>	Wiry Panic	2		2	1		2	2			5	2	2	
	<i>Eragrostis brownii</i>	Brown's Lovegrass													
	* <i>Eragrostis cilianensis</i>	Stinkgrass												1	
	* <i>Eragrostis curvula</i>	African Lovegrass		1	1	1		1						30	
	<i>Eragrostis leptostachya</i>	Paddock Lovegrass			2							1	1		
	<i>Hemarthria uncinata</i>	Mat Grass													
	<i>Imperata cylindrica</i>	Blady Grass			2		10					1			
	* <i>Melinis repens</i>	Red Natal Grass													
	<i>Microlaena stipoides</i>	Weeping Grass	1	20	1		15	5	20	1		2			
	<i>Oplismenus aemulus</i>	Broad-leaved Basket Grass							2						
	<i>Oplismenus imbecillis</i>	Narrow-leaved Basket Grass								1					
	<i>Panicum simile</i>	Two-colour Panic												1	
	<i>Paspalidium distans</i>													1	
	* <i>Paspalum dilatatum</i>	Paspalum			1									2	
	* <i>Paspalum urvillei</i>	Vasey Grass													
	* <i>Pennisetum clandestinum</i>	Kikuyu Grass													
	<i>Phragmites australis</i>	Common Reed													
	* <i>Phyllostachys aurea</i>	Yellow Bamboo													

Family	Scientific name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	SIMTA site
	<i>Poa sp.</i>												1		
	* <i>Setaria parviflora</i>				3		2							2	
	* <i>Sporobolus africanus</i>	Rat-tail Grass													
	<i>Themeda triandra</i>	Kangaroo Grass	10		2	5						1	1	10	
Pontederiaceae	* <i>Eichhornia crassipes</i>	Water Hyacinth													
Restionaceae	<i>Empodisma minus</i>	Tanglefoot												1	
	<i>Leptocarpus tenax</i>						2					30			
	<i>Lepyrodia muelleri</i>	Common Scale-rush													
	<i>Lepyrodia scariosa</i>		2			1						10			
Typhaceae	<i>Typha orientalis</i>	Broad-leaf Cumbungi									2				
Xanthorrhoeaceae	<i>Xanthorrhoea media</i>	Grass Tree	5		1		1					1	1		

APPENDIX E

EPBC ACT PROTECTED MATTERS SEARCH



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 07/11/14 09:07:20

[Summary](#)

[Details](#)

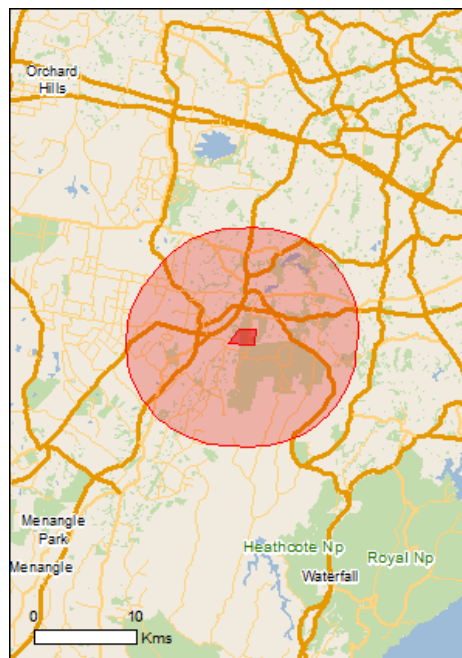
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

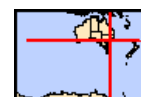
[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	7
Listed Threatened Species:	69
Listed Migratory Species:	34

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As [heritage values](#) of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	19
Commonwealth Heritage Places:	3
Listed Marine Species:	35
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	29
State and Territory Reserves:	3
Regional Forest Agreements:	None
Invasive Species:	54
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Historic		
Vietnam War Comradeship Memorial	NSW	Nominated place

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Coastal Upland Swamps in the Sydney Basin Bioregion	Endangered	Community likely to occur within area
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	Critically Endangered	Community likely to occur within area
Shale/Sandstone Transition Forest	Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Turpentine-Ironbark Forest in the Sydney Basin Bioregion	Critically Endangered	Community likely to occur within area
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Community may occur within area
Western Sydney Dry Rainforest and Moist Woodland on Shale	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora epomophora Southern Royal Albatross [25996]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Status	Type of Presence to occur within area
Diomedea epomophora_sanfordi Northern Royal Albatross [82331]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans_antipodensis Antipodean Albatross [82269]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans_exulans Tristan Albatross [82337]	Endangered	Species or species habitat may occur within area
Diomedea exulans_gibsoni Gibson's Albatross [82271]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis_nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta_cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta_salvini Salvin's Albatross [82343]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta_steady White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris_impavida Campbell Albatross [82449]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Fish		
Epinephelus daemeli		
Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Macquaria australasica		
Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Prototroctes maraena		
Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Frogs		
Heleioporus australiacus		
Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat likely to occur within area
Litoria aurea		
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat likely to occur within area
Litoria littlejohni		
Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat may occur within area
Litoria raniformis		
Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog [1828]	Vulnerable	Species or species habitat may occur within area
Mixophyes balbus		
Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Isoodon obesulus obesulus		
Southern Brown Bandicoot (Eastern) [68050]	Endangered	Species or species habitat may occur within area
Petrogale penicillata		
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Plants		
Acacia pubescens		
Downy Wattle, Hairy Stemmed Wattle [18800]	Vulnerable	Species or species habitat likely to occur within area
Allocastraria glareicola		
[21932]	Endangered	Migration route known to occur within area
Asterolasia elegans		
[56780]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
Caladenia tessellata		within area
Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area
Cryptostylis hunteriana		
Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
Cynanchum elegans		
White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Deyeuxia appressa		
[7438]	Endangered	Species or species habitat likely to occur within area
Eucalyptus camfieldii		
Camfield's Stringybark [15460]	Vulnerable	Species or species habitat likely to occur within area
Genoplesium baueri		
Yellow Gnat-orchid [7528]	Endangered	Species or species habitat known to occur within area
Grevillea parviflora subsp. parviflora		
Small-flower Grevillea [64910]	Vulnerable	Species or species habitat known to occur within area
Hibbertia puberula subsp. glabrescens		
[86645]	Critically Endangered	Species or species habitat likely to occur within area
Leucopogon exolasius		
Woronora Beard-heath [14251]	Vulnerable	Species or species habitat likely to occur within area
Melaleuca biconvexa		
Biconvex Paperbark [5583]	Vulnerable	Species or species habitat may occur within area
Melaleuca deanei		
Deane's Melaleuca [5818]	Vulnerable	Species or species habitat likely to occur within area
Pelargonium sp. Striatellum (G.W.Carr 10345)		
Omeo Stork's-bill [84065]	Endangered	Species or species habitat may occur within area
Persoonia hirsuta		
Hairy Persoonia [19006]	Endangered	Species or species habitat likely to occur within area
Persoonia nutans		
Nodding Geebung [18119]	Endangered	Species or species habitat likely to occur within area
Pimelea curviflora var. curviflora		
[4182]	Vulnerable	Species or species habitat likely to occur within area
Pimelea spicata		
Spiked Rice-flower [20834]	Endangered	Species or species habitat known to occur within area
Pomaderris brunnea		
Rufous Pomaderris [16845]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis gibbosa		
Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Pterostylis saxicola Sydney Plains Greenhood [64537]	Endangered	Species or species habitat known to occur within area
Pultenaea parviflora [19380]	Vulnerable	Species or species habitat likely to occur within area
Streblus pendulinus Siah's Backbone, Sia's Backbone, Isaac Wood [21618]	Endangered	Species or species habitat likely to occur within area
Thelymitra kangaloonica Kangaloon Sun Orchid [81861]	Critically Endangered	Species or species habitat may occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area

Reptiles

Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hoplocephalus bungaroides Broad-headed Snake [1182]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [\[Resource Information \]](#)

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered*	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered*	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross [64459]	Vulnerable*	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species

Name	Threatened	Type of Presence
Hirundapus caudacutus White-throated Needletail [682]		habitat known to occur within area Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [\[Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Nuclear Science & Technology Organisation
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Australian Telecommunications Corporation
Commonwealth Land - Commonwealth Bank of Australia
Commonwealth Land - Commonwealth Trading Bank of Australia
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Director of War Service Homes
Commonwealth Land - Telstra Corporation Limited
Defence - CAMP SAPPER-EAST HILLS (Lot 2) : CAMP SAPPER TRAINING AREA (Lot 1)
Defence - EAST HILLS BARRACKS - OP SAFE HAVEN
Defence - INGLEBURN AREA (Bardia Barracks)
Defence - MOOREBANK AREA INC SME
Defence - Suite 8, Library Plaza
Defence - VILLAWOOD - MOTOR REPAIR W/SHP (VILLAWOOD GEMS BASE)

Name		
Defence - WET BRIDGING SITE - CASULA		
Commonwealth Heritage Places		[Resource Information]
Name	State	Status
Indigenous		
Cubbitch Barta National Estate Area	NSW	Listed place
Historic		
Defence National Storage and Distribution Centre	NSW	Listed place
Old Army / Internment Camp Group Holsworthy	NSW	Listed place
Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat likely to occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena		
Tristan Albatross [66471]	Endangered*	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto)		
Southern Royal Albatross [1072]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato)		
Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni		
Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered*	Foraging, feeding or related behaviour likely to occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus		
White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor		
Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus		
Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli		
Northern Giant-Petrel [1061]	Vulnerable	Species or species

Name	Threatened	Type of Presence
Merops ornatus Rainbow Bee-eater [670]	Critically Endangered	habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]	Endangered*	Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]		Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]		Species or species habitat may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross [64459]	Vulnerable*	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	habitat known to occur within area Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Extra Information

Places on the RNE [\[Resource Information \]](#)

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Georges River Wetlands	NSW	Indicative Place
Voyager Point	NSW	Registered
Indigenous		
Cubbitch Barta National Estate Area	NSW	Registered
Historic		
Bankstown Airport	NSW	Indicative Place
Fairfield Fire Station	NSW	Indicative Place
Liverpool Fire Station	NSW	Indicative Place
The 13th Jyotirlinga (icon)	NSW	Indicative Place
Defence National Storage and Distribution Centre	NSW	Interim List
Bernera including Site and Knoll	NSW	Registered
Collingwood	NSW	Registered
Denham Court and St Marys Anglican Chapel	NSW	Registered
Glenfield Farm	NSW	Registered
Horningsea Park	NSW	Registered
Hoxton Park Airport	NSW	Registered
Ingleburn Army Camp	NSW	Registered
Kitchener House	NSW	Registered
Lansdowne Bridge	NSW	Registered
Liverpool Courthouse (former)	NSW	Registered
Liverpool Dam	NSW	Registered
Liverpool Hospital (former)	NSW	Registered
Macquarie Field Garden	NSW	Registered
Macquarie Field House	NSW	Registered
Old Army / Internment Camp Group Holsworthy	NSW	Registered
Prefabricated Cottages Ingleburn Village	NSW	Registered
Robin Hood Farm	NSW	Registered
St Lukes Anglican Church	NSW	Registered
The Homestead	NSW	Registered
The Homestead	NSW	Registered
Varro Ville	NSW	Registered

State and Territory Reserves [\[Resource Information \]](#)

Name	State
Gandangara	NSW
Georges River	NSW
Leacock	NSW

Invasive Species	[Resource Information]
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Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis		
Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis		
Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris		
European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata		
Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus		
House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus		
Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pycnonotus jocosus		
Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis		
Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris		
Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula		
Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina		
Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus		
Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris		
Domestic Dog [82654]		Species or species habitat likely to occur

Name	Status	Type of Presence
Felis catus Cat, House Cat, Domestic Cat [19]		within area Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur

Name	Status	Type of Presence
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		within area Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur

Name	Status	Type of Presence
Ulex europaeus		within area
Gorse, Furze [7693]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area
Nationally Important Wetlands		[Resource Information]
Name		State
Liverpool Military Training Area		NSW
Voyager Point		NSW

Coordinates

-33.954838 150.91173,-33.954838 150.91173,-33.954624 150.927179,-33.965089 150.925548,
-33.965232 150.920828,-33.965232 150.914476,-33.964449 150.907438,-33.964449
150.902288,-33.954838 150.91173

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [Department of Environment, Climate Change and Water, New South Wales](#)
- [Department of Sustainability and Environment, Victoria](#)
- [Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [Department of Environment and Natural Resources, South Australia](#)
- [Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [Environmental and Resource Management, Queensland](#)
- [Department of Environment and Conservation, Western Australia](#)
- [Department of the Environment, Climate Change, Energy and Water](#)
- [Birds Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Museum Victoria](#)
- [Australian Museum](#)
- [SA Museum](#)
- [Queensland Museum](#)
- [Online Zoological Collections of Australian Museums](#)
- [Queensland Herbarium](#)
- [National Herbarium of NSW](#)
- [Royal Botanic Gardens and National Herbarium of Victoria](#)
- [Tasmanian Herbarium](#)
- [State Herbarium of South Australia](#)
- [Northern Territory Herbarium](#)
- [Western Australian Herbarium](#)
- [Australian National Herbarium, Atherton and Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [State Forests of NSW](#)
- [Geoscience Australia](#)
- [CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

